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Seasonal Occurrence and Abundance of Sharpshooter Leafhoppers in Alabama Orchards and Vineyards

XING MA, ELINA CONEVA, HENRY FADAMIRO, JOHN F. MURPHY, CHARLES RAY, and FENNY DANE
Department of Horticulture, Auburn University, Auburn, Alabama, USA

Although the bacterium Xylella fastidiosa *(Xf) has been confirmed to cause economic losses to numerous fruit crop species in the southeastern U.S. since 1933, no science-based information is available on the occurrence of infection in economic fruit crops grown in Alabama, as well as the presence of effective Xf vectors in the state. An investigation to identify the sharpshooter (Hemiptera: Cicadellidae) fauna and to determine their occurrence in selected orchards and vineyards was conducted in Alabama during 2008–2009. Leafhoppers were trapped in three different geographic locations: in the Gulf Coast, Central, and North Alabama. Seven species of sharpshooters were identified, including:* Homalodisca vitripennis *(Germar),* H. insolita *(Walker),* Oncometopia orbona *(Fabricius),* Paraulacizes irrorata *(Fabricius),* Graphocephala coccinea *(Forster),* Graphocephala versuta *(Say), and* Draeculacephala *spp.* H. vitripennis *and* G. versuta *were the most prevalent species in Alabama orchards and vineyards; however, their proportion varied by location.* H. vitripennis *was the most abundant species trapped in the Gulf Coast area, whereas G. versuta was the most prevalent sharpshooter species in Central and North Alabama. The results are discussed in relation to the likelihood and efficiency of these species as Xf vectors in Alabama.*

KEYWORDS Xylella fastidiosa, *sharpshooter leafhopper,* Homalodisca vitripennis, Homalodisca insolita, Oncometopia

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Address correspondence to Elina Coneva, Department of Horticulture, Auburn University, 101 Funchess Hall, Auburn, AL 36849, USA. E-mail: edc0001@auburn.edu

orbona, Graphocephala versuta, *grape, peach, plum, blueberry, citrus*

INTRODUCTION

Recently, the xylem-limited bacterium, Xylella fastidiosa (*Xf*), has emerged as one of the most significant new disease threats in the Americas (Hopkins and Prucell, 2002). This pathogen has a relatively wide host range (Mizell et al., 2009), and induces a variety of plant diseases in numerous fruit and nut crops, such as bunch grape (Davis et al., 1978; Wells et al., 1983), peach, plum (Boyhan et al., 1997), citrus (Chang et al., 1993), avocado (Montero-Astúa and Saborio-R, 2008), pecan (Sanderlin and Heyderich-Alger, 2000), and almond (Mircetich et al., 1976). Most recently, a new disorder affecting southern highbush blueberry cultivars was observed in the southeastern U.S. and subsequently proved to be caused by *Xf*. The disease was named bacterial leaf scorch of blueberries (Chang et al., 2009).

In Alabama, fruit crops of economic importance threatened by the spread of *Xf* include peach (*Prunus persica*), plum (*Prunus domestica*), blueberry (*Vaccinium ashei*), hybrid bunch grapes (*Vitis* spp.), muscadine grapes (*Vitis rotundifolia*), and Satsuma mandarin (*Citrus unshiu*). According to the National Agricultural Statistics Service, United States Department of Agriculture (http://quickstats.nass.usda.gov/), peach production has been the largest fruit tree industry in Alabama for the last decade. Peach acreage reached 1,013 ha in 2007 in Alabama, of which 913 ha were bearing peach orchards. Blueberry production ranks second among fruit crops in terms of acreage, with a total of 249 ha. Grape production, including bunch and muscadine grape, ranks third with 189 hectares. When compared to grape production one decade ago, there is a 41% increase representing considerable growth. The category of plum and prune ranks next to the grape, and shows only a slight increase for the last decade. One possible reason is the losses associated with plum leaf scald (PLS) and the associated short longevity of plum orchards in Alabama, where the PLS disease pressure is high. The citrus industry currently accounts for 44 ha. The production of Satsuma mandarin in Mobile and Baldwin County of Alabama has been growing since the early 1990s (Fadamiro et al., 2008).

Mechanical transmission, root grafting, and insect vectors are the known transmission pathways of *Xf* (Krell et al., 2007). Since *Xf* is strictly confined in xylem vessels of the plant, xylem-feeding insects from the sharpshooter subfamily (Cicadellidae: Cicadellinae) (Severin, 1949) and the spittlebug family (Cercopidae) (Severin, 1950) are considered the major vectors transmitting *Xf*-induced diseases.

Thirty-nine species of sharpshooters have been confirmed to transmit *Xf*-induced diseases (Redak et al., 2004). Among those *Xf* vectors, *Xyphon* *fulgida*, *Draeculacephala minerva*, *Homalodisca vitripennis*, *Graphocephla atropunctata*, and *Oncometopia* spp. were found to be abundant in fields with *Xf* infection or in adjacent fields in North America (Purcell and Frazier, 1985). Myers et al. (2007) determined that the most abundant sharpshooter vectors in North Carolina were *Oncometopia orbona*, *G. versuta*, *Paraphlepsius irroratus*, and *Agalliota vvvconstricta*. The identity of sharpshooter vectors in Alabama has not yet been reported and science-based information on this economically important vector is lacking.

The transmission efficiency of *Xf* is dependent on a combination of host, vector, and pathogen strain (Redak et al., 2004), and only a small proportion of the combinations have been studied. The importance of the *Xf* vector was considered to also be related to its occurrence on, or near, *Xf*-infected orchards or vineyards (Almeida et al., 2005). Thus, *H. vitripennis* was thought to be the most economically important vector within the sharpshooter subfamily due to its abundance in vineyards (Redak et al., 2004). *Graphocephala atropunctata* (Signoret) was abundant in riparian vineyards and irrigated landscapes in California (Hopkins and Purcell, 2002). The distribution of *D. minerva* and *X. fulgida* was associated with the *Xf* transmission in vineyards adjacent to irrigated pastures and alfalfa fields in the Central Valley, California (Hewitt et al., 1942).

According to Turner and Pollard (1959), *H. vitripennis* is a strictly southern species, abundant from the latitude of Augusta, Georgia, to Leesburg, Florida, with a western boundary of ValVerde and Edwards counties in Texas. Studies by Sorensen and Gill (1996) demonstrated that the range of *H. vitripennis* has extended to several counties in southern California.

Although in the southeastern U.S., *Draeculacephala* spp., *Homalodisca vitripennis*, *Graphocephla* spp., and *Oncometopia* spp. (Mizell et al., 2003; Myers et al., 2007) vector species are considered to be prevalent in orchards and vineyards, no scientifically based records exist of the prevailing species identity and occurrence in Alabama orchards and vineyards. The main objectives of this study were to: (1) determine seasonal abundance of key sharpshooter species in three geographical regions—Gulf Coast, Central, and North Alabama; and (2) survey sharpshooter populations on six different fruit crops including hybrid bunch grapes, muscadine grapes, peaches, plums, Satsuma mandarins, and blueberries.

MATERIALS AND METHODS

Site Selection

Three locations representing three distinct geographical regions in Alabama were selected (Table 1): Mobile (Gulf Coast), Clanton (central AL), and Athens (north AL).

TABLE 1 Sharpshooter Trapping Sites in Alabama, 2008–2009: Location, Elevation and Fruit Crop Description

Region	Location	County	Latitude	Longitude	Elevation (m)	Crop
Gulf Coast	Mobile	Mobile	30°26.4′	88°13.1′	23	Peach Satsuma mandarin
		Baldwin	30°32.6′	87°44.5′	41	Plum Muscadine grape Blueberry
Central Alabama	Clanton	Chilton	32°55.2′	88°40.3′	207	Peach Plum Satsuma Muscadine grape Bunch grape Blueberry
North Alabama	Athens	Limestone	34°6.1′	86°54.0′	207	Peach Plum Bunch grape Blueberry

Sharpshooter Trapping

Double sided 7.62 cm × 15.24 cm yellow sticky traps (Great Lakes IPM Inc., Vestaburg, Michigan, USA) (Hall and Hunter, 2008) were deployed on six fruit species, including hybrid bunch grape, muscadine grape, peach, plum, and Satsuma mandarin in the 2008 survey. Rabbiteye blueberry plots were added to the 2009 survey. The experimental fruit orchards or vineyards included in our investigation were maintained by the landowners or Alabama Agricultural Experiment Station personnel and standard commercial production and pest management practices were applied.

In 2008, from May 21 until October 10, four traps per crop per experimental site were used to capture insects present in the orchards. The number of glassy-winged sharpshooter (*H. vitripennis*) captured on each trap was recorded biweekly. In 2009, trapping at the experimental sites began on April 1 and continued until September 18. We initiated an earlier trapping in 2009 to monitor the beginning of the sharpshooter entrance into the orchards and vineyards, since early season infections are reported to play a significant role, especially in vineyard infections (Feil and Purcell, 2001). A 4-cm strip of clear, fibrous tape (Clear Duck tape; Henkel Consumer Adhesives, Inc., Avon, Ohio, USA) was placed on the tops of both sides of the trap to prevent trap tearing in strong winds (Myers et al., 2007). For each fruit species, traps were placed on the outer limbs of fruit trees located on the orchard periphery. Traps were positioned on the cordon wires at about 1 m above ground on the perimeter of each vineyard (Myers et al., 2007). Every other week, traps were removed from trees, enclosed in 1.25 L plastic bags for transportation to the lab, and subsequently stored at room temperature prior to insect identification and counting. Traps were processed in the lab by using Histoclear (RA Lamb LLC, Apex, North Carolina, USA) to dissolve the adhesive and remove the trapped insects. Species identification was done by comparison to a published key developed by the Texas A&M University (http://beaumont.tamu.edu/research/agroecosystems/grapes/KeyToLeafhoppers.htm# Introduction) and using sharpshooter pictures confirmed by the specialist at the Plant Disease Diagnostic Lab at Auburn University. The total number of insects of each confirmed sharpshooter species was counted and recorded after identification. Individual species representatives were preserved in 70% ethanol, subsequently pinned as voucher specimens, and deposited in the Auburn University Entomological Museum.

We hypothesized that the leafhopper abundance would vary depending on the geographical location in Alabama based on the previously established *H. vitripennis* range.

For a comparison of trap captures across the growing season within all crops in a site, analysis of variance with repeated measures was performed using JMP (SAS Institute, Cary, North Carolina, USA).

RESULTS

Seasonal Abundance of Key Sharpshooter Species

In 2008, a total number of 5,289 *H. vitripennis* adults were captured from 432 yellow sticky traps deployed at three Alabama locations on five fruit crops (Table 2). In 2009, we expanded the survey to include data on other leafhopper species present on traps. Consequently, nine leafhopper species from five genera were identified in 2009. The total number of all sharpshooter insects captured during the second year of our study was 6,534. Four large

TABLE 2 Number of Leafhoppers Trapped on Yellow Sticky Traps in Commercial Orchards and Vineyards in Three Alabama Regions during 2008 and 2009, and the Percent Composition of the Most Prevalent Species

Year	Leafhopper species	Total trapped in all orchards and vineyards (No.)	Percentage of all trapped (%)
2008	*Homalodisca vitripennis*	5,289	100
2009	*Homalodisca vitripennis*	3,358	51.4
	Graphocaphala versuta	2,532	38.8
	Homalodisca insolita	241	3.7
	Oncometopia orbona	195	3.0
	Draeculacephala spp.	90	1.4
	Graphocephala coccinea	69	1.1
	Paraulacizes irrorata	49	0.7
	Total	6,534	100

size species (body length >10 mm) were identified in Alabama orchards and vineyards, including: *Homalodisca vitripennis* (Germar)—(glassy-winged sharpshooter), *H. insolita* (Walker), *Oncometopia orbona* (Fabricius)—(broad-headed sharpshooter), and *Paraulacizes irrorata* (Fabricius)—(speckled sharpshooter). Small size species (body length <10 mm) included *Graphocephala coccinea* (Forster)—(red-banded leafhopper), *G. versuta* (Say), and *Draeculacephala* spp. Due to the slight color pattern differences among various *Draeculacephala* species, we did not separate between *Draeculacephala* spp., instead, *Draeculacephala* spp. individual representatives were considered as a group in this study. Identification of *Draeculacephala* species suggested that *Draeculacephala* species, at a minimum, consisted of *D. balli, D. bradleyi, and D. mollipes.*

Our results revealed that *H. vitripennis* and *G. versuta* were the most prevalent sharpshooter species captured in Alabama orchards and vineyards, constituting 51.4 and 38.8% of the total number trapped respectively (Table 2). All other sharpshooter species captured in our traps accounted for a small percentage of total sharpshooter populations and ranged from 0.7% for *P. irrorrata* to 3.7% for *H. insolita*.

Representative specimens of all collected species were preserved in 75% alcohol. The capture period of *H. vitripennis* began in mid- to late May in both years throughout the state (Fig. 1). The greatest numbers of *H. vitripennis* were trapped in both years in the Mobile area with a peak capture in mid-June. Generally, very large numbers of *H. vitripennis* were trapped in Mobile with 2008 traps totaling 3,735 individuals and 2009 traps totaling 1,534 individuals during the peak trapping periods. In Clanton, *H. vitripennis* was captured in the beginning of June in both years of the study. Peak captures occurred in late July to early August in 2008. In 2009, the capture peaked in late June to early July with a second peak in mid-August. At Athens, *H. vitripennis* captures were relatively low in 2008, with a peak of less than 1 insects/trap on average in late July to early August. No *H. vitripennis* individuals were trapped in Athens during the 2009 season. Overall, the *H. vitripennis* catches were highest in Mobile and lowest in the Athens region in both years of the study.

Sharpshooter species trapped during 2009 varied in their relative composition between the three growing regions studied. Eighty-one percent of the leafhoppers caught in orchards and vineyards in the Gulf Coast area were *H. vitripennis*, compared with 41% in Central Alabama, and 0% in North Alabama. In contrast, 76% of the leafhoppers trapped in North Alabama were *Graphocephala versuta,* compared with 53% in Central Alabama, and 7% in the Gulf Coast area.

In 2009, *H. vitripennis,* captured on six crops, was the most frequently captured sharpshooter species in the Mobile area, with a peak in mid-June, when the maximum mean number was nearly 40 insects/trap (Fig. 2). A decrease in capture numbers was observed in July and by the

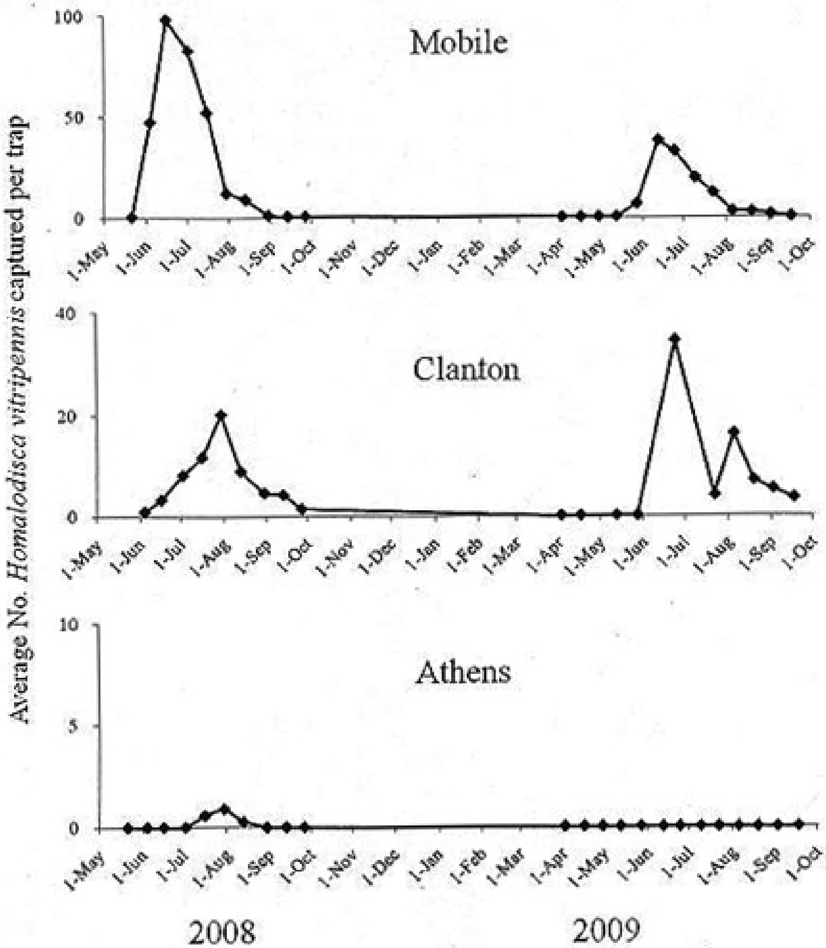

FIGURE 1 Mean number of *Homalodisca vitripennis* captured on yellow sticky traps placed at six fruit crops or vineyards in Mobile (Gulf Coast), Clanton (Central AL), and Athens (North AL) in 2008 and 2009. Each number represents the average sharpshooter capture of four traps per crop on a given sampling date.

beginning of August the mean number of insects captured per trap was five. All other sharpshooter species captured at the Mobile location had a relatively low number of captures throughout the entire season. *H. insolita* were frequently captured in two periods: early April and late July to early August. In early April, the average number of *H. insolita* captured per trap was 1.3, and increased to 4.7 individuals per trap in July to early August.

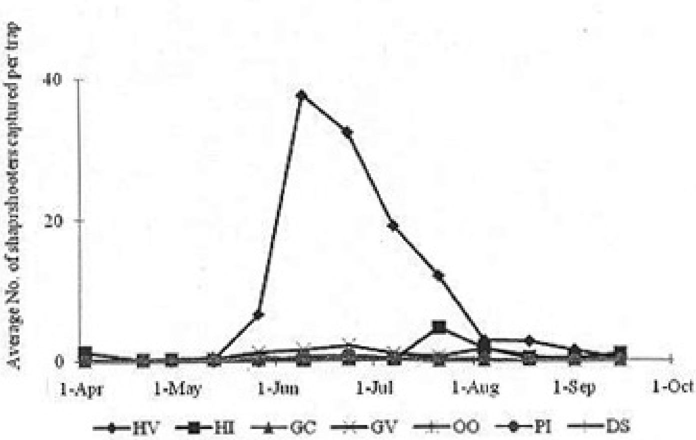

FIGURE 2 Seasonal capture of seven sharpshooter species in Mobile (Gulf Coast) in 2009. Each number represents the average sharpshooter capture across the growing season of four traps per crop on six crop species. Insect species name: HV = *Homalodisca vitripennis*; HI = *Homalodisca insolita*; GC = *Graphocephala coccinea*; GV = *Graphocephala versuta*; OO = *Oncometopia orbona*; PI = *Paraulacizes irrorata*; DS = *Draeculacephala* spp.

The first collection of *G. versuta* was in mid-April and persisted throughout the growing season with a low average number per trap. Its capture number peaked in late June with an average number of 2.2 individuals per trap. No *Draculacephala* spp. were trapped on yellow cards until late May. In late June, 0.3 individuals per trap were recorded. *G. coccinea*, *O. orbona*, and *P. irrorata* were absent from yellow sticky traps deployed at the Mobile location. Their average number never exceeded one per trap throughout the growing season.

In Clanton (Fig. 3), *H. vitripennis* and *G. versuta* were the most frequently trapped sharpshooter species. The peak capture for *H. vitripennis* was recorded in late June, when the average number of insects per trap reached 34. In early August, a second peak of *H. vitripennis* captures was observed with an average of 16 insects per trap. *G. versuta* sharpshooters were captured for the first time in Clanton in mid-June during the 2009 season. In late June, a peak capture of *G. versuta* was recorded, when the average number reached 18 per trap. Numbers of captured *G. versuta* remained greater than 10 per trap throughout the rest of the season in 2009. *O. orbona* was also observed on traps in Clanton after mid-June. Its peak capture occurred in late June and early August when 2 insects per trap were recorded. *Draeculacephala* spp. began to be trapped in Clanton at the same period as *G. versuta* and *O. oborna* species. Its capture was low throughout the season, with an average number less than 0.3 insects per trap. Individuals of *H. insolita* were captured in nine out of ten sampling cycles. The only cycle in which it did not appear on traps was in mid-April. *H insolita* had

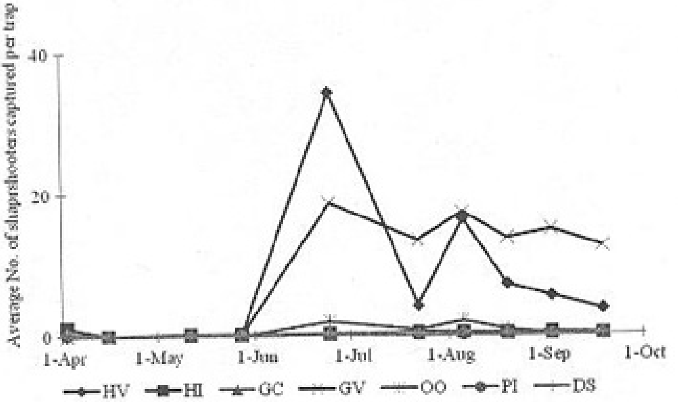

FIGURE 3 Seasonal capture of seven sharpshooter species in Clanton (Central Alabama) in 2009. Each number represents the average sharpshooter capture across the growing season of four traps per crop on six crop species. Insect species name: HV = *Homalodisca vitripennis*; HI = *Homalodisca insolita*; GC = *Graphocephala coccinea*; GV = *Graphocephala versuta*; OO = *Oncometopia orbona*; PI = *Paraulacizes irrorata*; DS = *Draeculacephala* spp.

its peak capture of 1.2 insects per trap in early April. *P. irrorata* was captured only in early April and mid-June throughout the 2009 season and the number of captured individuals was very low.

At the Athens location, no *H. vitripennis* were captured during the 2009 sampling season (Fig. 4). *H. insolita* were found on traps only in the last two sampling cycles in September. *G. versuta* was the most frequently captured sharpshooter species in Athens, where a peak of 12 insects per trap was recorded in late June. Our results suggest that *G. versuta* population began to be trapped in late May in Athens and captures gradually decreased to 0.1 insect per trap in mid-September. *G. coccinea* appeared on yellow sticky traps in mid-June and the mean number of captures was low (0.3 insects per trap). *O. orbona* appeared on traps in mid-May and persisted until late August in Athens with a peak observed in late July (1.3 individuals per trap). *Draeculacephala* spp. appeared between mid-June and early September with a high capture of two insects per trap in late August. *P. irrorata* was captured in mid-April and July and only low numbers of insects were trapped.

Relative Sharpshooter Abundance on Six Fruit Crop Species

In 2008, *H. vitripennis* was found in all three locations studied in our survey. Significant differences were found between the average numbers of

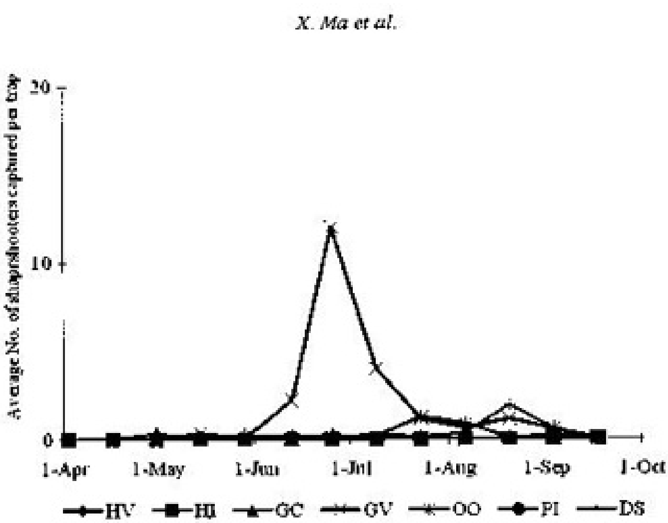

FIGURE 4 Seasonal capture of seven sharpshooter species in Athens (North Alabama) in 2009. Each number represents the average sharpshooter capture across the growing season of four traps per crop on six crop species. Insect species name: HV = *Homalodisca vitripennis*; HI = *Homalodisca insolita*; GC = *Graphocephala coccinea*; GV = *Graphocephala versuta*; OO = *Oncometopia orbona*; PI = *Paraulacizes irrorata*; DS = *Draeculacephala* spp.

H. vitripennis captured per trap during the entire season based on the type of crop species grown at the Clanton and Mobile locations (Table 3). The greatest number of *H. vitripennis* (17.2) captured per trap at Clanton was found on hybrid bunch grapes. High numbers of *H. vitripennis* were also found on Satsuma mandarins and muscadine grapes in the same location, while a significantly lower mean number of *H. vitripennis* were observed

TABLE 3 Seasonal Mean Capture of *Homalodisca vitripennis* Trapped Bi-Weekly on Five Fruit Crops Using Yellow Sticky Traps from Three Alabama Locations in 2008

	Location								
	Athens			Clanton			Mobile		
Crop	Mean		SEM	Mean		SEM	Mean		SEM
Bunch grape	0.0	±	0.0	17.2	±	5a		—	
Peach	0.2	±	0.1	0.4	±	0.1c	10.1	±	2.6b
Plum	0.3	±	0.2	1.5	±	0.4bc	42.8	±	15.4ab
Satsuma mandarin		—		8.9	±	2.5ab	14.4	±	3.6b
Muscadine grape		—		7.1	±	1.8ab	52.3	±	13.3a
P-value	0.1061			< 0.0001			0.0021		
Significance[a]	NS			***			**		

NS, *, **, *** indicates nonsignificant or significant differences at $P = 0.05, 0.01$, or 0.001 respectively. Mean separation within columns by LSD at $P = 0.05$.

on peaches and plums. In Mobile, the highest number of *H. vitripennis* (52.3 insects/trap) was observed on muscadine grapes, and was not significantly different from the mean number of *H. vitripennis* found on plums (42.8 insects/trap). In both locations, significantly lower *H. vitripennis* numbers were found on peach trees. The capture of *H. vitripennis* was very low throughout the growing season on all of the crops studied at Athens. In 2009, no *H. vitripennis* were captured on yellow sticky traps in Athens (Table 4). In Clanton and Mobile, significant differences in insect abundance were again found on different crop species. The highest average number of *H. vitripennis* in Clanton were on hybrid bunch grapes (21.5 insects/trap) followed by muscadine grapes (13.8 insects/trap), and Satsuma mandarins (9.5 insects/trap). In Mobile, *H. vitripennis* was most numerous on Satsuma mandarins, followed by muscadine grapes.

Within each survey location, significant differences were found in the mean number of *Graphocephala versuta* trapped on different fruit crop species during the 2009 season. In Athens, the highest seasonal abundance of *G. versuta* was found on blueberry (3.4 insects/trap), which was not significantly different from the insect abundance on hybrid bunch grape (2.6 insects/trap) (Table 5). Significant differences of seasonal *G. versuta* mean number captured per trap were found between crops in Clanton. The average *G. versuta* captures from muscadine grape, hybrid bunch grape, and Satsuma mandarin were high—20.3 insects/trap, 17.8 insects/trap, and 8.5 insects/trap, respectively. However, blueberry and peach species were less preferred by *G. versuta* in Clanton, where an average of 4.3 insects/trap and 3.8 insects/trap were observed, respectively. In Mobile, a significant difference was found in the seasonal abundance of *G. versuta* based on the fruit species studied, with the highest seasonal mean number of *G. versuta* captured on Satsuma mandarin,

TABLE 4 Seasonal Mean Capture of *Homalodisca vitripennis* Trapped Bi-Weekly on Six Fruit Crops Using Yellow Sticky Traps from Three Alabama Locations in 2009

	Location								
	Athens			Clanton			Mobile		
Crop	Mean		SEM	Mean		SEM	Mean		SEM
Blueberry	0.0	±	0.0	0.2	±	0.1c	4.2	±	1.8b
Hybrid bunch grape	0.0	±	0.0	21.5	±	7.1a		—	
Peach	0.0	±	0.0	1.3	±	0.5bc	3.7	±	1.0b
Plum	0.0	±	0.0	1.8	±	0.5bc		—	
Satsuma mandarin		—		9.5	±	3.4ab	15.0	±	5.1a
Muscadine grape		—		13.8	±	3.5a	12.5	±	3.1a
P-value	N/A			< 0.0001			0.0105		
Significance[z]	N/A			***			*		

*, **, *** indicates nonsignificant or significant differences at $P = 0.05$, 0.01, or 0.001 respectively. Mean separation within columns by LSD at $P = 0.05$. N/A indicates not applicable.

TABLE 5 Seasonal Mean Capture of *Graphocephala versuta* Trapped Bi-Weekly on Six Fruit Crops Using Yellow Sticky Traps from Three Alabama Locations in 2009

	Location								
	Athens			Clanton			Mobile		
Crop	Mean		SEM	Mean		SEM	Mean		SEM
Blueberry	3.4	±	1.0a	4.3	±	1.3c	0.3	±	0.1b
Hybrid bunch grape	2.6	±	1.0ab	17.8	±	4.7ab		—	
Peach	0.9	±	0.3b	3.8	±	1.4c	0.4	±	0.1b
Plum	0.6	±	0.2b	7.6	±	2.0bc		—	
Satsuma mandarin		—		8.5	±	1.9abc	2.1	±	0.5a
Muscadine grape		—		20.3	±	3.5a	0.2	±	0.1b
P-value	0.0025			< 0.0001			< 0.0001		
Significance[z]	**			***			***		

*, **, *** indicates significant differences at $P = 0.05$, 0.01, or 0.001 respectively. Mean separation within columns by LSD at $P = 0.05$.

2.1 individuals/trap, which is significantly greater than the average capture number from the other three fruit crops studied.

H. insolita, *O. orbona*, *Draeculacephala* spp., *G. coccinea*, and *P. irrorata* species were found in all three locations included in our survey, but their numbers remained relatively low through the season (data not shown). In Mobile, even though *H. insolita*, *O. orbona*, *G. coccinea*, and *P. irrorata* populations were captured in relatively low numbers on sticky traps on all of the fruit crops studied, the average insect number was significantly higher on the Satsuma mandarin crop, when compared to the rest of the fruit species investigated at the same location.

DISCUSSION

Seven sharpshooter species were identified for the first time in orchards and vineyards representing three different growing regions in Alabama. *H. vitripennis* and *G. versuta* were determined to be the primary sharpshooter species in Alabama orchards and vineyards. *H. vitripennis* are known to be endemic to the southeast U.S. (Turner and Pollard, 1959), and recent research has confirmed their prevalence in Florida (Hall and Hunter, 2008). Our results confirmed *H. vitripennis* prevalence in the Gulf Coast and Central Alabama, where the presence of *Xf*-induced diseases in fruit crops is also high (Boyhan et al., 1997; Ma and Coneva, unpublished). *Xf* was ubiquitously available among wild plants (Purcell and Hopkins, 2002) in the southeastern U.S., which coincides with *H. vitripennis* feeding on a various type of host plants (Hoddle et al., 2003). High population densities of *H. vitripennis* in Central and South Alabama, where the disease pressure is high, might contribute to the spread of *Xf* infection to economic fruit crops in the state.

These data support our hypothesis that *H. vitripennis* is more abundant in south Alabama in comparison with central and north Alabama. Hoddle et al. (2003) determined that possible constraints on the northern distribution of *H. vitripennis* could be related to temperature, humidity, and rainfall clines or interspecific competition with other proconiine sharpshooters that have similar habitat requirements.

Our results suggest *G. versuta* is the second most abundant sharpshooter in Alabama based on orchard and vineyard overall capture numbers. It could be the major vector of *Xf* in Limestone and Blount Counties, which rank second and third in peach production, where *H. vitripennis* captures were low. All other sharpshooter species found in orchards and vineyards appear to have low population numbers, but since most of them are effective *Xf* vectors and appear to be highly involved in *Xf* epidemics, further research is needed to determine their significance as *Xf* vectors in Alabama.

Our data on relative adult sharpshooter abundance on different fruit crop species support studies conducted in Florida (Conklin and Mizell, 2010) on *H. vitripennis* preferred feeding hosts, where plant preference depended on the season and locality, but in general *Citrus* spp. were among the preferred feeding plant host species.

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