# Survey of the Spiders of Cotton in New Mexico with Seasonal Evaluations Between Bt and Non-Bt Varieties[1]

C. Scott Bundy,[2] Paul F. Smith, David B. Richman, and Robert L. Steiner[3]

New Mexico State University, Department of Entomology, Plant Pathology, and Weed Science, P.O. Box 30003, Las Cruces, NM 88003 USA

J. Entomol. Sci. 40(4): 355-367 (October 2005)

**Abstract** The relative abundance of spiders was evaluated over two growing seasons among six large fields of cotton representing the major forms of cotton grown in New Mexico (conventional acala, Bt acala, conventional pima, and organic pima). Spiders were collected both from the foliage and from the ground surface. Forty-two genera of spiders in 19 families were identified. The most abundant spiders collected were wolf spiders, sheetweb spiders, crab spiders, ghost spiders, and meshweb weavers. *Pardosa sternalis* (Thorell) was the most common spider collected overall during this study. Seasonal comparisons of spider abundance between conventional and Bt cotton were not significantly different. However, significant month by variety interactions were observed for some species.

**Key Words** Spiders, cotton, Bt, pima, acala, organic, *Pardosa sternalis*

Spiders are an important, yet poorly understood, component of arthropod management in agroecosystems (Mansour et al. 1983, Young and Edwards 1990, Young and Lockley 1985). They are one of the most abundant groups of arthropods associated with cotton (Plagens 1983, Breene et al. 1993, Liu et al. 2003), and over 300 species of spiders may be associated with this crop in the U.S. alone (Whitcomb and Bell 1964, Young and Edwards 1990).

Reports on the impact of spiders on pest populations in cotton are variable. Generally, spiders as a group appear to reduce overall pest populations without acting as key predators (Breene et al. 1993, Nyffeler et al. 1994). However, they have been reported to be the most important predators of the cotton fleahopper, *Pseudatomoscelis seriatus* (Reuter), in East Texas (Breene et al. 1989), where their value at managing this pest has been estimated to be 3× that of predatory insects (Sterling et al. 1992). Examples of cotton pests upon which spiders as a group have had an impact include the cotton bollworm, *Helicoverpa zea* (Boddie), tobacco budworm, *Heliothis virescens* (F.) (Ruberson and Greenstone 1998, Sterling et al. 1989), and Egyptian cotton leafworm, *Spodoptera littoralis* Boisduval (Mansour 1987).

[1]Received 29 March 2005; accepted for publication 13 August 2005.

[2]Address inquiries (email: cbundy@nmsu.edu).

[3]Department of Economics and International Business, PO Box 30001, New Mexico State University, Las Cruces, New Mexico 88003.

Few studies have examined the potential effects of crop variety on spider populations. Spiders have been found to be significantly more abundant on transgenic Bt than conventional cotton (Deng et al. 2003). Others have observed no differences (Sisterson et al. 2004). The overall importance of crop variety on spider abundance is not known.

Species associated with cotton have been extensively surveyed for several states, including Arkansas (Whitcomb and Bell 1964), California (Leigh and Hunter 1969), and Texas (Breene et al. 1993). However, little is known about spider diversity on cotton in New Mexico. This study was initiated to determine the species and abundance of spiders present among the common varieties of cotton grown in New Mexico and to evaluate potential impacts of conventional acala and Bt cotton varieties on the relative abundance of common spiders.

## Materials and Methods

The survey was conducted in 2003 and 2004 in the south central region of New Mexico. Cotton used for this study each season was conventional acala 1517-99 (2 sites), transgenic Bt (2 sites), organic pima S-6 (1 site), and conventional pima S-6 (1 site). The Bt fields were acala 1517-99 for 2003, and Fibermax 989 for 2004. The conventional pima cotton was grown at the Leyendecker Plant Sciences Research Center near Las Cruces; all others were growers' fields within a ≈32 km radius of this site. Each field (0.81-6.1 ha each) was divided into a sampling area of 32 rows (≈102 cm, spacing) by ≈183 m. This portion of the field was flagged, and all samples were obtained within this area. Sampling was initiated both years in midJune (shortly after squaring) and continued weekly until plants were defoliated. No insecticides were applied to plots with the exception of the conventional pima fields. This site was sprayed to control pink bollworm, *Pectinophora gossypiella* (Saunders), as part of a regional eradication project. Lorsban®-4E (chlorpyrifos, Dow Agrosciences, Indianapolis, IN) was applied in 2003 on 3, 12, and 25 June, and 19 August in 2003; Lock-On® (chlorpyrifos, Dow Agrosciences, Indianapolis, IN) was applied on 16 and 30 June, 12 and 22 July, and 2 August in 2004.

**Plant samples.** Spiders on the cotton plants were sampled using the beat bucket method described by Knutson and Wilson (1999). Eighty plants were randomly sampled per field site. Spiders were placed in vials containing 80% EtOH and transported to the laboratory for identification.

**Ground samples.** Spiders frequenting the ground and bases of plants were sampled using pitfall traps. Each trap consisted of two plastic cups (≈946 ml each), one inside the other; the inner cup remained in the ground to prevent trap collapse; the outer cup, resting within the inner cup, maintained its rim flush with the soil surface and was half-filled with a 50% propylene glycol solution. A plastic pie plate (17.5 cm diam), secured by two nails, covered the trap to prevent flooding by rain. Five pitfall traps were placed between plants within rows at each field site in a large "x" pattern. Four of the traps (forming the outer points of the "x") were placed ≈31 m from each edge of the field: two of each were in the same row, 8 rows in from the sampling area margins and ≈122 m from each other. The fifth pitfall trap was located in the center of the field (≈91 m from edge of the sampling area). Samples were removed weekly, and propylene glycol levels were replenished. Specimens were transported to the laboratory, separated using a kitchen strainer (8 cm diam), sorted under a dissecting microscope, and placed in vials containing 80% EtOH to await identification.

**Statistical analyses.** Relative abundance of the most common spider groups was compared between fields of conventional acala and Bt cotton with a repeated measures analysis of variance using the PROC MIXED procedure of SAS (SAS 2003), allowing for different variances at each month; data were analyzed separately by year. Treatment (cotton variety) by time (month) interaction was first tested, and if this factor was significant, a test for differences in variety was performed separately at each month using the LSMEANS statement in PROC MIXED. If the treatment by time interaction was not significant, then variety and month differences were tested. Level of significance was set at 0.05. We were unable to compare spider abundance for conventional and organic pima varieties as these were not replicated within a season.

## Results

**Spider survey.** A total of 4,475 spiders was collected in 2003. At least 45 species of spiders in 41 genera representing 19 families were present (Tables 1, 2). Spider abundance was lower in 2004 than in 2003 at a total of 1490 spiders collected. At least 34 species of spiders in 28 genera representing 15 families were present (Tables 3, 4). The most common spider collected overall was the wolf spider, *Pardosa sternalis* (Thorell), at 44% and 36% of the total spiders collected in 2003 and 2004, respectively.

The most common spiders collected from cotton plants in 2003 included crab spiders (Thomisidae), meshweb weavers (Dictynidae), and ghost spiders (Anyphaenidae) (Table 1). Crab spiders composed 31% of the total collected from cotton plants and were primarily from the genus *Misumenops*. Meshweb spiders, *Dictyna* sp., were the second most common group collected at 16% of the total, followed closely by the ghost spiders at 15%. The most common spiders collected from cotton plants in 2004 were ghost spiders, crab spiders, and long-jawed orb weavers (Tetragnathidae) (Table 3). Ghost spiders, primarily *Hibana incursa* (Chamberlin), made up 34% of the total collected from cotton plants. Crab spiders in the genus *Misumenops* were the second most common group at 20%. The tetragnathids, represented primarily by *Tetragnatha laboriosa* Hentz, composed 12% of spiders on cotton plants.

Ground-dwelling spiders were 71% and 60% of the total spiders collected in 2003 and 2004, respectively. The overwhelming majority of these (86% in 2003 and 71% in 2004) were wolf spiders (Lycosidae). Approximately 60% of the total spiders collected from pitfalls each season were *P. sternalis*. The second most common group each season was the sheetweb spiders (Linyphiidae). This family was represented primarily by the genera *Eperigone* and *Grammonota* at approximately 10% in 2003 (Table 2) and by the genus *Grammonota* at approximately 23% in 2004 (Table 4).

**Varietal comparisons.** Season-long abundance of common spiders as measured in percentages of the total population was not significantly different between Bt and conventional acala cotton for either year. However, there were significant variety by date interactions each season. In 2003, these interactions were significant for *P.*

**Table 1. Spiders of New Mexico cotton fields collected by beat bucket from plant foliage, 2003**

| | | Field* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Family | Species | CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
| Anyphaenidae | *Anyphaena* sp. | 9 | 2 | 2 | 2 | 1 | 0 | 16 |
| | *Hibana incursa* | 29 | 43 | 49 | 34 | 24 | 14 | 193 |
| Araneidae | *Larinia* sp. | 1 | 1 | 0 | 0 | 0 | 2 | 4 |
| | *Metapeira arizonica* | 13 | 8 | 6 | 9 | 3 | 6 | 45 |
| | *Neoscona* sp. | 2 | 5 | 0 | 0 | 0 | 2 | 9 |
| | unknown araneid | 1 | 8 | 2 | 0 | 2 | 0 | 13 |
| Clubionidae | *Clubiona* sp. | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Corinnidae | *Trachelas* sp. | 0 | 0 | 1 | 3 | 0 | 7 | 11 |
| Dictynidae | *Dictyna reticulata* | 10 | 20 | 9 | 5 | 8 | 32 | 84 |
| | *Dictyna* sp. | 15 | 16 | 15 | 13 | 12 | 49 | 120 |
| Gnaphosidae | *Zelotes* sp. | 0 | 0 | 0 | 1 | 0 | 2 | 3 |
| | unknown immatures | 0 | 1 | 0 | 2 | 0 | 3 | 6 |
| Linyphiidae | *Eperigone* sp. | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | *Erigone* sp. | 0 | 1 | 2 | 0 | 0 | 1 | 4 |
| | *Grammonota* sp. | 2 | 0 | 3 | 4 | 0 | 4 | 13 |
| | unknown erigonine | 1 | 0 | 2 | 0 | 1 | 1 | 5 |
| | unknown linyphiine | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Lycosidae | unknown immature | 4 | 1 | 1 | 2 | 1 | 1 | 10 |
| Mimetidae | *Mimetus* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Miturgidae | *Cheiracanthium inclusum* | 1 | 7 | 3 | 18 | 5 | 25 | 59 |
| Oxyopidae | *Hamataliwa grisea* | 2 | 0 | 0 | 1 | 1 | 0 | 4 |
| | *Oxyopes salticus* | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| Philodromidae | *Ebo* sp. | 3 | 3 | 0 | 2 | 1 | 0 | 9 |
| | *Philodromus* sp. | 0 | 0 | 0 | 0 | 1 | 0 | 1 |

**Table 1. Continued.**

| Family | Species | Field* CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
|---|---|---|---|---|---|---|---|---|
| Salticidae | *Habronattus klauseri* | 1 | 1 | 0 | 1 | 0 | 0 | 3 |
| | *Metaphidippus chera* | 27 | 19 | 35 | 33 | 18 | 3 | 135 |
| | *Pelegrina* sp. | 0 | 0 | 1 | 0 | 1 | 0 | 2 |
| Salticidae | *Phidippus apacheanus* | 1 | 0 | 0 | 0 | 1 | 0 | 2 |
| | *Phidippus audax* | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | *Phidippus* sp. | 1 | 4 | 1 | 1 | 0 | 0 | 7 |
| | *Sassacus vittis* | 1 | 2 | 1 | 0 | 0 | 4 | 8 |
| Tetragnathidae | *Tetragnatha laboriosa* | 3 | 9 | 4 | 6 | 17 | 18 | 57 |
| Theridiidae | *Achaearanea canionis* | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| | *Latrodectus hesperus* | 3 | 0 | 0 | 0 | 0 | 0 | 3 |
| | *Theridion* sp. | 14 | 14 | 16 | 12 | 7 | 0 | 63 |
| | unknown therediid | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Thomisidae | *Misumenops coloradensis* | 30 | 63 | 20 | 15 | 27 | 44 | 199 |
| | *Misumenops* sp. | 34 | 36 | 26 | 37 | 22 | 40 | 195 |
| | *Xysticus* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | unknown thomisid | 0 | 0 | 2 | 0 | 0 | 1 | 3 |

* Cotton examined included conventional acala (CON1, CON2), transgenic Bt acala (BT1, BT2), conventional Pima (P1), and organic Pima (OP1).

*sternalis* (Fig. 1) ($F$ = 6.02, df = 4, $P$ = 0.0155) and *Eperigone* ($F$ = 86.07, df = 4, $P$ = 0.0001). Average percentages of *P. sternalis* were significantly greater in August for Bt than for conventional cotton ($F$ = 19.76, df = 1, $P$ = 0.0022). Percentages of *Eperigone* were significantly greater in July, August, and September for conventional than for Bt cotton (Fig. 2) ($F$ = 12.43, df = 1, $P$ = 0.0078; $F$ = 24.40, df = 1, $P$ = 0.0011; $F$ = 7.48, df = 1, $P$ = 0.0257; respectively). In 2004, these interactions were significant for *Misumenops* ($F$ = 10.22, df = 3, $P$ = 0.0090). Average percentages of *Misumenops* were significantly greater in September for Bt than for conventional cotton (Fig. 3) ($F$ = 24.17, df = 1, $P$ = 0.0027).

**Table 2. Ground-dwelling spiders of New Mexico collected from cotton fields by pitfall trap, 2003**

| | | Field* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Family | Species | CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
| Anyphaenidae | *Hibana incursa* | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Araneidae | *Larinia* sp. | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| | *Metapeira* sp. | 0 | 0 | 1 | 1 | 0 | 0 | 2 |
| | *Neoscona* sp. | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| Corinnidae | *Trachelas* sp. | 1 | 0 | 0 | 0 | 0 | 3 | 4 |
| | *Castianera* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Dictynidae | *Dictyna* sp. | 1 | 0 | 0 | 1 | 0 | 1 | 3 |
| Gnaphosida | *Herpyllus* sp. | 4 | 0 | 0 | 2 | 2 | 0 | 8 |
| | *Micaria emertoni* | 5 | 4 | 0 | 0 | 4 | 5 | 18 |
| | *Trachyzelotes jaxartensis* | 0 | 0 | 0 | 0 | 2 | 0 | 2 |
| | *Urozelotes rusticus* | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | *Zelotes* sp. | 0 | 0 | 0 | 2 | 0 | 0 | 2 |
| | unknown gnaphosid | 1 | 0 | 2 | 2 | 0 | 1 | 6 |
| Linyphiidae | *Eperigone* sp. | 28 | 24 | 25 | 10 | 6 | 11 | 104 |
| | *Erigone* sp. | 18 | 3 | 13 | 5 | 5 | 5 | 49 |
| | *Grammonota* sp. | 8 | 6 | 15 | 17 | 8 | 25 | 79 |
| | *Tennesseelum formica* | 15 | 1 | 6 | 2 | 0 | 9 | 33 |
| | unknown erigonine | 7 | 1 | 3 | 4 | 8 | 14 | 37 |
| | unknown linyphiine | 3 | 3 | 4 | 1 | 1 | 1 | 13 |
| Lycosidae | *Hogna* sp. | 20 | 14 | 22 | 15 | 19 | 22 | 112 |
| | *Pardosa sternalis* | 155 | 53 | 1212 | 362 | 65 | 112 | 1959 |
| | unknown lycosid | 47 | 13 | 176 | 159 | 82 | 185 | 662 |
| Mimetidae | *Mimetus* sp. | 0 | 0 | 0 | 1 | 0 | 2 | 3 |
| Miturgidae | *Cheiracanthium inclusum* | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Nesticidae | *Eidmannella pallida* | 0 | 5 | 0 | 16 | 0 | 0 | 21 |

**Table 2. Continued.**

| Family | Species | Field* CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
|---|---|---|---|---|---|---|---|---|
| Oecobiidae | *Oecobius* sp. | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Oxyopidae | *Oxyopes salticus* | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Pholcidae | *Psilochorus imatatus* | 4 | 4 | 2 | 2 | 1 | 0 | 13 |
| Salticidae | *Habronattus klauseri* | 10 | 5 | 2 | 5 | 1 | 2 | 25 |
| Tetragnathidae | *Tetragnatha laboriosa* | 0 | 0 | 1 | 1 | 0 | 6 | 8 |
| Theridiidae | *Latrodectus hesperus* | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | *Theridion* sp. | 1 | 1 | 0 | 1 | 2 | 0 | 5 |

* Cotton examined included conventional acala (CON1, CON2), transgenic Bt acala (BT1, BT2), conventional Pima (P1), and organic Pima (OP1).

## Discussion

Although many families of spiders were collected, a few appeared to dominate the system: wolf spiders, sheetweb spiders, crab spiders, ghost spiders, and meshweb weavers. Both wolf and ghost spiders are wandering spiders that actively hunt their prey; the former are typically active on the ground, although at least one species is often found on cotton plants at night (Breene et al. 1993), whereas the latter usually are active on foliage. The crab spiders are ambush predators most commonly found waiting for prey in flowers (Wise 1993). As indicated by their common names the sheetweb and meshweb spiders are web builders that feed on trapped prey. The common sheetweb spiders collected in this study all build their webs on or near ground level (Young and Edwards 1990). The meshweb weavers build their webs on the cotton plant (Breene et al. 1993). The long-jawed orb weaver, *T. laboriosa*, which was among the more common spiders found on plants during 2004, builds horizontal webs between rows in the cotton canopy and primarily captures insects flying upward (Richman et al. 1990, CSB, personal observations). All genera above have been reported to be predators of important pests of cotton (Breene et al. 1993).

Spider diversity in agroecosystems appears to be variable for different regions of the U. S. (Richman et al. 1990). In the western U.S., there is a tendency for domination by a few spider species in agricultural systems. This is exemplified in New Mexico by the results of the current work for cotton and by previous research for alfalfa (Richman et al. 1990), the work of Leigh and Hunter (1969) in California cotton and Yeargan and Dondale (1974) in California alfalfa. In these cases, lycosids, especially those in the *P. sternalis* group, were the most abundant spiders in the system, usually making up ≈40% or more of the total sampled population.

In the eastern half of the country, greater species diversity with less dominance by

**Table 3. Spiders of New Mexico cotton fields collected by beat bucket from plant foliage, 2004**

| | | Field* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Family | Species | CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
| Anyphaenidae | *Anyphaena* sp. | 2 | 35 | 2 | 1 | 2 | 0 | 42 |
| | *Hibana incursa* | 11 | 118 | 9 | 5 | 6 | 8 | 157 |
| Araneidae | *Larinia* sp. | 0 | 0 | 2 | 0 | 0 | 1 | 3 |
| | *Metapeira arizonica* | 1 | 0 | 3 | 1 | 0 | 1 | 6 |
| | unknown araneid | 0 | 2 | 0 | 2 | 1 | 0 | 5 |
| Corinnidae | *Trachelas* sp. | 1 | 0 | 0 | 0 | 0 | 4 | 5 |
| | unknown corinnid | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| Dictynidae | *Dictyna reticulata* | 5 | 0 | 2 | 6 | 0 | 3 | 16 |
| | *Dictyna* sp. | 10 | 2 | 7 | 8 | 2 | 5 | 34 |
| Gnaphosidae | *Micaria* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | *Zelotes* sp. | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| | unknown gnaphosid | 0 | 1 | 0 | 2 | 0 | 3 | 6 |
| Linyphiidae | *Eperigone* sp. | 3 | 0 | 1 | 0 | 0 | 0 | 4 |
| | *Erigone* sp. | 2 | 1 | 1 | 1 | 0 | 0 | 5 |
| | *Grammonota* sp. | 2 | 8 | 0 | 0 | 0 | 4 | 14 |
| Lycosidae | *Hogna* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| | *Pardosa sternalis* | 1 | 5 | 12 | 0 | 0 | 1 | 19 |
| Miturgidae | *Cheiracanthium inclusum* | 4 | 5 | 3 | 3 | 1 | 4 | 20 |
| Philodromidae | *Ebo* sp. | 2 | 3 | 3 | 1 | 2 | 1 | 12 |
| Salticidae | *Habronattus klauseri* | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | *Habronattus* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | *Metaphidippus chera* | 6 | 6 | 6 | 6 | 4 | 1 | 29 |
| | *Metaphidippus* sp. | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | *Sassacus vittis* | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Tetragnathidae | *Tetragnatha laboriosa* | 12 | 8 | 20 | 9 | 3 | 10 | 62 |
| | *Tetragnatha* sp. | 4 | 0 | 1 | 2 | 0 | 0 | 7 |

**Table 3. Continued.**

| Family | Species | Field* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
| Theridiidae | *Theridion* sp. | 4 | 4 | 4 | 1 | 0 | 0 | 13 |
| Thomisidae | *Misumenops coloradensis* | 14 | 14 | 27 | 18 | 11 | 25 | 109 |
| | *Misumenops* sp. | 5 | 0 | 2 | 4 | 0 | 1 | 12 |

* Cotton examined included conventional acala (CON1, CON2), transgenic Bt acala (BT1, BT2), conventional Pima (P1), and organic Pima (OP1).

a few species is common (Whitcomb et al. 1963, Whitcomb and Bell 1964), possibly as a result of a larger meadow and "prairie"-adapted fauna. A cotton or alfalfa field may mimic these habitats in structure, if not in diversity of plant species present, as pecan groves probably mimic Rio Grande river bosque forests (Richman 2003).

In general, cotton variety should not have a strong impact on spider populations relative to most insect predators. Spider numbers may be influenced by differences in populations of prey items associated with certain varieties, e.g., lepidopteran populations on Bt versus conventional cotton; however, the effects likely will be less than

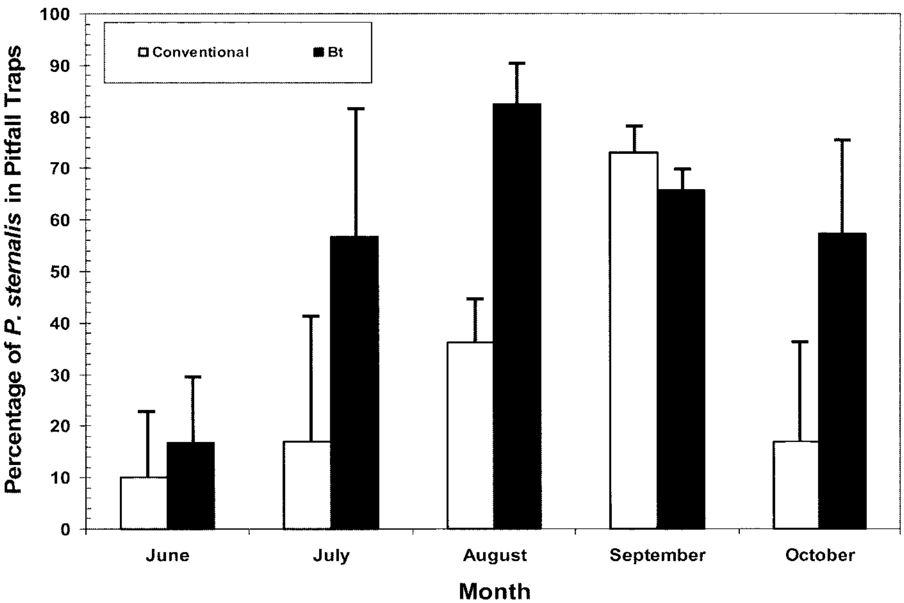


Fig. 1. Mean (+SE) percentages of *Pardosa sternalis* collected from conventional and Bt cotton fields by month in relationship to the total of all spiders collected from pitfall traps, 2003.

**Table 4. Ground-dwelling spiders of New Mexico collected from cotton fields by pitfall trap, 2004**

| | | Field* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Family | Species | CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
| Anyphaenidae | *Hibana incursa* | 0 | 0 | 1 | 1 | 0 | 1 | 3 |
| | *Anyphaena* sp. | 0 | 1 | 0 | 0 | 0 | 1 | 2 |
| Araneidae | *Metapeira* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | *Neoscona* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Corinnidae | *Trachelas* sp. | 1 | 1 | 2 | 0 | 0 | 0 | 4 |
| | unknown corinnid | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| Dictynidae | *Dictyna* sp. | 0 | 0 | 0 | 0 | 0 | 3 | 3 |
| Gnaphosida | *Drassylus* | 0 | 0 | 0 | 1 | 0 | 0 | 1 |
| | *Micaria emertoni* | 2 | 0 | 0 | 1 | 0 | 0 | 3 |
| | *Micaria* sp. | 0 | 0 | 0 | 0 | 0 | 5 | 5 |
| | *Trachyzelotes jaxartensis* | 0 | 0 | 1 | 0 | 0 | 0 | 1 |
| | *Zelotes* sp. | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| | unknown gnaphosid | 0 | 1 | 0 | 1 | 0 | 0 | 2 |
| Linyphiidae | *Eperigone* sp. | 2 | 2 | 1 | 4 | 0 | 2 | 11 |
| | *Erigone* sp. | 3 | 1 | 7 | 9 | 0 | 11 | 31 |
| | *Grammonota* sp. | 22 | 17 | 17 | 63 | 17 | 17 | 153 |
| | *Tennesseelum formicum* | 2 | 0 | 0 | 0 | 1 | 2 | 5 |
| | unknown erigonine | 0 | 0 | 0 | 2 | 0 | 1 | 3 |
| | unknown linyphiine | 0 | 0 | 1 | 0 | 0 | 3 | 4 |
| Lycosidae | *Hogna* sp. | 32 | 10 | 15 | 9 | 7 | 23 | 96 |
| | *Pardosa sternalis* | 55 | 27 | 135 | 163 | 96 | 69 | 545 |
| Nesticidae | *Eidmannella pallida* | 3 | 0 | 0 | 1 | 0 | 0 | 4 |
| Philodromidae | *Ebo* sp. | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| Pholcidae | *Psilochorus imatatus* | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| Salticidae | *Habronattus klauseri* | 2 | 3 | 1 | 5 | 0 | 1 | 12 |

**Table 4. Continued.**

| Family | Species | Field* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | CON1 | CON2 | BT1 | BT2 | P1 | OP1 | Total |
| Tetragnathidae | *Tetragnatha laboriosa* | 0 | 2 | 0 | 0 | 0 | 0 | 2 |
| Theridiidae | *Theridion* sp. | 3 | 0 | 0 | 0 | 0 | 1 | 4 |

* Cotton examined included conventional acala (CON1, CON2), transgenic Bt acala (BT1, BT2), conventional Pima (P1), and organic Pima (OP1).

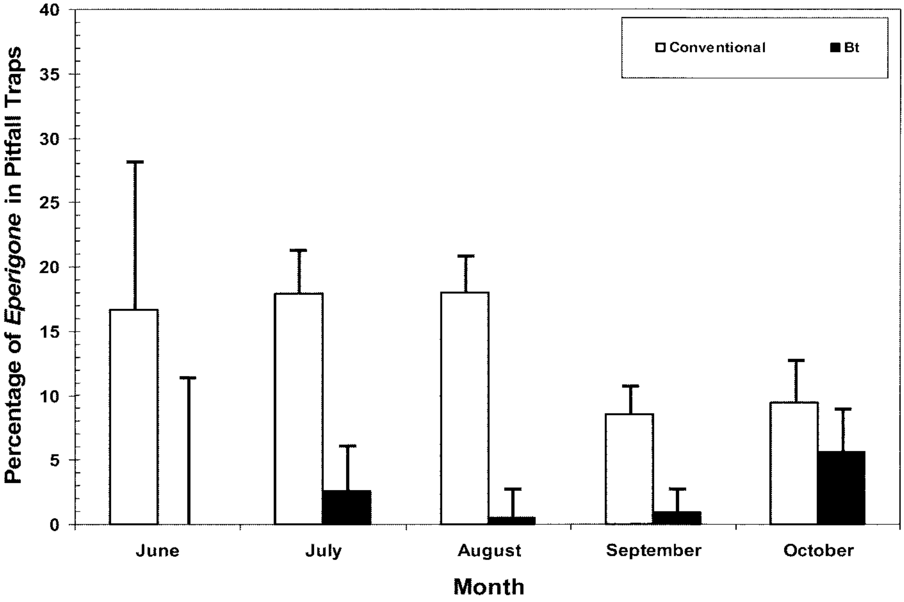


Fig. 2. Mean (+SE) percentages of *Eperigone* sp. collected from conventional and Bt cotton fields by month in relationship to the total of all spiders collected from pitfall traps, 2003.

that of most other generalist predators because spiders may survive extended periods of time without food (Wise 1993).

A more important factor affecting spider populations is movement from surrounding vegetation. *Pardosa* and *Eperigone*, both of which showed significant variety by month interactions, are capable of rapid dispersal. The large numbers of wolf spiders observed in one Bt field during the first year of this study were probably the result of immigration from a neighboring alfalfa field where this species is highly abundant (Richman et al. 1990). *Eperigone*, a member of the Subfamily Erigoninae, is known to commonly balloon as an adult (Richman et al. 1990) and is capable of quick movement into new areas.

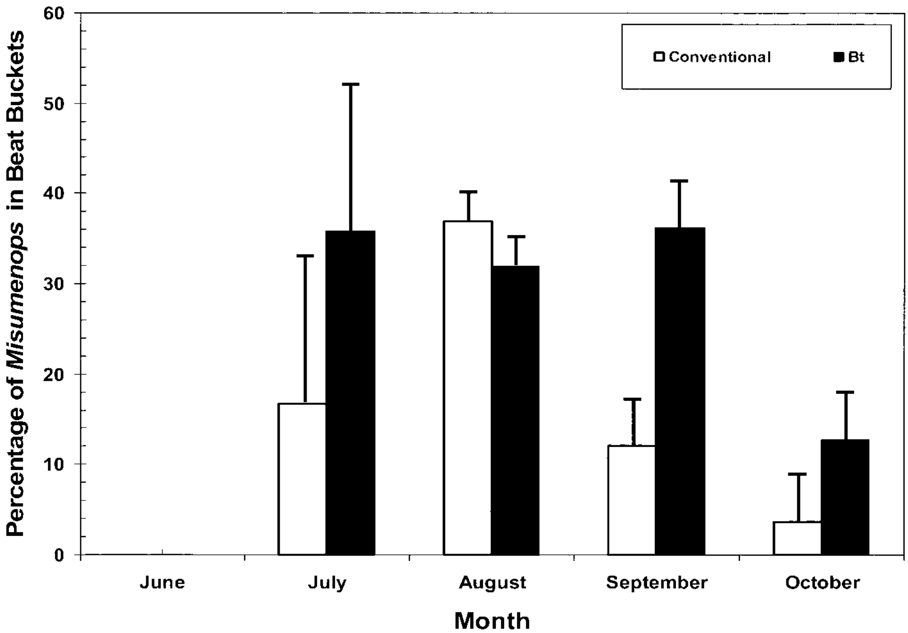


Fig. 3. Mean (+SE) percentages of *Misumenops* spp. collected from conventional and Bt cotton fields by month in relationship to the total of all spiders collected by beat bucket from plant foliage, 2004.

The biology and feeding behavior of the "dominant" spiders observed during this study needs to be examined more closely to determine any potential benefits to cotton IPM. Of particular interest is *P. sternalis*. If found to be an effective biocontrol agent, its close association with alfalfa possibly could be used to direct movement to cotton during periods of pest outbreak with carefully-timed cuttings of hay.

## Acknowledgments

The authors thank Sean O'Donnell, Stephanie Redman, Jason French, and Derek Romig for assistance in the field, and growers Dose Alvarez and Charles Tharp for use of their fields. The research was funded in part by the New Mexico Agricultural Experiment Station, Las Cruces (Project No. NM-1527477).

## References Cited

**Breene, R. G., D. A. Dean, M. Nyffeler and G. B. Edwards. 1993.** Biology, predation ecology, and significance of spiders in Texas cotton exosystems with a key to the species. Bull. Texas A&M Exp. Stn. 1711: 115 p.

**Breene, R. G., W. L. Sterling and D. A. Dean. 1989.** Predators of the cotton fleahopper on cotton. Southwest. Entomol. 14: 159-166.

**Deng, S., J. Xu, Q. Zhang, S. Zhou and G. Xu. 2003.** Effect of transgenic *Bt* cotton on population dynamics of the non-target pests and natural enemies of pests. Acta Entomologia Sinica 46: 1-5.

**Knutson, A. E. and W. T. Wilson. 1999.** The beat bucket: a rapid, reliable method for sampling predatory insects and spiders in cotton, pp. 1120-1125. *In* P. Dugger and D. Richter (eds.), Proc. 1999 Beltwide Cotton Conferences, Memphis. 1488 pp.

**Leigh, T. F. and R. E. Hunter. 1969.** Predacious spiders in California cotton. California Agric., 1969. pp. 4-5.

**Liu, W., M. Hou, F. Wan and F. Wang. 2003.** Temporal and spatial niche dynamics of spiders and their control effects on cotton bollworms in transgenic Bt cotton fields. Entomol. Knowledge 40: 160-163.

**Mansour, F., D. B. Richman and W. H. Whitcomb. 1983.** Spider management in agroecosystems: habitat manipulation. Environ. Manage. 7: 43-49.

**Mansour, F. 1987.** Spiders in sprayed and unsprayed cotton fields in Israel, their interactions with cotton pests and their importance as predators of the Egyptian cotton leafworm, *Spodoptera littoralis*. Phytoparasitica 15: 31-41.

**Nyffeler, M., W. L. Sterling and D. A. Dean. 1994.** Insectivorous activities of spiders in United States field crops. J. Appl. Entomol. 118: 113-128.

**Plagens, M. J. 1983.** Populations of *Misumenops* (Araneida: Thomisidae) in two Arizona cotton fields. Environ. Entomol. 12: 572-575.

**Richman, D. B. 2003.** Spiders (Araneae) of pecan orchards in the southwestern United States and their role in pest suppression. Southwest. Entomol. Suppl. No. 27: 115-122.

**Richman, D. B., J. J. Ellington, K. R. Kiser and G. F. Faubion. 1990.** A comparison of New Mexico alfalfa spider fauna with Eastern and California Faunas. Southwest. Entomol. 15: 387-397.

**Ruberson, J. R. and M. H. Greenstone. 1998.** Predators of budworm/bollworm eggs in cotton: an immunological study, pp. 1095-1098. *In* P. Dugger and D. Richter (eds.), Proc. 1998 Beltwide Cotton Conferences, Memphis. 1743 pp.

**SAS Institute. 2003.** SAS for windows, version 9.1. SAS Institute. Cary, NC.

**Sisterson, M. S., R. W. Biggs, C. Olson, Y. Carrière, T. J. Dennehy and B. E. Tabashnik. 2004.** Arthropod abundance and diversity in Bt and non-Bt cotton fields. J. Environ. Entomol. 33: 921-929.

**Sterling, W. L., A. Dean and N. M. A. El-Salam. 1992.** Economic benefit of spider (Araneae) and insect (Hemiptera: Miridae) predators of cotton fleahoppers. J. Econ. Entomol. 85: 52-57.

**Sterling, W. L., L. M. El-Zik and L. T. Wilson. 1989.** Biological control of pest populations, pp. 155-189. *In* R. E. Frisbie, K. El-Zik, and L. T. Wilson (eds.), Integrated pest management systems and cotton production. J. Wiley, NY. 437 pp.

**Whitcomb, W. H. and K. Bell. 1964.** Predaceous insects, spiders, and mites of Arkansas cotton fields. Univ. Ark. Agric. Exp. Stn. Bull. 690: 1-84.

**Whitcomb, W. H., H. Exline and R. C. Hunter. 1963.** Spiders of the Arkansas cotton field. Ann. Entomol. Soc. Am. 50: 653-660.

**Wise, D. H. 1993.** Spiders in ecological webs. Cambridge Univ. Press, New York. 328 pp.

**Yeargan, K. V. and C. D. Dondale. 1974.** The spider fauna of alfalfa fields in northern California. Ann. Entomol. Soc. Am. 67: 681-682.

**Young, O. P. and G. B. Edwards. 1990.** Spiders in the United States field crops and their potential effect on crop pests. J. Arachnology 18: 1-27.

**Young, O. P. and T. C. Lockley. 1985.** The striped lynx spider, *Oxyopes salticus*, in agroecosystems. Entomophaga 30: 329-346.