The *Journal of Cotton Science 30:39–46* (*2026*)
http://journal.cotton.org, © The Cotton Foundation 2026

ARTHROPOD MANAGEMENT & APPLIED ECOLOGY

Impact of Tarnished Plant Bug (Hemiptera: Miridae) on Cotton Yields at Different Distances from the Edge of Fields

Tyler Towles*, Jeffrey Gore, Whitney D. Crow, Angus L. Catchot Jr., Don R. Cook, Scott Stewart, Glenn Studebaker, Ben Thrash, Nick Bateman, David Kerns, Sebe Brown, Kelly Tindall

ABSTRACT

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is a key pest of cotton, *Gossypium hirsutum* L., in the Mid-Southern U.S. Infestations are often exacerbated near field edges adjacent to alternative host plants, potentially leading to significant yield impacts. To manage tarnished plant bugs along field edges, studies were conducted across Arkansas, Louisiana, Mississippi, Missouri, and Tennessee to evaluate the influence of side-dress applied aldicarb treatments during early squaring on tarnished plant bug densities, square retention, and yield relative to the distance of a corn-cotton interface. Sweep net, drop cloth, and square retention samples were conducted at various distances from field edges. Sweep net samples indicated a significant interaction between sampling week and distance from the field edge, with more tarnished plant bugs detected at 7.62 m than 76.2 m from the field edge. Tarnished plant bug densities were lower in the aldicarb-treated plots compared to untreated plots. For drop cloth samples, significant main effects of week, treatment, and distance were observed, with the highest densities of tarnished plant bugs occurring during the fifth week of sample at 15.24 m from the field edge. Percent square retention was highest during the first week of sample and lowest the second week of sample. Yield losses were greatest within 22.86 m of the interface, even with insecticide management. These findings indicate that proposed in-field buffers could result in economic losses for producers, and aldicarb side-dress applications alone are unlikely to offset yield reductions under high tarnished plant bug pressure.

T. Towles*, J. Gore, and D.R. Cook, Mississippi State Univ., Stoneville, MS 38776; W.D. Crow and A.L. Catchot Jr., Mississippi State Univ., Mississippi State, MS 39762; S. Stewart and S. Brown, Univ. of Tennessee, Jackson, TN 38301; G. Studebaker, B. Thrash, and N. Bateman, Univ. of Arkansas, Fayetteville, AR 72701; D. Kerns, Texas A&M Univ., College Station, TX 77843; and K. Tindall, Univ. of Missouri, Portageville, MO 63873.
*Corresponding author: tt305@msstate.edu

Grown as an annual crop, cotton, *Gossypium hirsutum* L., is a perennial shrub with an indeterminate growth habit (Landivar and Benedict, 1996). The indeterminate growth habit results in an extended fruiting period compared to other cultivated crops. Reproductive development in cotton begins with the formation of the first square (flower bud) approximately 40 days after emergence and continues for two to three months. This growth habit makes insect management in cotton difficult because severe yield losses can occur over a longer time than other crops, especially from fruit feeding pests such as tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (Musser et al., 2009b).

Tarnished plant bug is the most economically damaging insect pest of cotton in the Mid-Southern U.S. states of Arkansas, Mississippi, Louisiana, Tennessee, and Missouri (Cook et al., 2025). Although tarnished plant bugs feed on multiple parts of a cotton plant, they primarily damage cotton by feeding on developing squares with piercing-sucking mouthparts (Layton, 2000). Squares less than 3.18 mm in diameter are preferred, but tarnished plant bugs will feed on all sized squares and small bolls (fruit) (Tugwell et al., 1976). Tarnished plant bugs inject digestive enzymes that cause localized necrosis to the developing anthers and usually cause the square to abscise depending on severity (Layton, 2000). When feeding occurs on larger squares that do not abscise, the resulting flower often will be discolored and misshapen with damaged anthers (Pack and Tugwell, 1976). Greater than 30% damage to anthers in an individual flower affects pollination and results in a malformed boll or abscission of the developing boll within a few days (Pack and Tugwell, 1976), sometimes leading to direct yield loss.

Tarnished plant bugs typically insert eggs singly into plant tissues, which hatch approximately 7 to 10 days following oviposition (Capinera, 2001; George et al., 2021). There are five nymphal instars that tarnished plant bugs complete every 3 to 4 days and the entire lifecycle from egg to adult is approximately 40 days (Dixon and Fasulo, 2001; George et al., 2021). Tarnished plant bugs overwinter as adults in a state of reproductive diapause (Snodgrass, 2003). Historical literature reported that tarnished plant bugs complete one to two generations on winter and spring annual hosts, including henbit (*Lamium amplexicaule* L.), fleabane (*Erigeron philadelphicus* L.), buttercup (*Ranunculus* spp.), shepherd's purse (*Capsella bursa-pastoris* L.), butterweed (*Senecio glabellus* Poiret), and sour dock (*Rumex crispus* L.) before moving into agronomic crops (Cleveland, 1982; Fleischer and Gaylor, 1988; Snodgrass, 2003). However, more recent research showed that tarnished plant bugs break reproductive diapause at two different times during the winter (Snodgrass, 2003). That research showed that tarnished plant bug adults overwintering on winter annuals in Mississippi break reproductive diapause in late December and adults overwintering in dead plant material do not break diapause until the end of January (Snodgrass, 2003). This results in overlapping generations coming out of overwintering and contributes to the pest status of tarnished plant bugs by allowing them to build up greater populations in the spring (Snodgrass, 2003). When spring annuals begin to senesce, tarnished plant bug populations begin migrating into agronomic crops such as field corn, Zea mays L., and early maturing, indeterminate soybean, *Glycine max* (L.) Merr. (Snodgrass et al., 1984). Previous research has shown that although tarnished plant bug can use these crops as hosts, they are not considered significant pests (Abel et al., 2010; Buckelew et al., 2000; Hammond and Stinner, 1987; Lam and Pedigo, 1998; McPherson et al., 2001, 2003; Snodgrass et al., 2010). Field corn is considered a good reproductive host for tarnished plant bug (Abel et al., 2010), but reproduction is low on soybean (Snodgrass et al., 2010). Although soybean is considered a relatively poor reproductive host for tarnished plant bug, the land area planted to soybean is often two to three times greater than that planted to corn in the Mid-South. As a result, both crops potentially can serve as significant sources of tarnished plant bugs that move into cotton. Because tarnished plant bug populations increase in cultivated and non-cultivated hosts adjacent to cotton fields, initial infestations tend to occur along field borders (Cleveland, 1982; Outward et al., 2008; Snodgrass et al., 1984; Tugwell et al., 1976).

Aldicarb is a granular carbamate insecticide (IRAC group 1A) that affects acetylcholinesterase inhibitors. This insecticide is typically applied below the soil surface, either pre-plant or side-dressed, and rapid uptake by plant roots occurs (Risher et al., 1987). Side-dress applications of aldicarb historically were used to control in-season populations of nematodes, tarnished plant bugs, and other sucking arthropod species. Older literature showed aldicarb applied from 2.25 to 35.82 kg per hectare as a side-dress during cotton squaring significantly reduced adult and larval boll weevils developing in squares (Hopkins and Taft, 1965). Recently, this management tactic has become much less common due to the availability of alternative control options for these arthropod pests. Recently, the U.S. Environmental Protection Agency developed the "Insecticide Strategy to Reduce Exposure of Federally Listed Endangered and Threatened Species and Designated Critical Habitats from the Use of Conventional Agricultural Insecticides" (https://www.epa.gov/system/files/documents/2025-04/insecticide-strategy-final_0.pdf [verified 5 April 2025]). One of the mitigation measures in this strategy is to leave an in-field unsprayed buffer along the edge of fields. Leaving large swaths of cotton untreated for arthropod pests, especially tarnished plant bugs, could result in catastrophic economic losses on a state or regional scale. If foliar insecticide applications are prohibited along field edges to mitigate drift and run off, alternative methods for controlling pests along field edges should be evaluated. The objective of the current study was to quantify yield losses from tarnished plant bug along the edges of cotton fields adjacent to field corn. A secondary objective was to determine the effectiveness of using aldicarb (AgLogic 15GG, AgLogic Chemical LLC, Chapel Hill, NC) as a side-dress application to minimize yield losses along cotton borders.

MATERIALS AND METHODS

A study was conducted in commercial cotton fields in Arkansas, Louisiana, Missouri, Mississippi, and Tennessee from 2008 to 2010 to evaluate the impact of in-season application of aldicarb on tarnished plant bug infestations and yield along the edge of cotton fields. A total of 26 fields were used from the five states over the 3-yr period. Selected sites were commercial fields with a corn-cotton interface with cotton rows running parallel to the corn. Corn and cotton fields were not separated by more than approximately 12 m of uncultivated land (e.g., turn-row, ditch). The treatments included aldicarb (Temik 15G, Bayer CropScience, Raleigh, NC) and a non-treated control that were applied in addition to all normal production practices. Treatments (aldicarb and untreated control) were applied to the first 32 rows (30.48 m) from the edge of the field, adjacent to corn in randomly assigned blocks. Aldicarb was applied at 11.2 kg formulated product ha-1 as a sideband when the plants in the adjacent corn field were at the green silk stage or the cotton had reached the match-head square stage. The applicator was equipped with 38.1-cm diameter coulters, and the coulters were spaced approximately 25.4 cm on each side of the plants. The coulters cut a slot in the soil, and the aldicarb granules were deposited in the slot directly behind the coulters at a depth of 5.1 cm. When the aldicarb was applied, the applicator was passed through the non-treated plots so that any root pruning or other disturbance that occurred during application would be uniform across plots for both treatments. Plots were 30 m or greater in length, with three to five replications at each location depending on field size. All plots within a trial were ordered along the corn-cotton interface using a randomized complete block design. Except for the aldicarb applications, the fields were managed according to the growers' standard production practices, including insecticide applications over the entire field as recommended by the growers' independent crop consultant.

Sampling for tarnished plant bugs was initiated at the time of aldicarb application and collected weekly for 5 wks. Sweep net sampling was used throughout the trial to monitor adult tarnished plant bug densities. Drop cloth sampling was also conducted to monitor nymphal tarnished plant bug populations in the trial area. University extension recommendations encourage sweep nets to be used through squaring, whereas drop cloths become the predominant method for tarnished plant bug monitoring during bloom. This is because sweep nets are important for detecting adult tarnished plant bugs during the squaring stage, whereas drop cloths are effective at detecting tarnished plant bug nymphs, which are primarily present during cotton's blooming stages. The established threshold to justify insecticide applications for tarnished plant bugs in these trials are 8 bugs per 100 sweeps during the first 2 wks of squaring and 15 bugs per 100 sweeps during the 3rd wk of squaring until bloom. During bloom, the threshold is 3 bugs per 1.5 m row (Musser et al., 2009a, b). Four samples were collected within each plot at regular distances from the edge of the field. Each sample consisted of two sets of 25 sweeps (38.1-cm diameter sweep net) and two drop cloth samples (3.05 row m). Plots were divided into 7.62 m (8 row) sections moving away from the corn-cotton interface (0.97-7.72 m, 8.69-15.44 m, 16.41-23.16 m, and 24.13-30.88 m). The center two rows of each section were sampled. Sampled areas were marked so that the same areas could be re-sampled each week. Two additional samples were collected; one approximately 33.8 to 34.7 m from the edge of the field, and the other was approximately 76 m from the edge of the field to evaluate the width of the elevated tarnished plant bug density edge. These distances equated to the first 6 rows outside of the treated area and 45.7 m from the edge of each plot. These sample locations were adjacent to each plot and were outside of the treated area. Lint yield was estimated by harvesting 2 to 4 rows from each set of 8 rows of each plot (4 yield measurements per plot). Also, yield was estimated within the first 6 rows adjacent to each plot and at 45.7 m from the edge of each plot, the same areas where tarnished plant bugs were sampled outside of the test area. Yields were converted to kg lint ha^{-1} and differences were calculated by subtracting the yield in the untreated plots from the yield in the corresponding treated plots.

Data for tarnished plant bug numbers using a sweep net and drop cloth, and percent square retention were summarized for each location using PROC FREQ (SAS V. 9.4, SAS Institute, Cary, NC) to obtain the average of all replications at each location for each sample date. Mean tarnished plant bug densities and square retention percentage for each sampling period were subjected to repeated measures analysis of variance (PROC GLIMMIX) with week of sample as the repeated measure. The fixed effects in the model included week of sample, distance from field edge, treatment, and interactions. The random effects included site year (location by year), treatment nested in site year, and distance nested in site year. Data for yield loss were subjected to a general linear mixed model analysis of variance (PROC GLIMMIX). Distance from field edge was the fixed effect in the model, whereas site year was considered random. For all data, the Kenward-Rogers adjustment was used to determine degrees of freedom. Means were determined using LSMEANS and separated according to Tukey's HSD mean separation procedure (α = 0.05).

RESULTS

For number of total tarnished plant bugs in sweep net samples, there was an interaction between the week of sampling and distance from the corn-cotton interface (Table 1). No differences in tarnished plant bug numbers were observed among distances from the edge of fields for any week except week four (Fig. 1). During the fourth week of sampling, numbers of tarnished plant bugs were greater at 7.62 m from the field edge compared to 76.2 m from field edge. No differences among distances were observed in any other week of sample. For sweep net samples, there was also a main effect of treatment for tarnished plant bug numbers (Table 1). Plots treated with aldicarb had a mean (SEM) of 1.88 (0.06) tarnished plant bugs per 25 sweeps compared to a mean (SEM) of 2.15 (0.07) tarnished plant bugs per 25 sweeps in the untreated plots. No other effects or interactions affected tarnished plant bug numbers using a sweep net, except that there was a main effect for distance from the edge of fields (Table 1).

For drop cloth samples, there were main effects for week of sample, treatment, and distance from the edge of fields (Table 1). Tarnished plant bug densities were greater at 15.24 m from the edge of the fields compared to 76.2 m from the edges of fields (Fig. 2). Tarnished plant bug densities were greater during the fifth week of sample compared to all other sample dates (Fig. 3). Tarnished plant bug densities during the third and fourth weeks of sample were greater than the first and second weeks of sample, and tarnished plant bug densities during the second week of sample were greater than the first week of sample. No other differences in tarnished plant bug densities were observed related to distance from the corn-cotton interface. For the effect of treatment,

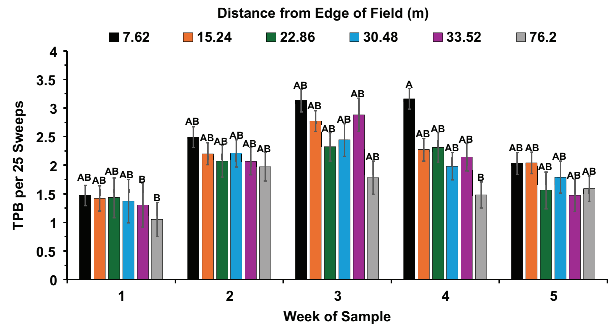

Figure 1. Interaction between week of sample and distance from the edge of fields for mean (SEM) number of tarnished plant bugs per 25 sweeps in cotton averaged across Arkansas, Mississippi, Louisiana, Tennessee, and Missouri from 2008 to 2010. Bars with a common letter are not significantly different according to Tukey's HSD Test, α = 0.05.

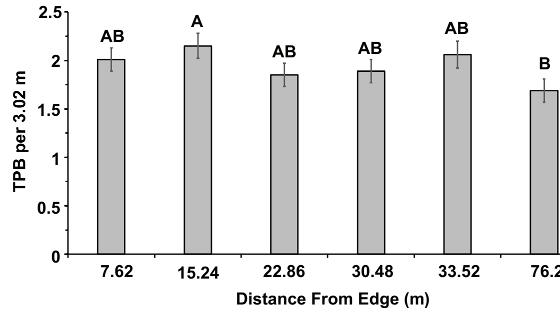

Figure 2. Influence of distance from the edge of fields for mean (SEM) number of tarnished plant bugs per 3.02 m of row based on drop cloth samples in cotton averaged across Arkansas, Mississippi, Louisiana, Tennessee, and Missouri from 2008 to 2010. Bars with a common letter are not significantly different according to Tukey's HSD Test, α = 0.05.

Table 1. Analysis of variance for the number of tarnished plant bugs for sweep net and drop cloth samples, and percent square retention in cotton as influenced by week of sample, aldicarb side-dress treatment, and distance from the edge of fields for a study conducted across Arkansas, Mississippi, Louisiana, Tennessee, and Missouri from 2008 to 2010

	Sweep Net			Drop Cloth			Square Retention		
	F	df	p > F	F	df	p > F	F	df	p > F
Week	1.54	4, 73.5	0.20	16.13	4, 969.7	<0.01	16.61	4, 1036	<0.01
Treatment	10.14	1, 28.13	<0.01	3.82	1, 964.6	0.05	3.14	1, 1034	0.08
Distance	6.13	5, 130.9	<0.01	4.48	5, 125.3	<0.01	1.48	5, 126.9	0.20
Week*Treatment	1.61	4, 865.9	0.17	0.43	4, 964.6	0.78	0.11	4, 1034	0.98
Week*Distance	3.32	20, 898	<0.01	0.73	20, 1042	0.80	0.38	20, 1106	0.99
Distance*Treatment	0.76	5, 875.8	0.58	0.21	5, 964.6	0.96	0.40	5, 1034	0.85
Week*Distance*Treatment	0.60	20, 868.6	0.92	0.16	20, 964.6	0.99	0.14	20, 1034	0.99

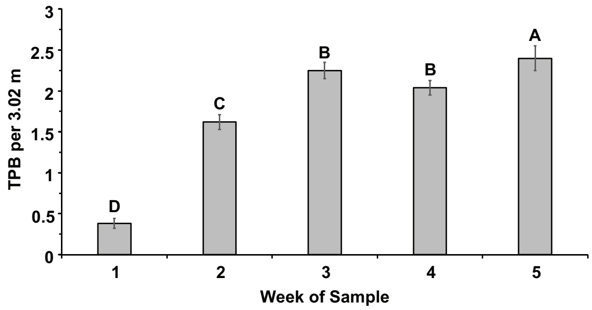

Figure 3. Influence of week of sample for mean (SEM) number of tarnished plant bugs per 3.02 m of row based on drop cloth samples in cotton averaged across Arkansas, Mississippi, Louisiana, Tennessee, and Missouri from 2008 to 2010. Bars with a common letter are not significantly different according to Tukey's HSD Test, α = 0.05.

mean (SEM) number of tarnished plant bugs was 1.77 (0.07) in the aldicarb treatment compared to 2.12 (0.08) in the untreated.

For percent square retention, there was a main effect for week of sample (Table 1). Percent square retention was greater during the first week of sample compared to all other weeks, and lower during the second week of sample compared to all other weeks (Fig. 4). No differences in percent square retention were observed among weeks three, four, and five of samples. No other main effects or interactions were observed for percent square retention (Table 1).

There was an effect of distance from the corn-cotton interface on cotton lint yields between aldicarb-treated and non-treated cotton ($F = 2.32$; df = 5, 268.6; $p = 0.04$). Yield losses at 7.62 m, 15.24 m, and 22.86 m from the edge of fields were greater than yield losses at 33.52 m from the edge of fields (Fig. 5). Yield loss at 15.24 m from the edge of fields was also greater than yield loss at 76.2 m from the edge of fields. Mean (SEM) yield losses were 77.4 (35.8), 90.3 (26.6), 75.2 (29.1), and 29.1 (29.2) kg ha^{-1} at 7.62, 15.24, 22.86, and 30.48 m from the edge of fields, respectively.

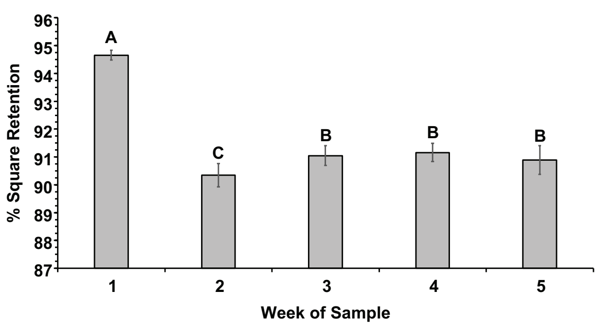

Figure 4. Influence of week of sample for mean (SEM) percent square retention in cotton averaged across Arkansas, Mississippi, Louisiana, Tennessee, and Missouri from 2008 to 2010. Bars with a common letter are not significantly different according to Tukey's HSD Test, α = 0.05.

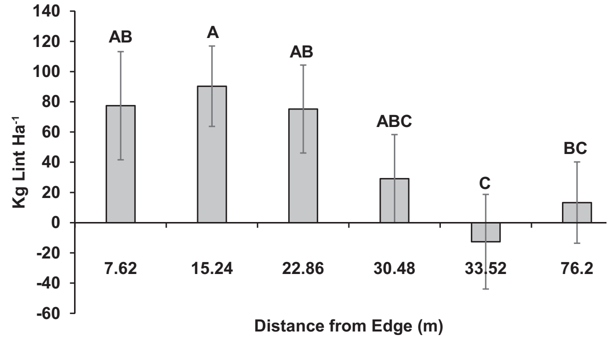

Figure 5. Influence of distance from the edge of fields for mean (SEM) differences in cotton yields between side-dress aldicarb treated and non-treated cotton averaged across Arkansas, Mississippi, Louisiana, Tennessee, and Missouri from 2008 to 2010. Bars with a common letter are not significantly different according to Tukey's HSD Test, α = 0.05.

DISCUSSION

Because the study was conducted on commercial fields, each farmer's field was managed for all insect pests, including tarnished plant bug, with foliar insecticide sprays based on recommendations from their crop advisor. Although we did not obtain spray records for the fields, the common foliar insecticides used across the region at that time included organophosphates (dicrotophos and acephate) tank mixed with a pyrethroid (most commonly bifenthrin), neonicotinoids (thiamethoxam and imidacloprid), and an insect growth regulator (novaluron) (Bateman et al., 2026; Brown et al., 2026; Crow et al., 2025; Davis et al., 2025). As a result of regular sprays, mean tarnished plant bug populations never exceeded the current action threshold with a sweep net or drop cloth (Musser et al., 2009b), and mean square retention never fell below 90% throughout the duration of the study. Even with low densities, the side-dress application of aldicarb at pinhead square generally resulted in lower numbers of tarnished plant bugs and greater square retention than in the untreated cotton. Previous research has shown that the use of aldicarb as a side-dress application reduced numbers of boll weevils in cotton (Timmons et al., 1973). Similarly, when caged onto cotton that was treated with two rates of aldicarb applied as a side-dress, tarnished plant bug mortality averaged 50.0 to 62.5% for adults and 57.5 to 63.0% for nymphs when corrected for control mortality (Scott and Snodgrass, 2001).

In a separate field study looking at in-furrow applications of aldicarb at the time of cotton planting, aldicarb treatments suppressed tarnished plant bug populations enough to cause increased squaring rates and increased bolls (Scott et al., 1985). In the current study, mean (SEM) yield increases from the use of aldicarb relative to the untreated control ranged from 29.1 (29.2) to 90.3 (26.6) kg ha^{-1}, depending on distance from the corn-cotton interface. In a similar study that used side-dress applications of aldicarb across 15 locations, yield differences between treated and untreated cotton ranged from 2 to 693 kg ha^{-1} but the differences were significant in only five locations (Parrott et al., 1985). Greater yield increases in the previous study compared to the current study are likely due to a few factors. The study by Parrott et al. (1985) used a greater rate of aldicarb (2.24 kg ai ha^{-1}) than we used in the current study (1.68 kg ai ha^{-1}). The fields used in the current study were scouted and sprayed based on established action thresholds, a practice that was not done by Parrott et al. (1985), which likely contributed to the differences between the two studies.

Results of the current study clearly demonstrate that tarnished plant bugs can cause significant yield losses along the edge of cotton fields, even with regular scouting and frequent foliar insecticide sprays that maintain tarnished plant bug populations below the current action threshold. This will be important for improving our understanding of tarnished plant bug population dynamics and their injury along cotton field borders. The data in the current study demonstrate that unmanaged buffers will result in a significant yield loss for growers. These data also suggest that the use of aldicarb applied as a side-dress can offset some of those losses. However, in a situation where foliar sprays are not made along field edges, the potential yield losses are likely too great for aldicarb to offset, assuming aldicarb would be applied to many fields. This is unlikely because of costs and specialized equipment needed to make side-dress applications. Aldicarb can be applied only as a side-dress during the early squaring period because of root pruning and plant damage at later stages of cotton development. A single application during the early squaring period is not likely to provide significant control into the flowering period when the greatest yield losses from tarnished plant bug occur (Wood et al., 2016). More research is needed to determine the impact of tarnished plant bug on cotton yield losses along cotton borders in an unsprayed situation. Additionally, research is needed to quantify the potential economic costs of in-field unsprayed borders in cotton to determine how mitigation practices could negatively impact the future profitability of cotton growers where tarnished plant bug is a key pest.

ACKNOWLEDGMENTS

Funding for this research was provided by Cotton Incorporated through Core Project 15-982-MS.

REFERENCES

Abel, C.A., G.L. Snodgrass, R. Jackson, and C. Allen. 2010. Oviposition and development of the tarnished plant bug (Heteroptera: Miridae) on field maize. Environ. Entomol. 39:1085–1091.

Bateman, N., J. Davis, A. Cato, B. Thrash, K. Loftin, P. Spradley, G. Studebaker, N. Joshi, and J. Zawislak. 2026. Insecticide recommendations for Arkansas. Publ. MP144. Univ. Arkansas Sys. Div. Agri., Little Rock, AR.

Brown, S., S. Steckel, J. Horton, G. Marotta, and N. Arey. 2026. 2026 Insect control recommendations for field crops. Ext. Publ. PB1928. Univ. Tennessee, Knoxville, TN.

Buckelew, L.D., L.P. Pedigo, H.M. Mero, M.D.K. Owen, and G.L. Tylka. 2000. Effects of weed management systems on canopy insects in herbicide-resistant soybeans. J. Econ. Entomol. 93:1437–1443.

Capinera, J.L. 2001. Handbook of Vegetable Pests. Academic Press, San Diego, CA.

Cleveland, T.C. 1982. Hibernation and host plant sequence studies of tarnished plant bugs, Lygus lineolaris, in the Mississippi Delta. Environ. Entomol. 11:1049–1052.

Cook, D.R., M. Threet, T. Towles, W.D. Crow, S.H. Graham, P. Ellsworth, G. Studebaker, B.C. Thrash, N.R. Bateman, I. Esquivel, P. Roberts, J. Villegas, C.A. Floyd, J. Pierce, D. Reisig, M. Smith, A. Faris, J. Greene, S.A. Brown, D.L. Kerns, T. Bryant, S. Malone, I. Grettenberger, B. Hutmacher, and A. Zukoff. 2025. 2024 cotton insect losses estimates. *In* Proc. Beltwide Cotton Conf., New Orleans, LA. 14-16 Jan. 2025. Natl. Cotton Counc. Am., Memphis, TN.

Crow, W., D. Cook, F. Musser, and T. Towles. 2025. 2026 Insect control guide for agronomic crops. Publ. 2471. Mississippi State Univ. Ext. Serv. Mississippi State, MS.

Davis, J., D. Kerns, B. Gueltig, C. Gregorie, F. Huang, M. Stout, J. Villegas, and B. Wilson. 2025. 2025 Louisiana field crops insect pest management guide. Publ. No. 1838-A. Louisiana State Univ. Agri. Center, Baton Rouge, LA.

Dixon, W.N., and T.R. Fasulo. 2001. Tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois) (Insecta: Hemiptera: Miridae). Publ. EENY-245. Univ. Florida

Fleischer, S.J., and M.J. Gaylor. 1988. *Lygus lineolaris* (Hemiptera: Miridae) population dynamics: nymphal development, life tables, and Leslie matrices on selected weeds and cotton. Environ. Entomol. 17:246–253.

George, J., J.P. Glover, J. Gore, W.D. Crow, and G.V.P. Reddy. 2021. Biology, ecology, and pest management of the tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), in southern row crops. Insects. 12:807.

Hammond, R.B., and B.R. Stinner. 1987. Soybean foliage insects in conservation tillage systems: effects of tillage, previous cropping history, and soil insecticide application. Environ. Entomol. 16:524–531.

Hopkins, A.R., and H.M. Taft. 1965. Control of certain cotton pests with a new systemic insecticide, UC-21149. J. Econ. Entomol. 58:746–749.

Lam, W.F., and L.P. Pedigo. 1998. Response of soybean insect communities to row width under crop residue management systems. Environ. Entomol. 27:1069–1079.

Landivar, J.A., and J.H. Benedict 1996. Monitoring system for the management of cotton growth and fruiting. Texas Ag. Exp. Sta. Bull. B02.

Layton, M.B. 2000. Biology and damage of the tarnished plant bug, *Lygus lineolaris*, in cotton. Southwest. Entomol. Suppl. 23:7–20.

McPherson, R.M., M.L. Wells, and C.S. Bundy. 2001. Impact of early production soybean production system on arthropod pest populations in Georgia. Environ. Entomol. 30:76–81.

McPherson, R.M., W.C. Johnson, B.G. Mullinix Jr., W.A. Mills III, and F.S. Peebles. 2003. Influence of herbicide tolerant soybean production systems on insect pest populations and pest induced crop damage. J. Econ. Entomol. 96:690–698.

Musser, F.R., A.L. Catchot, S.D. Stewart, R.D. Bagwell, G.M. Lorenz, K.V. Tindall, G.E. Studebaker, B.R. Leonard, D.S. Akin, D.R. Cook, and C.A. Daves. 2009a. Tarnished plant bug (Hemiptera: Miridae) thresholds and sampling comparisons for flowering cotton in the Midsouthern United States. J. Econ. Entomol. 102:1827–1836.

Musser, F.R., G.M. Lorenz, S.D. Stewart. R.D. Bagwell, B.R. Leonard, A.L. Catchot, K.V. Tindall, G.E. Studebaker, D.S. Akin, D.R. Cook, and C.A. Daves. 2009b. Tarnished plant bug (Hemiptera: Miridae) thresholds for cotton before bloom in the midsouth of the United States. J. Econ. Entomol. 102:2109–2115.

Outward, R., C. E. Sorenson, and J. R. Bradley, Jr. 2008. Effects of vegetated field borders on arthropods in cotton fields in eastern North Carolina. J. Insect Sci. 8:09.

Pack, T.M., and N.P. Tugwell. 1976. Clouded and tarnished plant bugs on cotton: a comparison of injury symptoms and damage of fruit parts. AR Agric. Exp. Stn. Report, Univ. Arkansas, Fayetteville, AR.

Parrott, W.L., J.N. Jenkins, W.R. Meredith, Jr., J.C. McCarty, Jr., and J.C. Bailey. 1985. Effects of aldicarb on tarnished plant bug (Hemiptera: Miridae) density and cotton yield. J. Econ. Entomol. 78:155–157.

Risher, J.F., F.L. Mink, and J.F. Strata. 1987. The toxicological effects of the carbamate insecticide aldicarb in mammals: a review. Environ. Health Perspect. 72:267–281.

Scott, W.P., and G.L. Snodgrass. 2001. Evaluation of Temik (aldicarb) applied as side-dress application on mortality of caged tarnished plant bugs, 1999. Arthropod Mgmt. Tests 26:F71. https://doi.org/10.1093/amt/26.1.F71.

Scott, W.P., J.W. Smith, and G.L. Snodgrass. 1985. Response of cotton arthropod populations in cotton to various dosages of aldicarb applied in the furrow at planting time. J. Econ. Entomol. 78:249–257.

Snodgrass, G.L. 2003. Role of reproductive diapause in the adaptation of the tarnished plant bug (Heteroptera: Miridae) to its winter habitat in the Mississippi Delta. Environ. Entomol. 32:945–952.

Snodgrass, G.L., W.P. Scott, and J.W. Smith. 1984. Host plants and seasonal distribution of the tarnished plant bug (Hemiptera: Miridae) in the delta of Arkansas, Louisiana, and Mississippi. Environ. Entomol. 13:110–116.

Snodgrass, G.L., R.E. Jackson, C.A. Abel, and O.P. Perera. 2010. Utilization of early soybeans for food and reproduction by the tarnished plant bug (Hemiptera: Miridae) in the Delta of Mississippi. Environ. Entomol. 29:1111–1121.

Timmons, F.D., T.S. Brook, and F.A. Harris. 1973. Effects of aldicarb applied side-dress to cotton on some arthropods in the Monroe County, Mississippi, boll weevil diapause-control area in 1969. J. Econ. Entomol. 66:152–153.

Tugwell, P., S.C. Young, B.A. Dumas, and J.R. Phillips 1976. Plant bugs in cotton: importance of infestation time, types of cotton injury, and significance of wild hosts near cotton. AR Agric. Exp. Stn. Rept., Univ. Arkansas, Fayetteville, AR.

Wood, C.W., J. Gore, A. Catchot, D. Cook, D. Dodds, and L.J. Krutz. 2016. Susceptibility of flowering cotton to damage and yield loss from tarnished plant bug (Hemiptera: Miridae). J. Econ. Entomol. 109:1188–1195.