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SUITABILITY OF DIFFERENT HOST PLANTS FOR NYMPHS
OF THE SHARPSHOOTER *TAPAJOSA RUBROMARGINATA*
(HEMIPTERA: CICADELLIDAE: PROCONINI)

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The Proconiini tribe (sharpshooters) is one of the largest groups of xylem-feeding insects and includes the majority of the known vectors of xylem-borne phytopathogenic organisms (Rakitov & Dietrich 2001; Redak et al. 2003). The glassy-winged sharpshooter (GWSS), *Homalodisca vitripennis* (Germar) (= *H. coagulata* Say, Takiya et al. 2006), has become a major pest in California primarily as vector of *Xylella fastidiosa*, a bacteria that causes severe diseases to grapes, citrus, and other important crops (Blua et al. 1999). The invasion of GWSS into California during the last decade and most recently the Pacific Islands in both Hemispheres promotes an increment of studies on diverse aspects of proconines hoppers.

The development of an effective pest management strategy to control *H. vitripennis* requires not only the knowledge of the pest biology but also of their parasitoids and other species potentially suitable for use in new association strategies. A search for, and evaluation and colonization of, egg parasitoids of closely related Proconiini in South America was initiated. Areas of Argentina, Chile, and Peru were selected for surveys due to their close matches to current and potential distributions of the GWSS in California (Jones 2003). Since Nov 2000, an extensive exploration of sharpshooter egg parasitoids in those regions was carried out. The survey was conducted using sentinel eggs of the common South American proconiini sharpshooter, *Tapajosa rubromarginata* Signoret. At least 20 species of egg parasitoids were recovered from this species during the study (Logarzo et al. 2003, 2004, 2006; Virla et al. 2005).

Few studies have evaluated the developmental biology of Proconiini, probably because of the difficulty in rearing these insects (Turner & Pollard 1959). *Homalodisca vitripennis* must be reared with host plants (Setamou & Jones 2005) due to the lack of an artificial diet or a diet-based rearing system for this and other sharpshooters. Efforts to rear *T. rubromarginata* in the laboratory with Johnson grass (*Sorghum halepense* L. Pers.) or sugar cane (*Saccharum officinarum* L.), the plants on which this species was mostly collected (Costilla et al. 1972; Virla et al. 2005), were un-

successful (EGV, pers. comm.). As was demonstrated for other sharpshooter species, nymphs and adults probably have different nutritional requirements, and only a few host plants apparently support the development of nymphs to maturity (Brodbeck et al. 1990; Mizell & Andersen 2001). The alternation of host plant is an important sharpshooter survival mechanism (Milanez et al. 2001). In addition, Milanez et al. (2003) demonstrated for *Oncometopia fascialis* (Signoret) that some plants promote higher feeding and survival rates than others. Nielson et al. (1975) working with *O. alpha* Fowler on broadbean (*Vicia faba* L.), and Setamou & Jones (2005) studying GWSS on cowpea (*Vigna unguiculata* L.) demonstrated the possibility of rearing a sharpshooter using a single host.

The objective of this study was to evaluate the suitability of seven selected host plants as host of *T. rubromarginata* to identify the best substrate to rear this sharpshooter from first instar to adult in laboratory. Nymph viability of *T. rubromarginata* on several substrates was estimated through no-choice tests. The criterion measured was the number of adults of *T. rubromarginata* emerged on each substrate.

All tests were conducted in a greenhouse at room temperature during spring and summer (Dec 2005 to Mar 2006) at $25.4 \pm 3.7^\circ\text{C}$, with a daily fluctuation of about 8°C , 60-80% RH (mean 68 ± 11), and natural photoperiod. Nymphs of *T. rubromarginata* for the test were obtained in the laboratory from field collected eggs laid in wild Johnson grass plants. The selected host plants were cultured in plastic pots, and watered to saturation every day. All the experiments began with 3-week-old plants, and in case of decay they were replaced by a new one of the same age.

To measure the most appropriate plant substrate a couple of newly emerged nymphs (less than 6 h old) were caged on a potted plant in a cylindrical cage (35 cm high \times 18 cm diam) of PET (polyethylene-terephthalate). For ventilation, the top end of the tube was covered with muslin fabric. One hundred nymphs (50 replicates, 2 nymphs each) of *T. rubromarginata* were tested on the 7

rearing plant treatments. Plant selection was based on plants used in the field by *T. rubromarginata* and host plants that positively demonstrated they were suitable hosts, such as cowpea. The 7 treatments were: (1) sweet orange (*Citrus sinensis* L. var. tangerina), (2) corn (*Zea mays* L.), (3) bermuda grass (*Cynodon dactylon* (L.) Pers.), (4) rescuegrass (*Bromus unioloides* HBK), (5) bur clover (*Medicago polymorpha* L.), (6) cowpea (*Vigna unguiculata* L.), and (7) a mixture of mint + oat (*Mentha piperita* + *Avena sativa* L.). Each replicate was checked daily to ensure plant quality and to record the instars reached by the nymphs and mortality. Nymphal development time data for Cowpea and mint + oat were subjected to Student's *t* test for mean separation at 0.05 level of significance.

Nymphs of *T. rubromarginata* reached adult stage on two plant, (1) cowpea, and (2) a combination of mint and oat. Nymphs were not able to reach the fifth instar in any of the 5 remaining plant treatment (Table 1). Forty-eight percent of the neonate nymphs were able to reach the adult stage on cowpea as host and 9% with mint + oat. The result on cowpea was similar to Setamou & Jones (2005) result in which 36% of GWSS nymphs reached adult stage on cowpea.

Contrary to our results, in which no nymphs of *T. rubromarginata* reached adult stage on sweet orange (*C. sinensis*), Paiva et al. (2001) recorded that 84% of *Acrogonia gracilis* (Osborn), 79.8% of *Dilobopterus costalimai* Young, and 49.9% of *Oncometopia fascialis* (Signoret) nymphs reached adult stage reared on this host. However, Almeida & Lopes (1999) recorded high mortality during the first instar of *Oncometopia fascialis* and *Homalodisca ignorata* Melichar when the immatures were fed with *C. sinensis*.

No nymphs of *T. tubromarginata* reached the adult stage on the remaining 5 plant substrates. All newly emerged nymphs reared with rescuegrass and sweet orange succumbed before the first molt. Less than 10% of the nymphs feeding on corn, Bermuda grass, or bur clover were able to pass to second instar. Only 1% of the nymphs fed corn reached 4th instar (Table 1). The behavior of nymphs and adults (feeding, movements, etc.) in the breeding cages was similar to that described

for other sharpshooters by Turner & Pollard (1959) and Nielson et al. (1975).

The proportion of sexes obtained both on mint + oat and on cowpea were 1:1 (5 females: 4 males in the first and 25 females: 23 males with cowpea). The entire pre-imaginal development time was similar in both treatments, cowpea (57.1 ± 12.3 d), and mint + oat (59.2 ± 4.3 d) (Table 2). Development time in males and females did not show differences in cowpea ($P = 0.45$, $P > 0.05$). Setamou & Jones (2005) reported that GWSS males developed faster than females. They established that females, because they may have greater nutritional needs than males for ovarian and eggs maturation, had a longer developmental period during the last nymphal stage. They hypothesized that this fact might prevent inbreeding of GWSS populations. In this study, sex differences were not found in the developmental duration for the whole pre-imaginal period of *T. rubromarginata* in either host plant system.

The data obtained provide evidence that cowpea is an appropriate substrate to rear *T. rubromarginata* in the laboratory. The information gathered in this study is not only useful to initiate studies designed to describe life history parameters for *T. rubromarginata* in the laboratory but also to enable studies on its natural enemies, in particular egg parasitoids. During the evaluation of the South American egg parasitoids in their native range we found serious limitations during the studies due to difficulties in egg supplies of *T. rubromarginata*; and due to reverse seasons, it was impossible to ship South American parasitoids to United States during winter.

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SUMMARY

The glassy-winged sharpshooter (GWSS), *Homalodisca vitripennis* (Germar) has become a major pest in California primarily as a vector of

TABLE 1. PERCENTAGE OF NYMPHS OF *TAPAJOSA RUBROMARGINATA* THAT REACH EACH INSTAR AND ADULT STAGE WHEN FED ON DIFFERENT HOST PLANTS.

<i>T. rubromarginata</i>	Cowpea	Mint + oats	Corn	Bur clover	Bermuda grass	Rescue grass	Sweet orange
1 st instar	100	100	100	100	100	100	100
2 nd instar	76	90	6	4	2	0	0
3 th instar	71	85	2	1	0	0	0
4 th instar	60	78	1	0	0	0	0
5 th instar	55	53	0	0	0	0	0
Adults	48	9	0	0	0	0	0

TABLE 2. DEVELOPMENT TIME OF NYMPHAL STAGE (I-V) OF *TAPAJOSA RUBROMARGINATA* ON COWPEA AND MINT + OATS. MEANS FOLLOWED BY THE SAME LETTER IN A ROW ARE NOT SIGNIFICANTLY DIFFERENT ($P > 0.05$, *t*-STUDENT TEST).

Development time	Cowpea		Mint + oats	
	Mean \pm SD days	Range	Mean \pm SD days	Range
Male + female	57.1 \pm 12.3 a	39-92	59.2 \pm 4.3 a	55-68
Male	58.6 \pm 12.3 a	39-80	59.0 \pm 3.3 a	55-63
Female	55.7 \pm 12.5 a	39-92	59.4 \pm 5.4 a	55-68

Xylella fastidiosa, a bacteria that cause severe diseases to grapes. Owing to the uncertainty of the effectiveness of egg parasitoids native to California against GWSS, a neo-classical biological control approach is ongoing. The survey of natural enemies is conducted on leafhoppers closely related to the target pest in South America. In 2000, egg parasitoids of *Tapajosa rubromarginata*, a sharpshooter closely related to GWSS, were sought in regions in South America where climate types and habitats were similar to California. Nymphs and adults have different nutritional requirements, alternating host plant as a survival mechanism. Apparently, only a few host plants support the development of nymphs to maturity. We tested the viability of nymphs of *T. rubromarginata* reared on sweet orange, corn, bermuda grass, rescuegrass, bur clover, cowpea, and a combination of mint + oat as an attempt to determine a suitable substrate to rear this sharpshooter. We recorded high mortality of the newly emerged nymphs maintained with rescuegrass, sweet orange, corn, Bermuda grass and bur clover. Nymphs successfully reached the adult stage only eating on cowpea plants and the combination of mint + oat. Based on the observed survival rate and the number of individuals that reached the adult stage, cowpea was the most appropriate substrate for rearing *T. rubromarginata* in the laboratory.

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