MORTALITY FACTORS OF THE AVOCADO LACE BUG, PSEUDACYSTA PERSEAE (HETEROPTERA: TINGIDAE), IN FLORIDA

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Abstract

The avocado lace bug (ALB), *Pseudacysta perseae* (Heidemann) (Heteroptera:Tingidae), is a pest of avocado, *Persea americana*, in Florida, the Caribbean Basin, California and northern South America. Different biotic mortality factors, i.e., the egg parasitoids *Erythmelus (Erythmelus) klopomor*, a new species of Trichogrammatidae, and the predators, *Chrysoperla rufilabris, Paracarniella cubana, Stethoconus vitripennis*, and *Tingidoletes praelonga*, have been reported as natural enemies of *P. perseae* in Florida. We determined the effect of these biotic factors during 3 seasons, by exposing *P. perseae* cohorts to known biotic factors, and compared their survival to cohorts protected from these factors. The total percent mortality caused by biotic factors was 16 to 90% above the mortality caused by abiotic factors during 3 seasons.

Key Words: *Erythmelus, Chrysoperla, Paracarniella, Stethoconus, Tingidoletes, Pseudacysta*, avocado

Resumen

El chinche de encaje del aguacate, *Pseudacysta perseae* (Heidemann) (Heteroptera: Tingidae) es una plaga de aguacate, *Persea americana*, en Florida, en las islas del Caribe, California y en la parte norte de Suramerica. Varios factores bioticos de mortalidad, tales como los parasitoides de huevos, *Erythmelus (Erythmelus) klopomor* y una nueva especie de Trichogrammatidae y los depredadores *Chrysoperla rufilabris, Paracarniella cubana, Stethoconus vitripennis*, y *Tingidoletes praelonga* han sido reportados como factores de mortalidad de *P. perseae* en la Florida. Se determinó el efecto de los factores de mortalidad durante 3 estaciones al exponer grupos de individuos de *P. perseae* a estos y se comparó esta mortalidad con la causada cuando grupos de *P. perseae* no estaban expuestos a los enemigos naturales. El porcentaje de mortalidad causado por los factores bioticos tuvo un rango del 16 al 93% de mortalidad al compararlo con el efecto de los factores abióticos durante las tres estaciones.

The avocado lace bug (ALB), *Pseudacysta perseae* (Heidemann) (Heteroptera:Tingidae), is a stenophagous insect originally found in Mexico and southeastern North America affecting plants of the genus *Persea* (Laurales: Lauraceae), i.e., *Persea americana*, *P. borbonia* and *P. pallustris*. During the last 15 years it has spread to most of the islands in the Caribbean region, northern South America, i.e., Venezuela and French Guyana and to southern California. (Mead & Peña 1991; Peña et al. 1998; Wysoki et al. 2002; Hoddle et al. 2005; Streito & Morival 2005; Etienne & Streito 2008). Because of a resurgence of *P. perseae* densities in the 1990s in South Florida, a survey for natural enemies was conducted in 1997 (Peña et al. 1998). During this survey, *Chrysoperla rufilabris* (Burmeister) (Neuroptera: Chrysopidae) and *Paracarniella cubana* (Bruner) (erroneously identified then as *Hyaliodes vitripennis* (Say)) (Heteroptera: Miridae) were observed to be the most common predators of *P. perseae* in south Florida (Peña et al. 1998). Egg parasitoids were recorded during the same survey including *Oligosita* spp. (Chalcidoidea: Trichogrammatidae), and an unidentified Mymarid species. According to the literature, no other egg parasitoids of *P. perseae* have been reported (Abud-Antun 1991; Medina-Gaud et al 1991; De la Torre et al. 1999; Morales 2000; Sandoval 2004; Streito & Morival 2005). In 2006, an additional survey for natural enemies was initiated and 2 additional predators were discovered, and as well as 2 parasitoid species. Predators include a new lestodiplosine midge (Diptera: Cecidomyiidae), *Tingidoletes praelonga* Gagné (Gagné et al. 2008), and an adventive Asian plant bug, *Stethoconus praefectus* (Distant) (Heteroptera: Miridae) (Henry et al. 2009; Holguin et al. 2009). The egg parasitoids were the mymarid, *Erythmelus (Erythmelus) klopomor* S. Triapitsyn (Triapitsyn et al. 2007) and a new undescribed species of Trichogrammatidae (J. D. Pinto, pers. comm.)

The reduction or lack of biotic mortality agents of the lace bug in Florida has been suspected as one of the reasons why the lace bug became a serious problem in this state only during mid-90s. One of the possible reasons for the outbreaks (Peña et al 1998) was heavy application of pesticides during the 1980s and 1990s, in that case, pyrethroids, that may have decimated the natural enemies responsible for regulating *P. perseae* populations. With the exception of Cuba (De la Torre et al. 1999), no report of natural enemies has been published from an area recently invaded by *P. perseae*. Our goal in this study was to determine if biotic factors may have an effect on the population densities of *P. perseae* in Florida.

Materials and Methods

Three experiments were conducted at the Univ. of Florida, Tropical Research and Education Center, Homestead, Florida in an unsprayed avocado grove. Two experiments were conducted during the fall (Oct-Nov) of 2006 and 2007) and 1 during the spring of 2008 (Feb-Mar). Twenty seven avocado cv. 'Lula' branches each with young, but hardened leaves (n = 8-12) were selected. Each branch was enclosed with a 50 × 30 cm white cotton bag and 10 *P. perseae* (2 males: 8 females, collected the same d from foliage of avocados held under greenhouse conditions) were placed on the foliage. Each bag was then sealed and numbered. One d after bagging, each leaf within each branch was examined for egg deposition, a circle around the area where the eggs were deposited was drawn with an ultra fine pointed Sharpie® Permanent Marker, and the number of eggs within each cohort was counted. *Pseudacysta perseae* adults were removed. The leaves with approximately one half of the eggs were covered with cotton bags as explained above (exclusion treatment) and the leaves of the other half were left exposed, i.e., not bagged. Therefore, in the bagged treatment the *P. perseae* population was exposed to abiotic factors only, while in the exposed treatment the *P. perseae* population was exposed to both biotic and abiotic factors. The fate of each *P. perseae* stage was observed every two d for approx. 2 mo or until the cohorts reached adulthood. All eggs on each leaf were used as a single replication. Parasitized eggs were determined by counting the number of hatched nymphs. The tiny emerged mymarid or trichogrammatid egg parasitoids were not counted, because they cannot be observed without the aid of a microscope. Once hatched, *P. perseae* nymphs tend to aggregate and remain on the leaf where they had hatched; migration to different leaf areas seldom occurs. If adults from foreign cohorts appeared on the experimental area, these were immediately removed. At the end of the 2007 fall trial, leaves were collected and leaf tissue injured by the cohorts was cut out and placed on a drawing paper and the area measured. A paired t-test (SAS 2008) was used to determine differences between the leaf area damaged by cohorts exposed to biotic plus abiotic factors and the area damaged by cohorts on leaves where biotic factors were excluded.

Life Tables

An instantaneous life table (Waters 1969) was used to determine the number of dying individuals of *P. perseae* from the 3 experiments at a given time (fall 2006, fall 2007, and spring 2008) and to differentiate the amount of mortality caused by biotic plus abiotic factors (non-exclusion treatment) from abiotic factors (exclusion treatment) (Waters 1969; Bellows et al. 1992). Then, the difference in the amount of mortality between the biotic and abiotic factors determined.

Results and Discussion

Densities of eggs either exposed or protected from predators were similar during each test conducted across different seasons. During fall 2006 and fall 2007, lower densities of third, fourth and fifth *P. perseae* instars as well as adults were recorded (t-test, P = 0.05) when these cohorts were exposed to biotic mortality factors than when not so exposed (Fig. 1). During spring 2008, lower

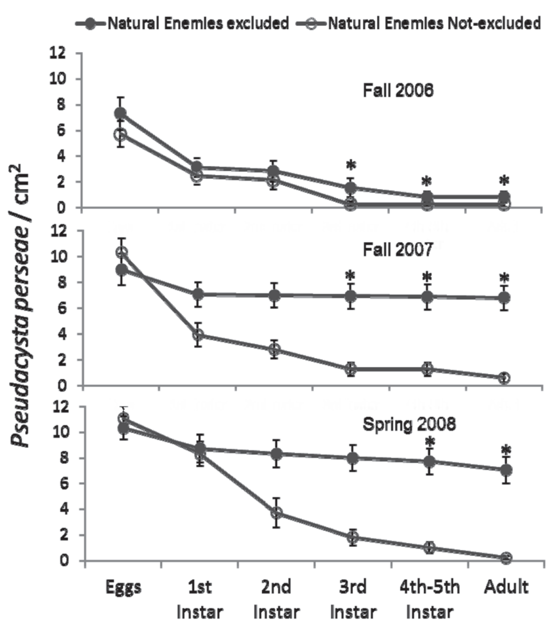

Fig. 1. Trend of *Pseudacysta perseae* cohorts when exposed to natural enemies, and when natural enemies were excluded at Homestead, Florida, USA.

TABLE 1. LIFE TABLES OF *PSEUDACYSTA PERSEAE* DURING 3 DIFFERENT SEASONS WHEN COHORTS WERE EITHER EXPOSED TO OR PROTECTED FROM BIOTIC FACTORS.

	Natural Enemies Not-excluded				Natural Enemies Excluded				
Stage	Lx_1	dx_1	$100qx_1$	[1]dx_1	Lx_2	dx_2	$100qx_2$	[2]dx_2	[3]$(dx_1 - dx_2)$
FALL 2006									
Egg	80.0	45.0	56.3	56.3	95.0	54.0	56.8	56.8	-0.5
Nymph 1	35.0	5.0	14.3	6.3	41.0	4.0	9.8	4.2	2.1
Nymph 2	30.0	26.0	86.7	32.5	37.0	17.0	45.9	18.0	14.5
Nymph 3-4	4.0	0.0	0.0	0.0	20.0	9.0	45.0	9.5	-9.5
Nymph 4-5	4.0	0.0	0.0	0.0	11.0	0.0	0.0	0.0	0.0
Adult	4.0				11.0				0.0
Total		76.0		95.0		84.0		88.5	6.6
FALL 2007									
Egg	155.0	89.0	57.4	57.4	135.0	26.0	19.3	19.3	38.2
Early 1st instar	66.0	7.0	10.0	4.5	108.0	2.0	1.8	1.5	3.0
Late 1st instar	59.0	17.0	28.0	11.0	106.0	1.0	0.9	0.7	10.3
2nd instar	42.0	23.0	54.0	14.8	105.0	1.0	1.0	0.7	14.1
3rd Instar	19.0	0.0	0.0	0.0	104.0	1.0	1.0	0.7	-0.7
4th Instar	19.0	10.0	52.0	6.5	103.0	1.0	1.0	0.7	5.8
Adult	9.0				102.0				0.0
Total		146.0		94.2		32.0		23.6	70.6
SPRING 2008									
Egg	166.0	41.0	25.3	25.3	155.0	18.0	11.6	11.6	13.7
Nymph 1	125.0	35.0	28.0	21.1	137.0	6.0	4.4	3.9	17.2
Nymph 2	90.0	34.0	37.7	20.4	131.0	6.0	4.6	3.9	16.5
Nymph 3	56.0	29.0	51..4	11.3	125.0	5.0	4.0	3.2	8.1
Nymph 4	27.0	12.0	44.4	7.1	120.0	4.0	3.3	2.6	4.5
Nymph 5	15.0	12.0	80.0	7.1	116.0	2.0	1.7	1.3	5.8
Adult	3.0				114.0				0.0
Total		163.0		92.2		41.0		26.5	65.7

[1]dx_1 as percent of the initial number.
[2]dx_2 as percent of the initial number.
[3]Differences of mortality caused by biotic (cohorts exposed) and abiotic factors (cohorts bagged), i.e., mortality caused by natural enemies.

densities of fourth-fifth instars and adults were observed on those cohorts that were exposed to both biotic and abiotic factors compared to those in the exclusion treatment (*t*-test, P = 0.001) (Fig. 1).

Life tables for cohorts exposed to biotic and abiotic factors showed that the number of eggs not hatching represented the life stage with the highest values of dying individuals for both treatments (especially during fall 2006 and fall 2007) (Table 1). Egg mortality caused by natural enemies was nil during fall 2006, but increased to 38% and 33% during fall 2007 and spring 2008, respectively (Table 1). This indicates that egg parasitoids are likely to be a key egg mortality factor during certain yr, but unreliable in other yr. There were some differences among yr or seasons regarding exclusion vs. non-exclusion treatment results. For instance, mortality in the non-exclusion treatment was considerably greater in 2 of 3 tests (i.e., 2007 and 2008). Within the exclusion treatment in 2006, mortality was considerably greater than in the same treatment during the 2007 and 2008 studies, suggesting that predators had not been effectively eliminated by the exclusion bags during the 2006 test. With the exception of the egg stage, most of the stages were unaffected when cohorts were protected from biotic factors. A significantly ($d_{f1,16}$; F = 26.40; P = 0.0001) lower estimate of leaf area damage was obtained (0.83 ± 0.68 cm^2) when the *P. perseae* cohorts were not protected from naturally occurring mortality factors compared to the damaged leaf area (5.28 ± 2.50 cm^2) when predators and parasitoids were excluded from the *P. perseae* cohorts. These results may demonstrate the value of the natural enemies (especially predators) in preventing damage caused by this pest. During spring 2008, the effect of biotic factors observed for the eggs and all instars fluctuated from 7.07% to 25% (Table 1), while the percent of the cohorts dying from abiotic factors fluctuated from 1.3% to 11.61% (Table 1).

With only one exception (i.e., third instar nymphs, fall 2006) the percent mortality caused by biotic factors was 16%, 71% and 90 % during fall 2006, fall 2007 and spring 2008, respectively (Table 1). Until now, parasitoids collected in Florida (Peña et al. 2009) parasitizing eggs of *P. perseae*, have not been considered to be key mortality factors of this pest. However, after studying their effects during different seasons, we suggest that they may be key mortality factors during certain seasons or yr. The presence of different predators, such as *C. rufilabris* (Neuroptera: Chrysopidae), an unidentified chrysopid (Neuroptera: Chrysopidae), 2 mirids, *P. cubana* and *S. praefectus* and the presence of a new species of a cecidomyiid, *T. praelonga*, suggest that predators are the key constant element in maintaining populations of *P. perseae* at low levels in Florida. However, more tests should be conducted during different seasons and yr to determine the 'key age' interval of *P. perseae* that is most susceptible to biotic mortality factors.

Acknowledgments

We thank Drs. G. Evans, J. Pinto and S. Triapsin for their help in identifying the parasitoid specimens, and Drs. T. Henry and R. Gagne for their help in identifying predator specimens. We thank Drs. J. Jacas and P. Kendra for suggestions to improve this manuscript. We thank, D. Long for his help. This research was partially funded by the California Department of Agriculture.

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