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SEASONAL ABUNDANCE OF THE ASIAN CITRUS PSYLLID, *DIAPHORINA CITRI* (HOMOPTERA: PSYLLIDAE) IN SOUTHERN FLORIDA

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ABSTRACT

Seasonal abundance of the Asian citrus psyllid, *Diaphorina citri* Kuwayama, was studied weekly in two orange jasmine [*Murraya paniculata* (L.) Jack] plots in southern Florida from October 1998 to October 1999. Psyllid populations occur throughout the season on orange jasmine in southern Florida. Population peaks were observed in October, November, and December in 1998, and May and August in 1999. Psyllid population levels were positively related to the availability of new shoot flushes which were in turn related to the weekly minimum temperature and rainfall. Natural enemies were not key factors in regulating populations during the study period. The populations of adult psyllids were also studied weekly on potted orange jasmine and grapefruit (*Citrus paradisi* Macfadyen) plants from June 1999 to July 2000. The population levels of psyllid on both host plants were not significantly different and general population trends on the two hosts were similar over time. Continuous shoot flushes produced by orange jasmine could play an important role in maintaining high populations of this insect when new shoot flushes were not available in the commercial citrus groves.

Key Words: Asian citrus psyllid, seasonal abundance, temperature, rainfall

RESUMEN

Se estudiaron la abundancia estacional del psílido Asiático de cítricos, *Diaphorina citri* Kuwayama, semanalmente en dos parcelas de *Murraya paniculata* (L.) Jack] en el sur de Florida de Octubre de 1998 a Octubre de 1999. Las poblaciones del psílido ocurren atravez de la estación sobre *M. paniculata* en el sur de Florida. Se observaron los niveles más altos de la población en octubre, noviembre, y diciembre en 1998, y en mayo y agosto de 1999. Los niveles de población de psílido fueron relacionadas positivamente a la disponsibilidad de nuevas hojas que fueron a la vez relacionadas con la temperatura mínima y menor nivel de lluvia semanal. Los enemigos naturales no fueron un factor clave en regular la población durante el período del estudio. Tambien, se estudiaron las poblaciones de los psílidos adultos semanalmente en plantas de *M. paniculata* y toronja (*Citrus x paradisi* Macfadyen) en masetas de junio de 1999 hasta julio de 2000. Los niveles de la población de los psílidos sobre las dos plantas hospederas no fueron significantemente diferentes y las tendencias generales de la población sobre los dos hospederos fueron similares atravez del tiempo del estudio. El crecimiento continuo de los brotes de nuevas hojas producido por *M. paniculata* podría jugar un papel importante en mantener altas poblaciones de este insecto cuando los brotes de nuevas hojas no estan disponibles en los huertos comerciales de cítricos.

The Asian citrus psyllid, *Diaphorina citri* Kuwayama, was first found in south Florida on June 3, 1998. Subsequent findings were widespread in Broward, Palm Beach, Martin, Dade, St. Lucie, Hendry, and Collier Counties in a 3 month period (Halbert et al. 1998). *Diaphorina citri* damages citrus by depleting sap from the plant and injecting a salivary toxin that produces malformation of shoots and leaves. It also affects photosynthesis of the tree by excreting honeydew, which promotes the growth of sooty mold (Chien & Chu 1996). This insect is known to be the most efficient vector of citrus greening disease bacterium (*Liberobacter asiaticu*m) or huanglungbing.

Citrus greening is the most serious disease affecting most major citrus cultivars in Vietnam, Okinawa, China, Taiwan, Indonesia, The Philippines, India, Sri Lanka, Africa, and the Arabian Peninsula (Martinez & Wallace 1967, Moll & Van Vuuren 1977, Bove & Garnier 1984, Aubert 1987, Tsai et al. 1988, Su & Huang 1990, Aubert et al. 1996). Given high reproductive potential of this vector during the period of favorable weather conditions and food availability (Catling 1970, Mead 1977, Tsai & Liu 2000, Liu & Tsai 2000), this pest is expected to spread throughout citrus producing areas in Florida in 2-3 years. It poses a serious threat to other citrus producing states in the near future.

Diaphorina citri is of Far Eastern origin (Mead 1977). In the last three decades, research reports have been focused mainly on the transmission of citrus greening agent by *D. citri* (Salibe & Cortez 1966, Martinez & Wallace 1967, Capoor et al. 1974, Su & Huang 1990). Since the discovery of *D. citri* in south Florida, the biology of this psyllid and associated parasitoids including *Tamarixia radiata* (Waterston) and *Diaphorencyrtus aligarhensis* (Shafee, Alam & Agarwal) have been studied in Florida laboratories (Tsai & Liu 2000, Liu & Tsai 2000, McFarland and Hoy 2001). Field population dynamics is very limited (Tsai et al. 2000). To date, no effective control measures are known for *D. citri*. As part of an effort to develop an integrated management program for the Asian citrus psyllid in Florida, we surveyed the seasonal abundance of *D. citri* on orange jasmine (*Murraya paniculata* (L.) Jack) during October 1998 to October 1999 in south Florida. We also compared the population dynamics on potted orange jasmine and grapefruit (*Citrus paradisi* Macfadyen) from June 1999 to July 2000.

Materials and Methods

Experiment 1

Seasonal populations of *D. citri* were studied weekly in two orange jasmine plots from October 1998 to October 1999 in Pompano Beach and Davie, Broward County, Florida. Random samplings for psyllid adults were made at weekly intervals. One shoot (about 6-10 cm long) was selected from each square meter area by randomly throwing a pointed object made of a pencil with a ribbon tied to one end. The shoot was selected where the pencil had landed. A total of 100 shoots were selected from each field on each sampling date. Numbers of psyllid adults per shoot were counted and recorded.

Experiment 2

This experiment was conducted from June 1999 to July 2000 to compare population levels of citrus psyllid on orange jasmine and grapefruit

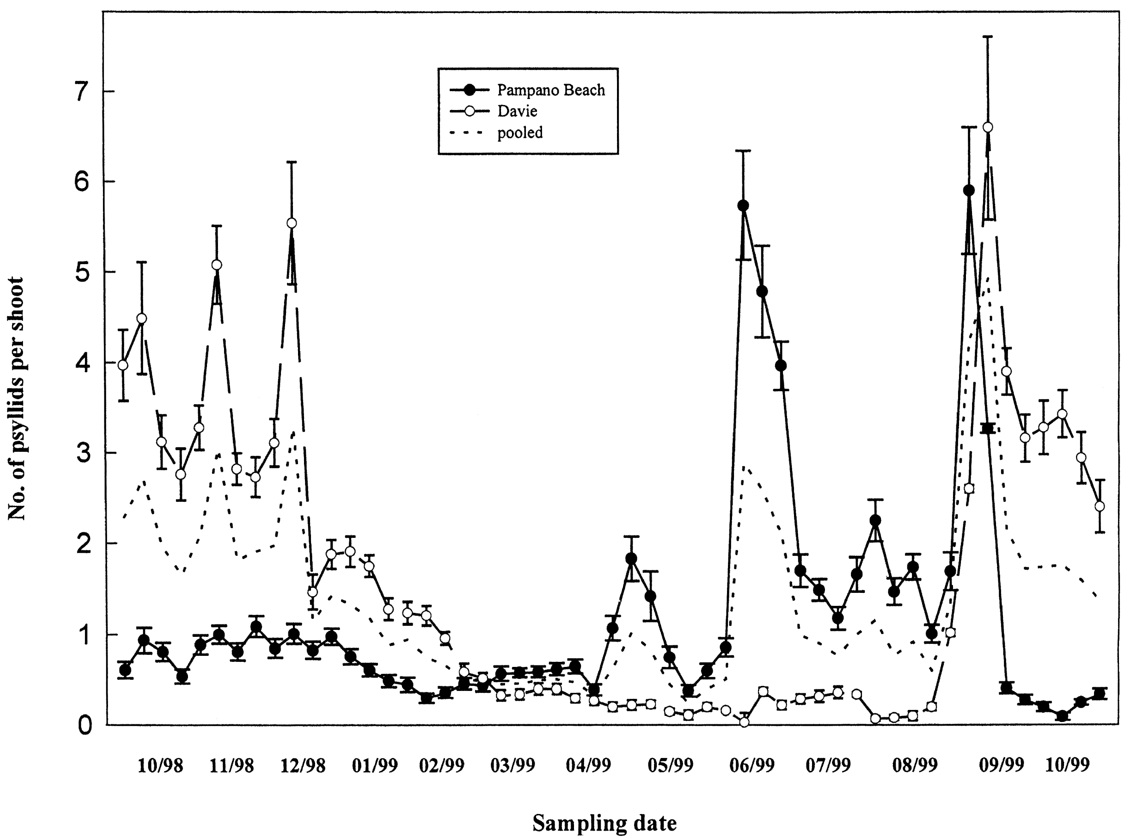

Fig. 1. Mean ± SE density of adult *D. citri* per shoot on orange jasmine at Pompano Beach (solid dots and line) and Davie (circles and dashed line) from October 1998 to October 1999. Dotted line is pooled mean adult densities of two sites.

(*Citrus paradisi* Macfadyen), at Fort Lauderdale Research and Education Center, University of Florida, Fort Lauderdale. About 200 potted orange jasmine plants and 250 potted grapefruit plants (both at 40-60 cm high) were randomly arranged. Numbers of psyllid adults on both host plants were sampled as described in experiment 1.

The plants in both experiments were not sprayed with insecticides during the course of the study. Meteorological data were kept at this center. The mean densities per shoot were calculated for each plot per sampling date. Paired comparison t tests were used to compare the difference between two sites in experiment 1 and between two host plants in experiment 2. Correlation analysis was employed to assess the relationship between population levels of *D. citri* and temperature and rainfall (SAS Institute 1988).

Results and Discussion

Experiment 1

The population dynamics of *D. citri* on orange jasmine at two sites are shown in Fig. 1. Psyllid adults were found on orange jasmine on all sampling dates, however, mean densities of *D. citri* varied significantly between two sites. The highest number of psyllid adults recorded on a shoot was 43. Although the distance between these two sites was only 15 miles, adult population levels were markedly different. At the Davie site, adult psyllid populations were high from October to December 1998, and then declined rapidly at the end of December 1998. The populations increased rapidly in August 1999, and reached the highest level in late August 1999 with a mean of 6.51 psyllids per shoot. Thereafter, the adult populations declined. At the Pompano Beach site, very few adults were recorded from October 1998 to April 1999. The first peak was recorded at the end of May, 1999 with a mean of 5.7 psyllids per shoot, and second peak was recorded in August 1999 with a mean of 5.9 psyllids per shoot. Overall adult populations were very low from December 1998 to May 1999 at both sites. Paired comparisons between the two sites indicated that population dynamics were not significantly different ($t = 1.20$, $df = 53$, $P = 0.2360$); therefore, we pooled the mean densities of psyllid populations at both sites and presented them also in Fig. 1. Psyllid populations in the field from October 1998 to October 1999 had five apparent peaks, appearing in October, November, December 1998, and May and Au-

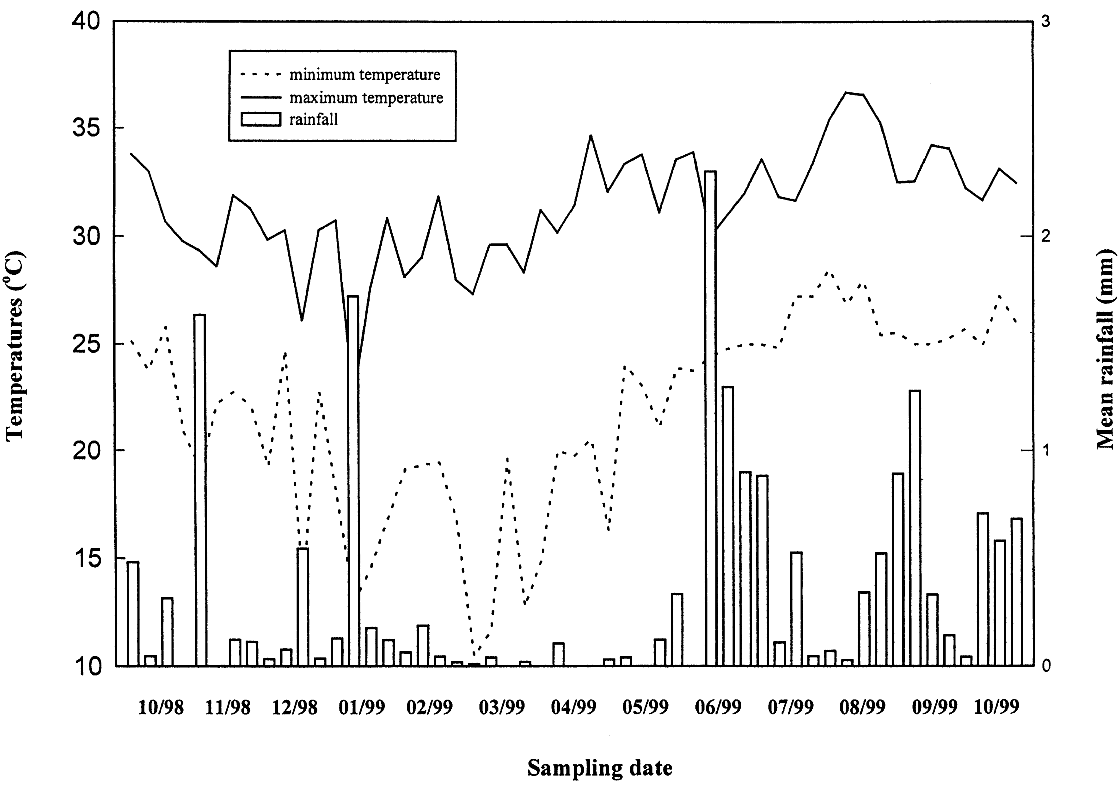

Fig. 2. Mean weekly maximum and minimum temperatures (lines) and rainfall (bars) from October 1998 to October 1999.

gust 1999. The peak populations of the psyllid seemed to coincide with the availability of the new shoot flushes.

Atwal et al. (1968) reported that there were four annual population peaks of *D. citri* on citrus which occurred during March, June, July, and August-November from 1965 to 1967 in Ludhiana, India. The highest population was observed in March. They suggested that both high and low temperatures were detrimental to the psyllid population increases. However, in the current study there were no population increases in March, and both sites had a very low population density from December 1998 through early May 1999.

Many psyllid species such as *Paratricza cockerelli* (Sulc.), *Psylla pyricola* Foerster, and *Cardiaspina albitextura* Taylor were reported to be intolerant of extreme weather (List 1939, Madsen et al. 1963, Clark 1964). Calting (1969) also reported that all stages of citrus psylla, *Trioza erytreae* (Del Guercio) were sensitive to high temperature together with low relative humidity. Its populations were consistently the highest in the cool and moist upland region and were always low in the hot and arid lowlands of South Africa. Most recently, Liu & Tsai (2000) reported that *D. citri* failed to complete development at 10 and 33°C, and McFarland & Hoy (2001) reported increases in *D. citri* population survival with increasing relative humidity in Florida.

The mean weekly maximum and minimum temperatures and rainfall during our study are shown in Fig. 2. Correlation analysis indicated that mean population densities were correlated significantly with minimum temperature ($r = 0.1045$, $n = 60$, $P = 0.0045$), and rainfall ($r = 0.4126$, $n = 60$, $P = 0.0021$), but not significantly correlated with maximum temperature ($r = 0.1045$, $n = 60$, $P = 0.4564$). The lowest weekly minimum temperature (10.5°C) occurred in last week of February 1999 with several extreme low temperatures during the period of March and April. Sites experienced little rainfall from February to late May 1999. This could be the reason why there was no population increase in March as compared to the study of Atwal et al (1968). Psyllid populations always increased rapidly after 1-2 weeks of heavy rain that resulted in the growth of new shoots of orange jasmine, and psyllid adults

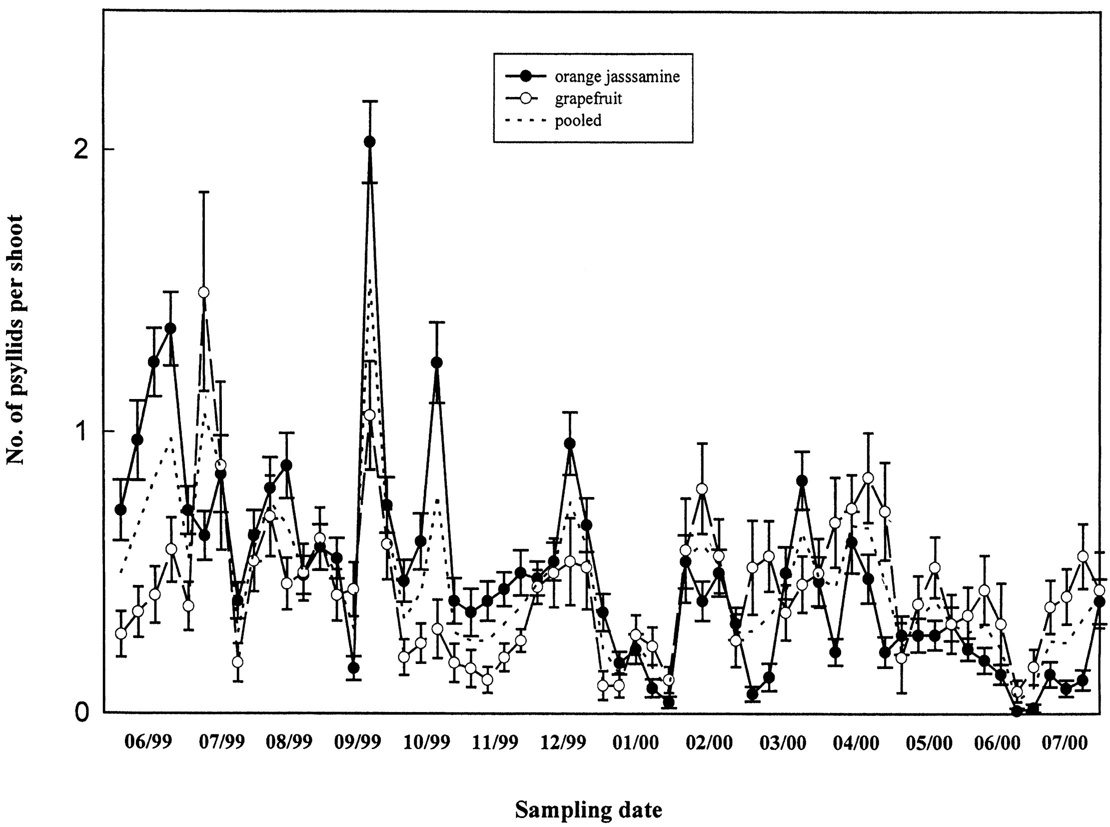

Fig. 3. Mean ± SE density of adult *D. citri* per shoot on potted orange jasmine (solid dots and line) and grapefruit (circles and dashed line) from June 1999 to July 2000. Dotted line is pooled mean adult densities on two hosts.

only laid eggs on newly formed terminal buds (Figs. 1 and 2) (Tsai & Liu 2000).

Natural enemies always were considered to play an important role in regulating insect population fluctuations in the field. However, during our study we rarely found any psyllids parasitized by parasitoids (<1% parasitism of nymphs) and found only a few cocinellid predators on the plants; natural enemies were not an important factor affecting the psyllid populations in this study.

Experiment 2

The densities of *D. citri* adults on potted orange jasmine and grapefruit from June 1999 to July 2000 are shown in Fig. 3. Although densities of *D. citri* adults varied greatly between the two host plants on various sampling dates, the relative densities and general population trends were similar over time (Fig. 3). Of 60 samplings, 29 observations of adult on orange jasmine were higher than those on grapefruit. The highest population density (2.1 psyllids per shoot) on orange jasmine was recorded in September 1999, whereas the highest population density (1.5 psyllids per shoot) on grapefruit was recorded in early July 1999. From June 1999 to July 2000, mean population densities on orange jasmine and grapefruit were 0.49 and 0.45 per shoot, respectively. Paired comparisons did not show significant differences in population densities between the two host plants ($t = 1.02$, $df = 60$, $P = 0.3099$). This suggests that the Asian citrus psyllid did not prefer one of the hosts over the other which is in agreement with that reported by Tsai & Liu (2000). They reported that this insect had similar intrinsic population rates of increase when reared on these two hosts. They concluded that the continuous shoot flushes produced by orange jasmine could play an important role in maintaining high populations of this insect when new flushes were not available in the commercial citrus groves. Population peaks of pooled observations occurred in June-July, September-October, December, and February-April. Unlike experiment 1, correlation analysis did not show the significant differences among mean population densities and weekly maximum temperatures ($r = 0.1038$, $n = 60$, $P = 0.4302$), minimum temperatures ($r = 0.2210$, $n = 60$, $P = 0.0899$), and rainfall ($r = 0.2236$, $n = 60$, $P = 0.0860$) (Fig. 4). However, the P values of minimum temperature and rainfall were very close to the significant level of $P = 0.05$. In their study, Liu & Tsai (2000)

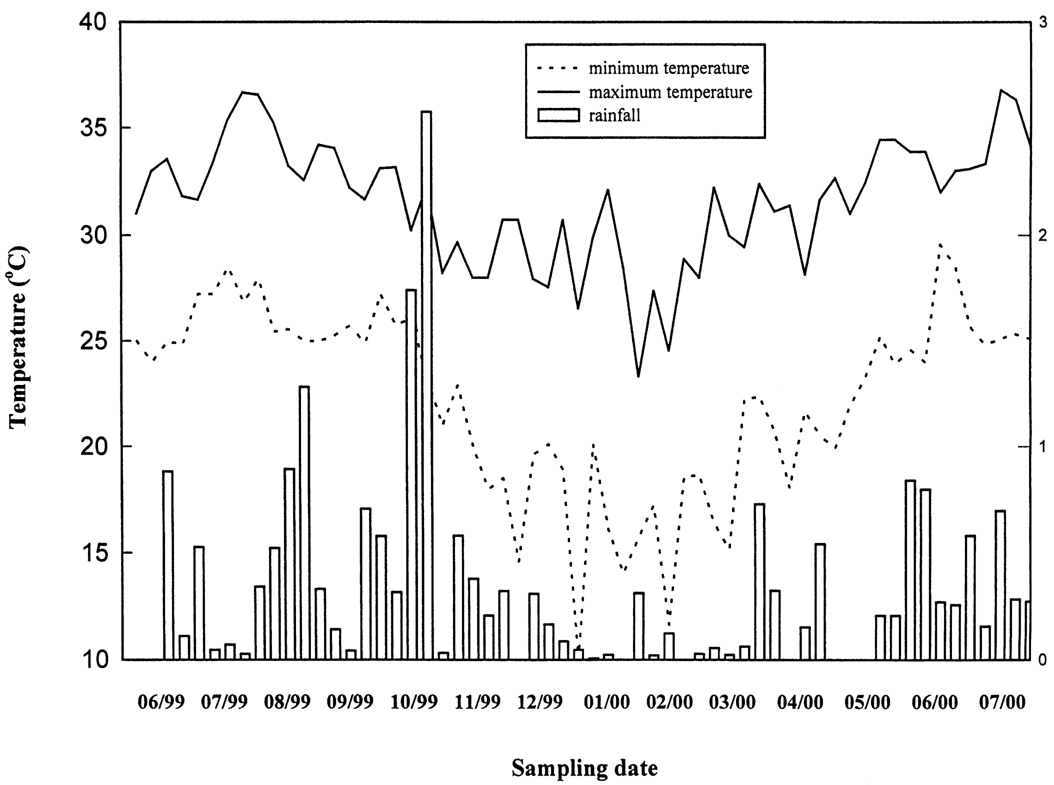

Fig. 4. Mean weekly maximum and minimum temperatures (lines) and rainfall (bars) from June 1999 to July 2000.

found that at 15°C *D. citri* had higher survival and reproductive rates than those at higher temperatures.

In general, *D. citri* thrived very well on both orange jasmine and citrus in south Florida and it has a good potential to become a major pest. Population peaks were generally observed whenever new shoot flushes became available; minimum temperature and rainfall may be key factors affecting psyllid population increases.

Acknowledgments

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