# Stink Bugs (Heteroptera: Pentatomidae), a Leaffooted Bug (Hemiptera: Coreidae), and their Predators in Sorghum in Georgia[1]

P. Glynn Tillman[2]

USDA-ARS, Crop Protection and Management Research Laboratory, PO Box 748, Tifton, Georgia 31793 USA

J. Entomol. Sci. 48(1): 9-16 (January 2013)

**Abstract** The objective of this 4-yr study was to determine species composition and abundance of stink bugs (Heteroptera: Pentatomidae) and a leaffooted bug (Hemiptera: Coreidae) and their predators in sorghum [*Sorghum bicolor* (L.) Moench spp. *bicolor*] in Georgia. *Nezara viridula* (L.) was the predominant species in sorghum; density of this stink bug was twice as high as that of the second most abundant stink bug, *Oebalus pugnax pugnax* (F.). *Euschistus servus* (Say) was the third most abundant stink bug species. Density of both *Leptoglossus phyllopus* (L.) and *Euschistus quadrator* (Rolston) was about half that of *E. servus*. *Chinavia hilaris* (Say), *Thyanta custator custator* (F.), *Euschistus tristigmus* (Say), *Euschistus ictericus* (L.), and *Piezodorus guildinii* (Westwood) were minor pests in sorghum. Adult bugs primarily fed on developing seed. For all bug species, except *E. tristigmus* and *E. ictericus*, sorghum served as a reproductive host plant. In order of descending overall abundance, bug predators present in sorghum were *Orius insidiosus* (Say), *Geocoris* spp. [*Geocoris punctipes* (Say) and *G. uliginosus* (Say)], lady beetle species, i.e., *Hippodamia convergens* Guerin-Meneville, *Coccinella septempunctata* (L.), *Coleomegilla maculata* (De Geer), and *Harmonia axyridis* (Pallas), spiders, i.e., *Peucetia viridans* (Hentz), *Oxyopes salticus* Hentz, and spiders in the Salticidae and Thomisidae families, *Solenopsis invicta* Buren, *Podisus maculiventris* (Say), *Sinea diadema* (F.), and *Nabis* spp. Conserving these natural enemies of panicle-feeding bugs in sorghum could possibly be used in management of these bugs in southeastern farmscapes.

**Key Words** sorghum, stink bugs, natural enemies

In the southeastern US, the population dynamics of stink bugs (Heteroptera: Pentatomidae) have changed over the past several years; a clear indication of this phenomenon is the emergence of stink bugs as major pests of cotton, *Gossypium hirsutum* L. (Greene and Turnipseed 1996). Grain sorghum [*Sorghum bicolor* (L.) Moench spp. *bicolor*] has been reported to be an important host plant for stink bugs, including the southern green stink bug, *Nezara viridula* (L.), the brown stink bug, *Euschistus servus* (Say), and the rice stink bug, *Oebalus pugnax pugnax* (F.), and the leaffooted bug, *Leptoglossus phyllopus* (L.) (Hemiptera: Coreidae), in Georgia (Wiseman and McMillian 1971, McMillian and Wiseman 1972). Because stink bug distribution and abundance are closely linked to crop phenology and seasonal succession of host plants (Velasco and Walter 1992), changes in stink bug populations likely have occurred in other crops, including grain sorghum, in southeastern farmscapes.

[1]Received 14 February 2012; accepted for publication 29 April 2012.
[2]Email: Glynn.Tillman@ars.usda.gov.

Consequently, the objective of this 4-yr study was to determine species composition and abundance of stink bugs and a leaffooted bug and their predators in sorghum in Georgia.

## Materials and Methods

**Sorghum.** A 4-row strip (3.7-m-wide) of sorghum was established along the length (ranging from 230 - 480 m) of an edge of commercial cotton fields in Irwin Co., GA. DeKalb E57, a semiopen panicle variety of sorghum, was planted at a rate of 25,500 seeds/ha. Sorghum was planted in 5 fields on 5 May 2004, 3 fields on 19 May 2005, 3 fields on 14 April 2006, and one field on 10 May 2007. Sorghum panicle development was based on descriptions in the University of Arkansas production manual for sorghum (University of Arkansas 2006); after heading and flowering, sorghum seed development begins and progresses through the developmental stages of milk, soft dough, hard dough, and physiological maturity.

**Insect sampling.** Sorghum was examined for stink bugs, the leaffooted bug, and their natural enemies on a weekly basis. For each sorghum sample, the aerial parts of all plants within a 1.83-m length of row were visually checked thoroughly for these insects. Stink bug species, developmental stage (*N. viridula*, *O. p. pugnax*, and *E. servus*), and sex [*N. viridula*, *E. servus*, *Euschistus quadrator* (Rolston), and *Chinavia hilaris* (Say) adults] were identified and recorded. In 2004, 5 random samples were taken from rows 1 and 2, and 4 random samples were taken from rows 3 and 4. For the remaining years, 9 random samples were obtained from each of the 4 rows. Voucher specimens are stored in the USDA-ARS, Crop Protection & Management Research Laboratory in Tifton, GA.

**Statistical Analysis.** Stink bug, leaffooted bug, and predator density data were analyzed using PROC MIXED (SAS Institute 2008). The fixed effect was species, and random effects were field within year and residual error. Least squares means were separated by least significant difference (LSD) (SAS Institute 2008) where appropriate. Density of bugs and their natural enemies were graphed over sorghum panicle development because stink bugs prefer to feed on plant "fruits/seeds" (Patel et al. 2006, Mizell et al. 2008). Means were obtained for number of *N. viridula*, *O. p. pugnax*, and *E. servus* nymphs and adults and *Orius insidiosus* (Say), *Geocoris* spp., spiders, lady beetles, and *Solenopsis invicta* Buren per sample over sorghum panicle development using PROC MEANS (SAS Institute 2008).

## Results and Discussion

**Panicle-feeding bug species.** Nine species of phytophagous stink bugs and one leaffooted bug species were present in sorghum over the study (Table 1). Generally, bug adults were found in sorghum panicles primarily feeding on developing seed and sometimes on stems, branches, and glumes of sorghum panicles, as observed by Hall and Teetes (1982), but they also could be detected resting or mating in foliage. Only adults of *Euschistus tristigmus* (Say) and *Euschistus ictericus* (L.) inhabited sorghum. For the remaining bug species, sorghum served as a reproductive host plant. Adult female stink bugs generally laid eggs on leaves, but sometimes in panicles. Very young nymphs fed on leaves, small stems, or very young seed whereas older nymphs exhibited feeding habits similar to the adults. These bug nymphs completed development to adults on this host plant.

**Table 1. Least squares means for number of phytophagous stink bugs and leaffooted bug per 1.83-m length of row and percentage of females (where known) in sorghum in Georgia in 2004 - 2007 and state references.**

| Species | No.* | % Females | State references |
|---|---|---|---|
| *N. viridula* | 1.0289a | 59 | GA[1,2], FL[3], TX[4], AR[5] |
| *O. p. pugnax* | 0.4614b | | GA[2], TX[4], OK[6] |
| *E. servus* | 0.3591c | 57 | GA[1], FL[3], TX[4], AR[5] |
| *L. phyllopus* | 0.1763d | | GA[1,2], FL[3], TX[4] |
| *E. quadrator* | 0.1669d | 56 | FL[3] |
| *C. hilaris* | 0.0789e | 91 | FL[3], AR[5] |
| *T. c. custator* | 0.0579e | | TX[4] |
| *E. tristigmus* | 0.0522e | | |
| *P. guildinii* | 0.0515e | | |
| *E. ictericus* | 0.0511e | | |

* Least squares means followed by the same lowercase letter are not significantly different (PROC MIXED, LSD, $P > 0.05$, $n = 2659$, common SE = 0.0187).

[1] Wiseman and McMillian 1971.

[2] McMillian and Wiseman 1972.

[3] Mizell et al. 2008.

[4] Hall and Teetes 1981.

[5] Smith et al. 2008.

[6] Dahms 1942.

Factorial analyses revealed a significant species effect ($F = 191.18$; df = 9, 27,000; $P = 0.0001$) for number of these pests per 1.83-m length of row in sorghum. *Nezara viridula* was the predominant species in sorghum; density of this stink bug was twice as high as that of the second most abundant stink bug, *O. p. pugnax*. *Euschistus servus* was the third most abundant stink bug species. Density of both *L. phyllopus* and *E. quadrator* was about half that of *E. servus*. *Chinavia hilaris*, *Thyanta custator custator* (F.), *E. tristigmus*, *Piezodorus guildinii* (Westwood), and *E. ictericus* were minor pests in sorghum.

Each of the first 7 sorghum panicle-feeding bug species listed in Table 1 previously have been reported to occur on sorghum (Dahms 1942, Wiseman and McMillian 1971, McMillian and Wiseman 1972, Hall and Teetes 1981, Mizell et al. 2008, Smith et al. 2008). Species composition varied by locality, but *N. viridula*, *O. p. pugnax*, *E. servus*, and *L. phyllopus* commonly have been found on sorghum (Table 1). *Euschistus tristigmus* and *E. ictericus* have not been reported to inhabit sorghum, but *Euschistus* spp. (*Euschistus impictiventris* Stål [Russell 1952] in Arizona and *Euschistus conperus* Uhler [Toscano and Stern 1976] in California), other than *E. servus* have been reported to feed on sorghum panicles. As far as is known, this is the first record of *P. guildinii* feeding on sorghum.

The 3 most predominant stink bug species, i.e., *N. viridula*, *E. servus*, and *O. p. pugnax*, were present on sorghum from the heading stage until maturation. Initially, *O. p. pugnax* adults were the most abundant stink bugs in sorghum (Fig. 1). Density of

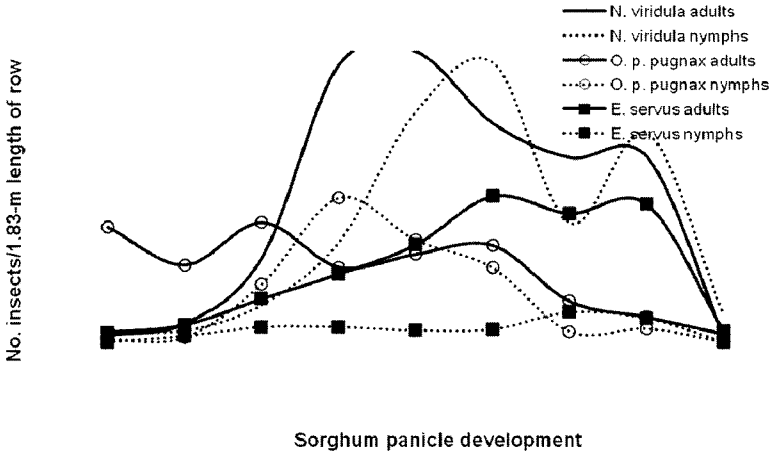


**Fig. 1. Mean number of *N. viridula*, *O. p. pugnax*, and *E. servus* nymphs and adults per 1.83-m length of row in sorghum in 2004 - 2007. HE, heading; FL, flowering; MI, milk; SD, soft dough; HD, hard dough; MA, mature.**

these adults remained relatively constant until declining near the hard dough stage. Soon after the appearance of *O. p. pugnax* adults, nymphs began developing on sorghum, peaking at the milk stage. *Nezara viridula* adults peaked during the milk to soft dough stage and were the most predominant stink bug adults from the milk to the hard dough stage. Subsequent *N. viridula* nymphs peaked at the soft dough stage. After *E. servus* adults peaked on sorghum in the soft dough stage, density of adults remained constant until the sorghum matured. Density of *E. servus* nymphs was relatively low, peaking a little during the soft to hard dough stage.

Similarly, in earlier studies sorghum panicle-feeding bug adults were observed on sorghum panicles at or soon after completion of flowering (Wiseman and McMillian 1971, Hall and Teetes 1981). Hall and Teetes (1981) collected *O. p. pugnax* adults on flowering and milk panicles, *L. phyllopus* and *E. servus* on milk and soft dough panicles, and *N. viridula* on soft and hard dough panicles. In one study, the milk stage of sorghum panicles was the most preferred stage for feeding by *E. servus* adults (Mizell et al. 2008). Likely, stink bug density at each sorghum panicle developmental stage varies depending on farmscape composition and seasonal succession of stink bug host plants in these farmscapes (Tillman 2011a) and sorghum variety (McMillian and Wiseman 1972) and planting date (Tillman 2010a).

**Predator species.** Several species of generalist insect predators were found in sorghum over the study (Table 2). Factorial analyses revealed a significant species effect ($F$ = 509.11; df = 7, 18,000; $P$ = 0.0001) for number of these predators per 1.83-m length of row in sorghum. *Orius insidiosus* was the predominant species, but density of *Geocoris* spp. was still relatively high; twice as high as density of the lady beetles and spiders. Density of red imported fire ants, *S. invicta*, was about half that of lady beetles and spiders. The spined soldier bug, *Podisus maculiventris* (Say), and the spined assassin bug, *Sinea diadema* (F.), and damsel bugs, *Nabis* spp., were the least abundant predators.

**Table 2. Least squares means for number of predators per 1.83-m length of row in sorghum in 2004 - 2007.**

| Species | No.* |
|---|---|
| *O. insidiosus* | 3.7117a |
| *Geocoris* spp.** | 3.0426b |
| Lady beetles*** | 1.7131c |
| Spiders**** | 1.6429c |
| *S. invicta* | 0.7876d |
| *P. maculiventris* | 0.1273e |
| *S. diadema* | 0.1111e |
| *Nabis* spp. | 0.1089e |

* Least squares means followed by the same lowercase letter are not significantly different (PROC MIXED, LSD, $P > 0.05$, $n = 2659$, common SE = 0.0566).

** *Geocoris punctipes* (Say) and *G. uliginosus* (Say).

*** *Hippodamia convergens* Guerin-Meneville, *Coccinella septempunctata* (L.), *Coleomegilla maculata* (De Geer), and *Harmonia axyridis* (Pallas).

**** *Peucetia viridans* (Hentz), *Oxyopes salticus* Hentz, spiders in the Salticidae and Thomisidae families, and unknown spiders.

The most predominant species of stink bug predators were present in sorghum from the heading stage to maturation (Fig. 2). However, *O. insidiosus* was very abundant on flowering panicles as reported earlier (Tillman 2006). Thrips (undetermined species) are not considered a pest of sorghum (Buntin 2009), but they were present in flowering panicles. Density of the heliothine *Helicoverpa zea* (Boddie), a known pest of sorghum (Buntin 2009), is higher on flowering panicles compared with all other stages of panicle development (Tillman 2006). Thus, *O. insidiosus* likely preyed on thrips and *H. zea* eggs as well as stink bug eggs. Indeed, this predator was observed on several occasions feeding on each of these prey items in sorghum as well as stink bug eggs on peanut and corn (Tillman 2008, 2010b). *Orius insidiosus* is an effective predator of adults and larvae of all thrips species (Ramachandran et al. 2001, Reitz et al. 2003). The prey-specific gut content enzyme-linked immunosorbent assay (ELISA) has been used to detect predation of *H. zea* eggs by this predator in cotton (Sansone and Smith 2001). When Ragsdale et al. (1981) tested 27 species for predation of *N. viridula* using ELISA, *O. insidiosus* was the second-most efficient predator of *N. viridula* eggs in soybean.

Lady beetles were more abundant on milk and soft dough stage sorghum. Aphids, i.e., the corn leaf aphid (*Rhopalosiphum maidis* (Fitch) and the greenbug (*Schizaphis graminum* (Rondani), *H. zea* eggs, and stink bug eggs and nymphs were present on sorghum at this time. Lady beetles were observed preying on these pests in sorghum. Lady beetles can have a significant impact on aphids attacking grain sorghum (Kring et al. 1985, Rice and Wilde 1988). In addition, lady beetles are known to attack *H. zea* eggs (Nuessly and Sterling 1994, Pfannenstiel and Yeargan 2002). Coccinellids have been observed feeding on stink bug eggs on soybean, peanut, and corn (Stam et al. 1987, Tillman 2008, 2010b), and adults and larvae of *Cycloneda sanguinea* L. and *C. maculata* were efficient egg predators of *N. viridula* in soybean (Ragsdale et al. 1981).

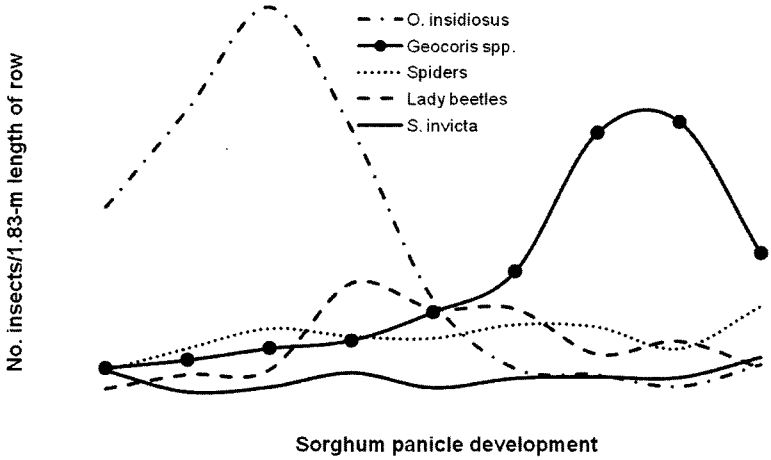


**Fig. 2. Mean number of *O. insidiosus*, *Geocoris* spp., spiders, lady beetles, and *S. invicta* per 1.83-m length of row in sorghum in 2004 - 2007. HE, heading; FL, flowering; MI, milk; SD, soft dough; HD, hard dough; MA, mature. *Geocoris* spp.: *G. punctipes* and *G. uliginosus*. Spiders: *P. viridans, O. salticus*, spiders in the Lycosidae and Thomisidae families and unknown spiders. Lady beetles: *H. convergens*, *C. septempunctata*, *C. maculata, H. axyridis*, *Scymnus* spp., *O. v-nigrum*, and *C. munda*.**

*Geocoris* spp. were more abundant on soft to hard dough sorghum panicles. These big-eyed bugs were observed feeding on larvae of *H. zea* and stink bug nymphs infesting these panicles. *Geocoris* spp. also have been observed attacking stink bug eggs on soybean, peanut, and corn (Stam et al. 1987; Tillman 2008, 2010b). *Geocoris punctipes* has been regarded as a successful predator of *Heliothis* spp. in the field and laboratory (Whitcomb and Bell 1964, Lingren et al. 1968). In the ELISA experiments conducted by Ragsdale et al. (1981), *G. punctipes* was the top predator of *N. viridula* eggs and the second-most efficient predator of *N. viridula* nymphs.

Density of spiders and *S. invicta* was relatively constant throughout sorghum panicle development. Ragsdale et al. (1981) determined that the brown striped lynx spider, *Oxyopes salticus* Hentz, was the top nymphal predator of *N. viridula*, and the bold jumping spider, *Phidippus audax* (Hentz), also preyed on nymphs of this stink bug in soybean. *Solenopsis invicta* commonly attacked egg masses of *N. viridula* and *E. servus* on peanuts and corn (Tillman 2008, 2010b). Ragsdale et al. (1981) determined that *S. invicta* was the seventh most efficient egg predator of *N. viridula* in soybean. In predator exclusion studies in this crop, *S. invicta* was implicated as an important egg predator of *N. viridula* (Krispyn and Todd 1982). In a later study, this ant species was observed to be the dominant egg predator of *N. viridula* in soybean during the vegetative stages (Stam et al. 1987).

*Podisus maculiventris* was the only predatory stink bug found in sorghum; it is a generalist predator, feeding on a variety of insect prey, including nymphs and adults of pest stink bugs in a diversity of crop and noncrop ecosystems (Ragsdale et al. 1981, McPherson et al. 1982, Tillman 2008). Stink bug eggs and nymphs are known

to be preyed upon by generalist predators in the Nabidae family (Ragsdale et al. 1981, Tillman 2008).

In summary, sorghum harbors many species of panicle-feeding bugs, but also many species of natural enemies of these pests including egg parasitoids of *N. viridula* and *E. servus* (Tillman 2011b). In an earlier study, placement of a strip of sorghum along a cotton field edge enhanced abundance of lady beetles in cotton (Tillman and Cottrell 2012). Possible explanations for this enhancement included providing newly abundant prey during senescence of corn and rye, providing new or preferred prey for adults developing in peanut, and concentrating abundant prey next to cotton fields. Regardless of the mechanisms involved, a habitat of sorghum could possibly be used in conservation biocontrol of stink bugs in southeastern farmscapes.

## Acknowledgments

The authors thank Kristie Graham (USDA, ARS, Crop Protection and Management Research Laboratory, Tifton, GA) for her technical assistance.

## References Cited

**Buntin, G. D. 2009.** Sorghum insect pests and their management, Bulletin 1283. Cooperative Extension Service, University of Georgia, Athens, GA.

**Dahms, R. G. 1942.** Rice stinkbug as a pest of sorghums. J. Econ. Entomol. 35: 945-946.

**Greene, J. K. and S. G. Turnipseed. 1996.** Stink bug thresholds in transgenic *B.t.* cotton. Proc. Beltwide Cotton Conferences, pp. 936-938.

**Hall, D. G. and G. L. Teetes. 1981.** Alternate host plants of sorghum panicle-feeding bugs in southeast central Texas. Southwest. Entomologist 6: 220-228.

**Hall, D. G. and G. L. Teetes. 1982.** Damage to grain sorghum by southern green stink bug, conchuela, and leaffooted bug. J. Econ. Entomol. 75: 620-625.

**Kring, T. J., F. E. Gilstrap and G. J. Michels Jr. 1985.** Role of indigenous coccinellids in regulating greenbugs (Homoptera: Aphididae) on Texas grain sorghum. J. Econ. Entomol. 78: 269-273.

**Krispyn, J. W. and J. W. Todd. 1982.** The red imported fire ant as a predator of the southern green stink bug on soybean in Georgia. J. Georgia Entomol. Sci. 17: 19-26.

**Lingren, P. D., R. L. Ridgway and S. L. Jones. 1968.** Consumption by several common arthropod predators of eggs and larvae of two *Heliothis* species that attack cotton. Ann. Entomol. Soc. Am. 61: 613-618.

**McMillian, W. W. and B. R. Wiseman. 1972.** Insect species present on sorghum heads of various stages of maturity. J. Georgia Entomol. Soc. 7: 179-182.

**McPherson, R. M., J. C. Smith and W. A. Allen. 1982.** Incidence of arthropod predators in different soybean cropping systems. Environ. Entomol. 11: 685-689.

**Mizell III, R. F., T. C. Riddle and A. S. Blount. 2008.** Trap cropping system to suppress stink bugs in the southern coastal plain. Proc. Florida State Horticult. Soc. 121: 377-382.

**Nuessly, G. S. and W. L. Sterling. 1994.** Mortality of *Helicoverpa zea* (Lepidoptera: Noctuidae) eggs in cotton as a function of oviposition sites, predator species, and desiccation. Environ. Entomol. 23: 1189-1202.

**Patel, D., M. Stout and J. Fuxa. 2006.** Effects of rice panicle age on quantitative and qualitative injury by the rice stink bug (Hemiptera: Pentatomidae). Fla. Entomol. 89: 321-327.

**Pfannenstiel, R. S. and K. V. Yeargan. 2002.** Identification and diel activity patterns of predators attacking *Helicoverpa zea* (Lepidoptera: Noctuidae) eggs in soybean and sweet corn. Environ. Entomol. 31: 232-242.

**Ragsdale, D. W., A. D. Larson and L. D. Newsom. 1981.** Quantitative assessment of predators of *Nezara viridula* eggs and nymphs within a soybean agroecosystem using ELISA. Environ. Entomol. 10: 402-405.

**Ramachandran, S., J. Funderburk, J. Stavisky and S. Olson. 2001.** Population abundance and movement of *Frankliniella* thrips (Thysanoptera: Thripidae) in northern Florida. Agric. For. Entomol. 3: 1-10.

**Reitz, S. R., E. L. Yearby, J. E. Funderburk, J. Stavisky, M. T. Momoi and S. M. Olson. 2003.** Integrated management tactics for *Frankliniella* thrips (Thysanoptera: Thripidae) in field-grown pepper. J. Econ. Entomol. 96: 1201-1214.

**Rice, M. E. and G. E. Wilde. 1988.** Experimental evaluation of predators and parasitoids in suppressing greenbugs (Homoptera: Aphididae) in sorghum and wheat. Environ. Entomol. 17: 836-841.

**Russell, E. E. 1952.** Stink bugs on seed alfalfa in southern Arizona. USDA Circ. 903: 1-19.

**Sansone, C. G. and J. W. Smith Jr. 2001.** Identifying predation of *Helicoverpa zea* (Lepidoptera: Noctuidae) eggs by *Orius* spp. (Hemiptera: Anthocoridae) in cotton by using ELISA. Environ. Entomol. 30: 431-438.

**SAS Institute. 2008.** SAS/STAT User's Guide, Version 9.2. SAS Institute, Cary, NC, USA.

**Smith, J. F., R. G. Luttrell and J. K. Greene. 2008.** Seasonal abundance of stink bugs (Heteroptera: Pentatomidae) and other polyphagous species in a multi-crop environment in south Arkansas. J. Entomol. Sci. 43: 1-12.

**Stam, P. A., L. D. Newsom and E. N. Lambremont. 1987.** Predation and food as factors affecting survival of *Nezara viridula* (L.) (Hemiptera: Pentatomidae) in a soybean ecosystem. Environ. Entomol. 16: 1211-1216.

**Tillman, P. G. 2006.** Relative attractiveness of developmental stages of sorghum panicles to predator, *Orius insidiosus* (Say) and prey, *Helicoverpa zea* (Boddie). J. Entomol. Sci. 41: 248-252.

**Tillman, P. G. 2008.** Populations of stink bugs (Heteroptera: Pentatomidae) and their natural enemies in peanuts. J. Entomol. Sci. 43: 191-207.

**Tillman, P. G. 2010a.** Composition and abundance of stink bugs (Heteroptera: Pentatomidae) in corn. Environ. Entomol. 39: 1765-1774.

**Tillman, P. G. 2010b.** Parasitism and predation of stink bug (Heteroptera: Pentatomidae) eggs in Georgia corn fields. Environ. Entomol. 39: 1184-1194.

**Tillman, P. G. 2011a.** Influence of corn on stink bugs (Heteroptera: Pentatomidae) in subsequent crops. Environ. Entomol. 40: 1159-1176.

**Tillman, P. G. 2011b.** Parasitism and predation of stink bug (Heteroptera: Pentatomidae) eggs in sorghum in Georgia. J. Entomol. Sci. 46: 171-174.

**Tillman, P. G. and T. E. Cottrell. 2012.** Incorporating a sorghum habitat for enhancing lady beetles (Coleoptera: Coccinellidae) in cotton. http://www.hindawi.com/journals/psyche/2012/150418/.

**Toscano, N. C. and V. M. Stern. 1976.** Dispersal of *Euschistus consperus* from alfalfa grown for seed to adjacent crops. J. Econ. Entomol. 69: 96-98.

**University of Arkansas. 2006.** Grain Sorghum Production Guide, MP 297, Cooperative Extension Service, University of Arkansas, Little Rock, AR.

**Velasco, L. R. I. and G. H. Walter. 1992.** Availability of different host plant species and changing abundance of the polyphagous bug *Nezara viridula* (Hemiptera: Pentatomidae). Environ. Entomol. 21: 751-759.

**Whitcomb, W. H. and K. O. Bell. 1964.** Predaceous insects, spiders, and mites of Arkansas cotton fields. Ark. Exp. Sts. Bull. 690: 3-78.

**Wiseman, B. R. and W. W. McMillian. 1972.** Damage to sorghum in south Georgia by Hemiptera. J. Georgia Entomol. Soc. 6: 237-242.