TOXICITY OF ACEPHATE, CYPERMETHRIN, AND OXAMYL TO TARNISHED PLANT BUGS IN VIAL BIOASSAYS AND CAGE STUDIES ON COTTON

J. H. Pankey, B. R. Leonard,
J. B. Graves, and E. Burris;
Research Assistant, Associate Professor,
Professor, and Assistant Professor; respectively,
LSU Agricultural Center,
Louisiana Agricultural Experiment Station
Baton Rouge, LA

Abstract

Tarnished plant bugs were collected from various hosts and locations throughout Louisiana to monitor for tolerance to a carbamate, organophos-phate, and pyrethroid insecticide. Insects were tested using the residual film vial bioassay. Field tests also were conducted with the same insecticides by caging tarnished plant bugs on treated cotton terminals. Tarnished plant bugs collected April through July of 1994 and 1995 usually had significantly lower LC_{50} values (4-37x) than collections from August when tested with cyper-methrin. LC_{50}'s for acephate ranged from 0.93 μg/vial (Franklin Parish in June, 1995) to 6.49 μg/vial (Richland Parish in June, 1994) a 7X difference. The lowest LC_{50} for oxamyl was 0.92 μg/vial (Caddo Parish from alfalfa, June 1995), while the highest value was 4.84 μg/vial (Franklin Parish from cotton, August 1995), a 5X difference. In the field tests, tarnished plant bug adult mortality was significantly higher on acephate and oxamyl treated terminals compared to cypermethrin treated terminals when test insects were caged 2 hours after treatment (HAT). There were no significant differences in mortality among treatments when nymphs were caged 2 HAT or when adults or nymphs were caged 2 days after treatments (DAT). When caged 2 HAT, there was no significant difference between adult and nymph mortality for each insecticide. However, when caged 2 DAT, adult mortality was significantly lower than nymph mortality for each insecticide.

Introduction

The tarnished plant bug, *Lygus lineolaris* (Palisot de Beauvois), is an impor-tant pest of cotton in the Mid-South. This insect has gained recognition over the past few years due to the declining efficacy of insecticides registered for its control. Resistance of this species to several insecticide classes (carbamates, organochlorines, organophosphate, and pyrethroids) has been documented over the past two decades. Resistance to the organophosphates, methyl parathion (Cleveland and Furr 1979) and dimethoate (Snodgrass and Scott 1988), was confirmed in tarnished plant bug populations from Mississippi. Recently, another field collection of tarnished plant bugs from Mississippi exhibited resistance to the pyrethroids, permethrin and bifenthrin (Snodgrass 1994). Tarnished plant bugs from this same region of Mississippi also exhibited resistance to the organophosphates, dicrotophos and methyl parathion (Snodgrass and Elzen 1995). In Arkansas, Hollingsworth et al. (1995, submitted) reported tarnished plant bugs to be resistant to an organophosphate, dimethoate; an organochlorine, endosulfan; a pyrethroid, lambda-cyhalothrin; and a carbamate, oxamyl.

Studies reported herein were conducted in Louisiana from April through September of 1994 and 1995 to determine the responses of tarnished plant bug populations from several hosts and locations to a representative carbamate (oxamyl), organophosphate (acephate), and pyrethroid (cypermethrin). Tests also were conducted to evaluate the efficacy of these insecticides against tarnished plant bugs caged on treated cotton plants.

Materials and Methods

Tarnished plant bugs were collected from various hosts and locations throughout Northeast Louisiana from April through September during both 1994 and 1995 (Table 1). All of the collections from North Louisiana were made in cotton producing parishes with relatively high insecticide use. In 1995, a collection was made in South Louisiana (near Baton Rouge in East Baton Rouge Parish), where cotton acreage and insecticide use is relatively low. Collections were made with a standard 15 in. diameter sweep net. After collection, tarnished plant bugs were placed in a 1.5 $ft.^3$ wire mesh cage, fed green beans (*Phaseolus* spp.), and held overnight.

Tarnished plant bug adults were tested for their responses to acephate, cypermethrin, and oxamyl using the vial bioassay (Snodgrass 1994). Technical-grade samples of acephate (Valent USA, Walnut Creek, CA), cypermethrin (FMC Corporation, Middleport, NY), and oxamyl (Du Pont E.I de Nemours, Wilmington, DE) were obtained from the manufacturers and appropriate doses prepared in acetone. Vials were treated individually with each insecticide as described by Plapp et al. (1987) and stored in the freezer until bioassays were conducted. Five-six concentrations were tested against each population. Acetone treated vials served as controls and percent mortality in the control vials was corrected using Abbott's formula (1925). Bioassays (3 tarnished plant bugs/vial) were done at room temperature (70°F) and observations for mortality made 24 h post-treatment. LC_{50} values, 95% confidence intervals, and slopes of ld-p lines were determined by probit analysis (Robertson and Preisler 1992). LC_{50} values were considered significantly different if 95% confidence limits did not overlap

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Field efficacy studies were conducted in 1995 at the Macon Ridge Location of the Northeast Research Station near Winnsboro, LA. Treatments were acephate (Orthene 90 SP [0.50 lb AI/acre], Valent USA, Walnut Creek, CA), cypermethrin (Ammo 3 EC [0.04 lb AI/acre], FMC Corp., Middleport, NY), and oxamyl (Vydate 3.77 L [0.25 lb AI/acre], E. I. DuPont de Nemours and Co., Wilmington, DE), and an untreated control. Plots were two rows (40-in. spacing) x 30 ft. Treatments were arranged in a randomized complete block design with four replications. Applications were made with a tractor mounted boom system equipped with two TX-8 hollow cone nozzles/row and calibrated to deliver 10 gallons finished spray/acre. Treatments were applied on 20 June and 22 July. Two hours after treatment (HAT), five adult or nymph (3-5 instar) tarnished plant bugs were introduced into small nylon mesh cages (2 cages/plot). Each cage was placed over a randomly selected plant terminal in each plot. Mortality was recorded 2 days after treatment (DAT). The plots were reinfested 2 DAT in the same manner as described previously, and mortality again recorded 2 DAT. Mortality in the untreated plots was used to correct for natural mortality occurring in the treated plots (Abbott 1925).

Results

During 1994, all tarnished plant bug colonies, except the May collection from cutleaf primrose in Tensas Parish, tested with cypermethrin from April through July had significantly lower LC_{50}'s (6-37x) compared to LC_{50}'s for August collections (Table 2). The Caddo Parish population collected from alfalfa in May had a significantly lower LC_{50} compared to the Tensas Parish collections from cutleaf primrose and mustard in May. For collections made in the same month, there were no other significant differences in LC_{50}'s among colonies made during April, May, June, July, or August (Table 2). Slopes of ld-p lines ranged from 0.76 (Concordia Parish in April) to 3.24 (Bossier Parish from cotton in June). In 1995, tarnished plant bugs tested from April through June with cypermethrin vials had significantly lower LC_{50}'s (4-22x) compared to LC_{50}'s for August collections from cotton (Table 3). The LC_{50} of the Franklin Parish collection in July was significantly lower than the LC_{50} of the August collection from Franklin Parish, but not from the LC_{50} of the Tensas Parish collection made in August. The East Baton Rouge and Franklin Parish collections in April had significantly lower LC_{50}'s than the Franklin Parish collection made in September. The Franklin Parish collection from *Coreopsis* spp. in June and the Caddo Parish collection from alfalfa in June also had significantly lower LC_{50}'s than the Franklin Parish collection in September. The East Baton Rouge Parish collection had a significantly lower LC_{50} compared to the Franklin Parish collection from May. There were no other significant differences in LC_{50}'s among collections from April through July (Table 3). Slopes of ld-p lines ranged from 0.99 to 2.74.

The acephate LC_{50} values for the collections made in 1994 ranged from 1.10 (Bossier Parish in June) to 6.49 (Richland Parish in June), a 5.9x variation. The Richland Parish collection in June had a significantly higher LC_{50} compared to the Bossier Parish collection, Tensas Parish collection, and Franklin Parish collection from *Coreopsis* spp. Collections from Bossier Parish in June, Tensas Parish in June, and the Franklin Parish collection from *Coreopsis* spp. in June were significantly lower (3-4x) than the Franklin Parish collection from cotton in September. The Tensas Parish collection from cotton in July had a significantly higher LC_{50} compared to the collection from mustard during the same month. During June and July, there were no significant differences in LC_{50}'s among populations collected from mustard in Franklin and Tensas Parishes. The Tensas Parish collection from cotton in September had a significantly lower LC_{50} compared to other collections made from cotton during July, August, and September. Slope values ranged from 1.51(Tensas Parish in August) to 3.22 (Tensas Parish in September) during 1994. All collections made from April through June 1995 had significantly lower LC_{50}'s (1.7-4.6x) than the Franklin Parish collection from cotton in August (Table 5). These same collections except those from East Baton Rouge Parish in April and Franklin Parish in May and Ouachita Parish in May also had significantly lower LC_{50}'s than the Tensas collection from cotton in August. Slopes of ld-p lines in 1995 ranged from 1.78 (Franklin Parish in June) to 2.61 (Tensas Parish in May).

There were no significant differences in oxamyl LC_{50}'s among populations tested in 1994 except that the LC_{50}'s for the Tensas and Richland Parish collections in June which were significantly lower than one of the Tensas collections from cotton in August (Table 6). A Tensas Parish collection from cotton in August had the highest LC_{50} (3.46) whereas the Tensas Parish collection from mustard in June had the lowest LC_{50} (1.32). Slope values ranged from 1.62 (Tensas Parish in August) to 2.51 (Franklin Parish in June). During 1995, all May and June collections tested except for the Franklin Parish in June had significantly lower LC_{50}'s compared to the Franklin Parish collection from cotton in August (Table 7). The LC_{50}'s of all May collections and the Caddo collection from alfalfa in June also were significantly lower from the LC_{50} of the Franklin Parish collection in July. Slope values ranged from 1.38 (Ouachita Parish in May) to 2.76 (Caddo Parish from alfalfa in June).

In the cage bioassays, there were no significant differences among insecticides in percent mortality of tarnished plant bug nymphs caged on treated cotton 2 HAT (Table 8). Acephate and oxamyl caused significantly higher adult mortalities than cypermethrin at 2 HAT (Table 8). However, there were no significant differences in mortality among the three insecticides on individual life stages, when tarnished plant bugs were caged on treated terminals 2 DAT. All three insecticides caused significantly higher mortality of nymphs compared to adults when tarnished plant bugs were caged on cotton 2 DAT (Table 9).

Discussion

Resistance to cypermethrin in Louisiana populations of tarnished plant bugs was documented in both 1994 and 1995. The variation in values over both years was 0.57-21.22 μg/vial (37x variation). The highest LC_{50} values were 21.22 μg/vial for 1994 and 12.69 for 1995. These values are not as high as others previously reported, but they are within the range of values for tarnished plant bug populations reported as resistant to pyrethroids in other states.

LC_{50}'s values followed a trend associated with seasonal use of pyrethroids. The lowest LC_{50} values were recorded during April, May, and June. During this period of the cotton growing season, pyrethroid use is low. The highest values were generally observed in August when pyrethroid use is more common. For the single collection made in September 1995, the LC_{50} was not significantly different from that of several collections made during May, June and July. Reversion of pyrethroid resistance may occur during Septem-ber because pyrethroid use generally declines in late August and September.

Low levels of resistance to acephate were recorded in both 1994 and 1995. There was a 7x difference (0.93-6.49 μg/vial) in values over the two years. The highest LC_{50} for 1994 (6.49) was recorded in June, while the highest value in 1995 (6.18) was recorded in July. The LC_{50}'s for acephate of Louisiana collections made in the early season were significantly lower than the LC_{50} (12.60 µg/vial) (95% CL = 11.06-14.51) of the Stoneville lab colony (Snodgrass 1994). The LC_{50} (8.90 µg/vial) (95% CL = 7.65-10.22) of a Mississippi collection from cotton (Snodgrass and Elzen 1995) was significantly higher than LC_{50}'s of all Louisiana collections from cotton except for the Tensas Parish collection from August, 1994. During May and June, acephate is an insecticide commonly used to control tarnished plant bugs. Other organophosphates such as azinphosmethyl, dicrotophos, dimethoate, methamidophos, and methyl parathion are used to control early season insect pests of cotton. Later in the season, organophosphates such as profenofos and sulprofos are used for control of pyrethroid-resistant tobacco budworms (*Heliothis virescens* (F.)). The continuous use of insecticides in this class throughout the cotton growing season probably contributes to the overall tolerance of tarnished plant bugs to organophosphate.

There were low levels of resistance to oxamyl recorded in 1994 and 1995 using the vial bioassay. The LC_{50}'s ranged from 0.92-4.84 μg/vial (5x variation) over both years. The highest LC_{50}'s for oxamyl were recorded in August of both years. Although oxamyl frequently is used to control insect pests during May and June in cotton, this use is probably not enough to cause tolerance of the tarnished plant bugs to carbamates. However, other carbamates such as aldicarb, methomyl, and thiodicarb also are used to control cotton insect pests. Further, carbamates have a similar mode of action as organophosphates and cross-resistance may occur. LC_{50} values for oxamyl from Arkansas collections (7.2-26.0 µg/vial) were higher than those observed for Louisiana collections (Hollingsworth et al. 1995 submitted).

There was a general variation in the susceptibility of tarnished plant bugs from Louisiana to all three classes of insecticides, but the changes in LC_{50}'s generally corresponded with the seasonal use pattern of that insecticide class. Although the data in this study are limited, the hosts from which the tarnished plant bugs were collected did not appear to influence insecticide susceptibility. Based on comparisons with previously published data, tarnished plant bugs in Louisiana have varying levels of susceptibility to pyrethroids, organophosphate, and carbamates which could result in control failures during late July and August.

Acephate and oxamyl caused significantly higher mortality than cypermethrin for tarnished plant bug adults caged on cotton 2 HAT. When caged on cotton 2 DAT, there were no significant differences in mortality among treatments for each life stage. However, the nymphs sustained significantly higher mortality compared to the adults for each treatment. Although contact activity of these insecticides would result in reasonable control of tarnished plant bugs, residual activity of these insecticides appears to be low.

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Table 1. Location, date, host, and sample size (n tested) of tarnished plant bug populations tested in vial bioassays.

Location(Parish)	Date	Host	n
Bossier	June 1994	Cotton	48[1]
	June 1994	Alfalfa	174[1]
	June 1994	Alfalfa	150[2]
Caddo	May 1994	Alfalfa	207[1]
	June 1995	Alfalfa	210[1]
	June 1995	Horse Weed	198[1]
	June 1995	Alfalfa	180[2]
	June 1995	Alfalfa	144[3]
	June 1995	Horse Weed	171[3]
Concordia	April 1994	Crimson Clover	237[1]
	June 1994	Cotton	120[1]
	July 1994	Cotton	54[1]
E. Baton Rouge	April 1995	Fleabane/Red Clover	251[1]
	April 1995	Fleabane/Red Clover	234[2]
Franklin	May 1994	Cutleaf Primrose	57[1]
	May 1994	Mustard	44[1]
	May 1994	Alfalfa	180[1]
	May 1994	Lespedeza	93[1]
	June 1994	Alfalfa	330[2]
	June 1994	Lespedeza	75[2]
	June 1994	*Coreopsis* spp.	49[2]
	June 1994	Mustard	179[2]
	June 1994	*Coreopsis* spp.	234[3]
	June 1994	*Coreopsis* spp.	150[3]
	June 1994	Mustard	165[3]
	April 1995	Crimson Clover	225[1]
	April 1995	Crimson Clover	210[2]
	May 1995	Cutleaf Primrose	164[1]
	May 1995	Cutleaf Primrose	180[2]
	May 1995	Cutleaf Primrose	216[3]
	June 1995	*Coreopsis* spp.	320[1]
	June 1995	*Coreopsis* spp.	216[2]
	June 1995	Alfalfa	216[3]
	July 1995	Mustard	208[1]
	July 1995	Mustard	142[2]
	July 1995	Cotton	195[3]

Table 1. Continued

Location(Parish)	Date	Host	n
Franklin	August 1995	Cotton	216[1]
	August 1995	Cotton	216[2]
	August 1995	Cotton	180[3]
	Sept. 1995	Cotton	150[1]
Morehouse	June 1994	Cotton	45[1]
Ouachita	May 1995	Cutleaf Primrose	198[1]
	May 1995	Cutleaf Primrose	180[2]
	May 1995	Cutleaf Primrose	180[3]
Richland	June 1994	Black-eyed Susan	90[2]
	June 1994	Black-eyed Susan	135[3]
Tensas	May 1994	Cutleaf Primrose	57[1]
	May 1994	Mustard	39[1]
	May 1994	Cutleaf Primrose	229[1]
	June 1994	Cotton	77[1]
	June 1994	Mustard	75[2]
	June 1994	Mustard	354[3]
	July 1994	Alfalfa	325[1]
	July 1994	Mustard	120[2]
	July 1994	Cotton	150[2]
	July 1994	Mustard	268[3]
	August 1994	Cotton	112[1]
	August 1994	Cotton	99[1]
	August 1994	Cotton	75[3]
	August 1994	Cotton	150[3]
	August 1994	Cotton	126[2]
	August 1994	Cotton	120[2]
	May 1995	Pansy Dog Shade	150[1]
	May 1995	Pansy Dog Shade	135[2]
	May 1995	Pansy Dog Shade	180[3]
	August 1995	Cotton	174[1]
	August 1995	Cotton	174[2]
	Sept. 1995	Cotton	165[2]

[1]Tested with cypermethrin treated vials.
[2]Tested with acephate treated vials.
[3]Tested with oxamyl treated vials.

Table 2. Responses of Louisiana tarnished plant bug strains collected during1994 to cypermethrin at 24 hours after exposure

Location (Parish)	April LC_{50} (95% CL)	April Slope ± SE	May LC_{50} (95%CL)	May Slope ± SE
Concordia	1.71 (0.65-4.67)	0.76 ± 0.12[2]	---------[1]	
Franklin	0.91 (0.65-1.19)	1.51 ±0.16[2]	0.83 (0.31-1.63)	1.32±0.32[3]
			2.45 (0.59-6.26)	1.62 ± 0.55[4]
			1.17 (0.89-1.52)	2.09 ± 0.25[5]
			1.42 (0.62-2.40)	2.06 ± 0.52[6]
Tensas	-----------------------[1]		2.99 (1.07-19.43)	0.83 ± 0.29[3]
			2.75 (1.25-8.36)	1.40 ± 0.41[4]
			0.80 (0.28-1.50)	1.24 ± 0.20[3]
Morehouse	-----------------------[1]		---------[1]	
Caddo	----------------------[1]		0.73 (0.56-0.92)	2.12 ± 0.25[5]

Location (Parish)	June LC_{50} (95% CL)	June Slope ± SE	July LC_{50} (95% CL)	July Slope ± SE
Concordia	0.58 (0.17-1.00)	1.19 ± 0.29[7]	1.14 (0.69-1.82)	2.33 ± 0.54[7]
Tensas	1.69 (0.82-3.47)	1.11 ± 0.28[7]	2.49 (1.49-3.81)	1.23 ± 0.20[5]
Morehouse	0.65 (0.08-1.82)	0.94 ± 0.34[7]	-----------[1]	
Bossier	0.93 (0.61-1.37)	3.24 ± 0.98[7]	-----------[1]	
	0.65 (0.02-1.49)	1.91 ± 0.67[5]		

Location (Parish)	August LC_{50} (95% CL)	August Slope ± SE
Tensas	15.89 (8.79-112.20)	1.58 ± 0.49[7]
	21.22 (10.73-518.6)	1.54 ± 0.55[7]

[1] Collections not made.
[2] Collected from crimson clover.
[3] Collected from cutleaf primrose.
[4] Collected from mustard.
[5] Collected from alfalfa.
[6] Collected from lespedeza.
[7] Collected from cotton.

Table 3. Responses of Louisiana tarnished plant bug strains collected during 1995 to cypermethrin at 24 hours after exposure.

Location (Parish)	April LC_{50} (95% CL)	April Slope ± SE	May LC_{50} (95% CL)	May Slope ± SE
E.Baton Rouge	0.85 (0.65-1.09)	1.78 ± 0.18[2]	-------[1]	
Franklin	0.68 (0.23-1.34)	1.27 ± 0.17[3]	1.97 (1.23-3.89)	1.85 ± 0.27[4]
Tensas	-------------------------[1]		1.10 (0.35-3.40)	1.03 ± 0.21[5]
Ouachita	-------------------------[1]		1.21 (0.69-2.05)	1.78 ± 0.21[4]
Caddo	-------------------------[1]		--------[1]	

Location (Parish)	June LC_{50} (95% CL)	June Slope ± SE	July LC_{50} (95% CL)	July Slope ± SE
Franklin	1.09 (0.65-1.59)	1.58 ± 0.22[6]	2.64 (0.85-4.26)	1.75 ± 0.50[9]
Caddo	0.57 (0.40-0.76)	1.70 ± 0.23[7]	------------[1]	
	1.34 (0.73-1.89)	2.74 ± 0.56[8]		

Location (Parish)	August LC_{50} (95% CL)	August Slope ± SE	September LC_{50} (95% CL)	September Slope ± SE
Franklin	12.69 (6.38-59.97)	1.47 ± 0.21[10]	3.47 (1.64-7.23)	1.13± 0.21[10]
Tensas	8.34 (4.20-29.20)	0.99 ± 0.18[10]	---------[1]	

[1] Collections not made.
[2] Collected from fleabane and red clover.
[3] Collected from crimson clover.
[4] Collected from cutleaf primrose.
[5] Collected from pansy dog shade.
[6] Collected from *Coreopsis* spp.
[7] Collected from alfalfa.
[8] Collected from horse weed.
[9] Collected from mustard.
[10] Collected from cotton.

Table 4. Responses of Louisiana tarnished plant bug strains collected during 1994 to acephate at 24 hours after exposure.

Location (Parish)	June LC$_{50}$ (95% CL)	June Slope ± SE	July LC$_{50}$ (95% CL)	July Slope ± SE
Bossier	1.10 (0.33-2.15)	1.79 ± 0.29[2]	---[1]	
Franklin	4.29 (2.93-5.58)	2.54 ± 0.42[2]	2.85 (1.80-4.37)	2.74 ± 0.33[5]
	2.31 (1.32-3.74)	1.65 ± 0.34[3]		
	1.16 (0.30-1.83)	2.44 ± 0.86[4]		
	1.80 (0.54-3.64)	2.11 ± 0.31[5]		
Tensas	1.49 (0.93-2.30)	2.20 ± 0.43[5]	1.99 (1.50-2.64)	2.59 ± 0.56[5]
			5.69 (4.55-7.15)	2.73 ± 0.38[7]
Richland	6.49 (2.75-10.6)	2.52 ± 0.69[6]	---[1]	

Location (Parish)	August LC$_{50}$ (95% CL)	August Slope ± SE	September LC$_{50}$ (95% CL)	September Slope ± SE
Franklin	---[1]		4.60 (3.42-6.68)	1.83±0.29[7]
Tensas	6.17 (4.20-9.83)	1.51 ± 0.26[7]	1.46 (1.19-1.77)	3.22 ±0.43[7]
	3.65 (2.03-6.70)	1.99 ± 0.30[7]		

[1] Collections not made.
[2] Collected from alfalfa.
[3] Collected from lespedeza.
[4] Collected from *Coreopsis* spp.
[5] Collected from mustard.
[6] Collected from black-eyed susan.
[7] Collected from cotton.

Table 5. Responses of Louisiana tarnished plant bug strains collected during 1995 to acephate at 24 hours after exposure.

Location (Parish)	April LC$_{50}$ (95% CL)	April Slope ± SE	May LC$_{50}$ (95% CL)	May Slope ± SE
E. Baton Rouge	1.70 (0.87-2.85)	1.82 ± 0.22[2]	---[1]	
Franklin	1.44 (1.10-1.85)	1.99 ± 0.25[3]	2.53 (1.96-3.22)	2.28 ± 0.28[4]
Tensas	---[1]		1.59 (1.23-2.03)	2.61 ± 0.37[5]
Ouachita	---[1]		2.23 (1.53-3.18)	2.46 ± 0.31[4]

Location (Parish)	June LC$_{50}$ (95% CL)	June Slope ± SE	July LC$_{50}$ (95% CL)	July Slope ± SE
Franklin	0.93 (0.63-1.24)	1.78 ± 0.25[6]	6.18 (2.21-9.01)	2.36 ± 0.70[8]
Caddo	0.99 (0.16-1.82)	2.48 ± 0.72[7]	---[1]	

Location (Parish)	August LC$_{50}$ (95% CL)	August Slope ± SE
Franklin	4.24 (3.36-5.39)	2.09 ± 0.24[9]
Tensas	2.76 (2.18-3.50)	2.58 ± 0.31[9]

[1] Collections not made.
[2] Collected from fleabane and crimson clover.
[3] Collected from crimson clover.
[4] Collected from cutleaf primrose.
[5] Collected from pansy dog shade.
[6] Collected from *Coreopsis* spp.
[7] Collected from alfalfa.
[8] Collected from mustard.
[9] Collected from cotton.

Table 6. Responses of Louisiana tarnished plant bug strains collected during1994 to oxamyl at 24 hours after exposure.

Location (Parish)	June LC50 (95% CL)	June Slope ± SE	July LC50 (95% CL)	July Slope ± SE
Franklin	--------[1]		1.64 (0.96-2.51)	2.06 ± 0.24[2]
			1.99 (0.54-3.61)	2.51 ± 0.49[2]
			1.59 (0.81-2.72)	1.81 ± 0.26[3]
Tensas	1.32 (0.88-1.80)	1.70 ± 0.20[3]	2.14 (0.74-3.65)	1.94 ± 0.34[3]
Richland	1.39 (0.92-1.94)	1.64 ± 0.28[4]	----------[1]	

Location (Parish)	August LC50 (95% CL)	August Slope ± SE
Tensas	3.46 (2.17-5.16)	1.97 ± 0.41[5]
	1.61 (0.73-2.80)	1.62 ± 0.25[5]

[1] Collections not made.
[2] Collected from *Coreopsis* spp.
[3] Collected from mustard.
[4] Collected from black-eyed susan.
[5] Collected from cotton.

Table 7. Responses of Louisiana tarnished plant bug strains collected during 1995 to oxamyl at 24 hours after exposure.

Location (Parish)	May LC50 (95% CL)	May Slope ± SE	June LC50 (95% CL)	June Slope ± SE
Franklin	1.54 (1.03-2.18)	2.07 ± 0.25[2]	2.58 (1.32-3.82)	2.15 ± 0.40[4]
Tensas	1.78 (1.38-2.26)	2.42 ± 0.31[3]	------------[1]	
Ouachita	0.96 (0.55-1.41)	1.38 ± 0.23[2]	------------[1]	
Caddo	------------------------[1]		0.92 (0.41-1.53)	2.76 ± 0.42[5]
			1.78 (1.15-2.80)	2.27 ± 0.32[6]

Location (Parish)	July LC50 (95% CL)	July Slope ± SE	August LC50 (95% CL)	August Slope ± SE
Franklin	3.03 (2.31-4.02)	1.88 ± 0.21[7]	4.84 (3.71-6.15)	2.49 ± 0.31[8]

[1] Collections not made.
[2] Collected from cutleaf primrose.
[3] Collected from pansy dog shade.
[4] Collected from *Coreopsis* spp.
[5] Collected from alfalfa.
[6] Collected from horse weed.
[7] Collected from mustard.
[8] Collected from cotton.

Table 8. Insecticide efficacy against tarnished plant bug adults and nymphs in a cage study on cotton[1].

Insecticide	% Mortality[2] Adults	Nymphs
Acephate	91.1a	77.6a
Cypermethrin	62.6b	67.2a
Oxamyl	87.1a	69.5a

Mortality values within columns followed by the same letter are not significantly different according to DMRT(P=0.05).
[1]Infested 2 hours after treatment (HAT).
[2]Corrected for control mortality of adults (14.4%) and nymphs (14.8%).

Table 9. Residual insecticide efficacy comparison between adult and nymph tarnished plant bugs in a cage study on cotton.[1]

Insecticide	% Mortality[2] Adults	Nymphs
Acephate	1.6a*	16.6a
Cypermethrin	6.3a*	18.9a
Oxamyl	4.9a*	27.2a

Mortality values within columns followed by the same letter are not significantly different according to DMRT(P=0.05).
*Indicates significant difference in mortality among life stages (adults vs. nymphs).
[1]Infested 2 days after treatment (DAT).
[2]Corrected for control mortality of adults (6.5%) and nymphs (3.8%).