Indian Journal of Entomology 84(1): 34-37 (2022) DoI.: 10.55446/IJE.2021.336

BEHAVIOURAL RESPONSE OF PARASITOID *ENCARSIA GUADELOUPAE* VIGGIANI TO INFESTED HOST PLANTS OF RUGOSE SPIRALING WHITEFLY *ALEURODICUS RUGIOPERCULATUS* MARTIN

M Saranya and J S Kennedy

Department of Agricultural Entomology, Tamil Nadu Agricultural University,
Coimbatore 641003, Tamil Nadu, India
*Email: jskennedy@tnau.ac.in (corresponding author)

ABSTRACT

The rugose spiralling whitefly (RSW) *Aleurodicus rugioperculatus* Martin is an invasive pest of coconut in India. The behavioural response of its parasitoid *Encarsia guadeloupae* Viggiani (Hymenoptera: Aphelinidae) on healthy and RSW infested host plants of coconut, banana, sapota and guava has been assessed in this study using a six arm olfactometer. Parasitoids' attraction was maximum with the infested banana leaves (1.62± 0.28) followed by coconut (1.28± 0.20), guava (1.05± 0.24) and sapota (0.82± 0.24). The results obtained also reveal that *E. guadeloupae* can be mass reared on banana plants infested with RSW nymphs to enable better mass production of the parasitoid.

Key words: *Aleurodicus rugioperculatus*, *Encarsia guadeloupae*, behavioural response, infested, healthy leaves, coconut, banana, sapota, guava, host: parasitoid ratios, parasitisation potential

India is the third largest producer of coconut in the world with productivity of 9,815 nuts (www. india stat. com, 2020), and insect pests are the major constraint in its production. Sundararaj et al. (2020) inventoried 454 species of whiteflies under 66 genera from India, comprising five species under two genera in the subfamily Aleurodicinae Quaintance and Baker and 449 species under 64 genera in the subfamily Aleyrodinae Westwood. Six species namely, *Aleurocanthus arecae* David and Manjunatha (India), *Aleurodicus dispersus* Russell (Central America), *A. rugioperculatus* Martin (Central America), *Aleurotrachelus atratus* Hempel (Brazil), *Paraleyrodes bondari* Peracchi (Central America), and *P. minei* Iaccarino (Syria) are known to have invaded coconut gardens in India. (Selvaraj et al. 2019; Alfred Daniel et al., 2020). In India, rugose spiraling whitefly (RSW) *A. rugioperculatus* was first documented in the coconut farms of Pollachi, Tamil Nadu and Palakkad, Kerala during July-August 2016. Infestation of RSW was recorded in coconut (40-60 %) and banana leaves (25-40 %) (Selvaraj et al., 2017). During heavy infestation, 60-70 % of the fronds were infested with RSW the resulting honey dew leads to sooty mould and affect the photosynthetic activity. There was no economic crop loss (Chandrika Mohan et al., 2017) but indirectly affects the photosynthetic efficiency and nut quality in coconut (Sundararaj and Selvaraj, 2017).

Excessive application of synthetic pyrethroids causes resurgence-induced feeding damage of RSW, also insecticides use was difficult due to its high dispersal ability and polyphagous nature in addition to health hazards. Hence, biocontrol agents in particular *Encarsia guadeloupae* Viggiani can be extensively used against RSW in coconut (Chandrika Mohan et al., 2017). In India, the maximum parasitisation of *E. guadeloupae* had been observed on RSW to be as high as 60-70% (Ramani et al., 2002). However, detailed study on its behavioural response and parasitization efficiency when reared on different host plants is meagre. The present study analyses the behavioural response of *E. guadeloupae* on healthy and RSW infested host plants so as to identify the preferred alternate host of RSW for its mass culture.

MATERIALS AND METHODS

The host plants selected were coconut (Chowghat Orange Dwarf), banana (Ney Poovan), sapota (CO-2) and guava (L-49) chosen based on the severe infestation reported by Selvaraj et al. (2017). RSW-infested coconut leaflets were collected from the Tamil Nadu Agricultural University (TNAU) orchard, Coimbatore, Tamil Nadu (11.0123°N,76.9355°E), and released on to mud potted (41 cm dia) plants of coconut (2 years old), banana (6 months old), sapota (6 months old), and guava (6 months old). These were maintained in a separate mini nethouse (270x 150x 210 cm with a nylon net mesh sized of 120 micron). RSW culture was maintained in the Insectary, Department of Agricultural Entomology at 31± 2°C, 60-75% RH under a natural light condition. Stock culture of the parasitoid *E. guadeloupae* was established by collecting the adults using an aspirator from banana in the TNAU orchard. Banana plants were infested with RSW adults for oviposition and allowed to maintain until the development of desired nymphal stage (second). Then, *E. guadeloupae* (1 day old) adults were released onto these for 24-48 hr for oviposition. From these the parasitized pupae were covered with clip cage (5 cm dia x 3 cm height) in banana plant. Parasitoids collected from these clip cages using aspirator were released on successive RSW nymphal generations for further *Encarsia* development. Mass maintenance of *E. guadeloupae* was done in mini nethouse (270x 150x 210 cm with a nylon net mesh sized of 120 micron), Insectary, Department of Agricultural Entomology at 31± 2°C, 60-75% RH under natural light.

Encarsia guadeloupae adults were subjected to behavioural bioassay to study the influence of host plant and RSW volatiles using six-arm olfactometer. Behavioural response was studied for the healthy plants followed by RSW infested leaves of coconut, banana, sapota and guava plants. About 10 g of host leaves of these host plants were kept in the arm and was firmly closed with a lid. Out of six arms, two arms were treated as control. The inlet of the olfactometer on the top center place was connected to an aquarium pump (220-240v AC) to release the pressure. After five minutes of saturation of different host odours in the olfactometer, ten numbers of one-day-old parasitoids were released in the olfactometer through a central opening, which also served as an odour exit hole. Observations were made on the number of parasitoids settled in each arm at 10, 20, 30, 40, 50 and 60 MAR (minutes after release). The experiment was replicated ten times. Data obtained were subjected to ANOVA, and means compared using general linear model (GLM) with Tukey's HSD test. All the data analyses were performed by using IBM SPSS Statistics 22.

RESULTS AND DISCUSSION

Significant difference were observed in the attraction of parasitoids between the healthy and RSW infested host plants over control in terms of number attracted; no attraction was observed with healthy leaves and control up to ten minutes after release (10 MAR); at 20 MAR, same number of parasitoids (0.10± 0.10) were attracted to healthy leaves of coconut, banana and sapota and no attraction in guava and control. Increasing trend of parasitoid attraction to healthy leaves was observed at 20, 30 and 40 MAR and decreasing trend was observed at 50 and 60 MAR. Number of parasitoids attracted was maximum with healthy leaves of banana (0.16± 0.04) followed by coconut (0.11± 0.03), guava (0.06± 0.02) and sapota (0.06± 0.02). Six arm olfactometer results showed significant differences in the orientation of *E.guadeloupae* towards RSW infested host plants; significantly more number of parasitoids were attracted to banana (1.62± 0.28) leaves followed by coconut (1.28± 0.20); and it was less with sapota (0.82± 0.24); host preference was in the order of banana > coconut > guava > sapota > control (Table 1).

Encarsia guadeloupae preferred to move with RSW nymphal stage on banana leaves. Successful parasitism eventually depends on the host selection process involving a sequence of phases mediated by physical and chemical stimuli from the host insect and host plants. Plants release blends of volatile organic compounds (VOCs) in response to herbivore damage. Parasitoids use these herbivore-induced plant volatiles as indirect cues to locate their herbivore hosts (Zhang et al., 2004; Nisha and Kennedy, 2015). Parasitization efficiency is highly influenced by the physical and chemical structures of the host plant (Lopez Avila, 1988; Shishehbor and Brennan, 1995; Vet et al. 1980). Such physical structures include waxy covering, dense and rigid hairs, fibrous lamina, pubescent, trichomes and leaf surface area (Rajam et al., 1988; Gruenhagen and Perring, 2001; Oster, 1995). Parasitoids get trapped in trichome exudates of velvetleaf *Aboutilon theofrasti* which cause poor parasitism on whitefly *Bemisia tabaci* (Gruenhagen and Perring, 2001b; Kishinevsky et al., 2017).

Thus, the behavioural response of *E. guadeloupae* involves more attraction to the RSW infesting banana followed by coconut. This is in accordance with the fact that various female parasitoids efficiently utilize the plant odours induced by its herbivore to locate host plants that may carry their hosts (Vet and Dicke, 1992; Turlings and Benrey, 1998; Turlings and Wäckers, 2004; Tamo et al. 2006). The present results suggest that *E. guadeloupae* can be mass-reared on banana plants infested with RSW nymphs more efficiently for mass rearing in biological control.

Table 1. Behavioural response of *E. guadeloupae* on healthy and RSW infested host plants

Host plants	No. of parasitoids attracted (M ± SE)													
	10 MAR		20 MAR		30 MAR		40 MAR		50MAR		60 MAR		Mean	
	H	I	H	I	H	I	H	I	H	I	H	I	H	I
Coconut	0.00 ± 0.00	0.50 ± 0.20	0.1 ± 0.10	1.20 ± 0.20	0.10 ± 0.10	1.50 ± 0.30	0.3 ± 0.10	2.00 ± 0.40	0.1 ± 0.10	1.40 ± 0.20	0.10 ± 0.00	1.10 ± 0.20	0.11 ± 0.03^{a}	1.28 ± 0.20^{cd}
Banana	0.00 ± 0.00	0.70±0.20	0.10 ±0.10	1.50 ± 0.30	0.20 ± 0.10	1.90 ± 0.40	0.40 ± 0.20	2.70 ± 0.40	0.20 ± 0.10	1.80 ± 0.30	0.10 ± 0.10	1.10 ± 0.20	0.16 ± 0.04^{a}	1.62 ± 0.28^{d}
Sapota	0.00 ± 0.00	0.20 ± 0.10	0.10 ±0.10	0.50 ± 0.20	0.10 ± 0.10	0.90 ± 0.40	0.10 ± 0.00	1.80 ± 0.50	0.10 ± 0.10	1.10 ± 0.20	0.00 ± 0.00	0.40 ± 0.20	0.06 ± 0.02^{a}	0.82 ± 0.24^{b}
Guava	0.00 ± 0.00	0.40 ± 0.20	0.00 ±0.00	0.70 ± 0.30	0.10 ± 0.10	1.10 ± 0.50	0.20 ± 0.10	2.00 ± 0.50	0.10 ± 0.10	1.40 ± 0.30	0.10 ± 0.00	0.70 ± 0.20	0.06 ± 0.02^{a}	1.05 ± 0.24^{bc}
Control	0.00 ± 0.00	0.00 ± 0.00	0.00 ±0.00	0.10 ± 0.10	0.00 ± 0.00	0.10 ± 0.10	0.00 ± 0.00	0.30 ± 0.20	0.00 ± 0.00	0.20 ± 0.10	0.00 ± 0.00	0.10 ± 0.10	0.00 ± 0.00^{b}	0.13 ± 0.04^{a}

MAR- Minutes After Release, H- Healthy; I- RSW infested leaves. Values with same lower case letters do not differ significantly according to Tukey HSD Test (F value =5.229 for healthy, and 37.036 for RSW infested; $p < 0.001$ level of significance); Values in each column mean± SE.

ACKNOWLEDGEMENTS

This study was supported by Department of Science and Technology, Government of India- New Delhi, under grant GOI- DST (SERB) /EMR/2016/005815.

REFERENCES

Alfred Daniel J, Ashok K, Pavithran S, Ranjith M. 2020. A review on invasive insect pests in india and their predators and parasitoids. Journal of Experimental Zoology India 23(2): 987-1006.

Chandrika Mohan, Josephrajkumar A, Merin Babu, Prathibha P S, Krishnakumar V, Hegde V, Chowdappa P. 2017. Invasive rugose spiralling whitefly in coconut, Technical Bulletin No. 117 (Centenary Series 60), ICAR-CPCRI, Regional Station, Kayamkulam. 16 pp.

Gruenhagen N M, Perring T M. 2001. Impact of leaf trichomes on parasitoid behavior and parasitism of silverleaf whiteflies (Homptera: Aleyrodidae). Southwestern Entomologist 26(4): 279-90.

Kishinevsky M, Keasar T, Bar-Massada A. 2017. Parasitoid abundance on plants: effects of host abundance, plant species, and plant flowering state. Arthropod-Plant Interactions 11(2): 155-61.

Lopez Avila, A. 1988. A comparative study of four species of *Encarsia* (Hymenoptera: Aphelinidae) as potential control agents for *Bemisia tabaci* (Gennadius) (Homoptera: Aleyrodidae). Doctoral dissertation, Imperial College London (University of London).

Nisha R, Kennedy J S. 2015. Behaviour and evolutionary response of parasitoid *Acerophagus papayae* Noyes and Schauff using different olfactometers. International Journal of Scientific and Research Publications 329.

Oster N. 1995. Factors influencing the parasitization efficiency of the parasitic wasp *Encarsia transvena*. M Sc Thesis, Tel Aviv University. 76 pp.

Rajam B, Peter C, David BV. 1988. Influence of host plants on the parasitism of *Bemisia tabaci gennadius* (Homoptera: Alyrodidae) by *Encarsia* sp. Current Science. 57(22):1246-7.

Ramani S, Poorani J, Bhumannavar B S. 2002. Spiralling whitefly, *Aleurodicus dispersus* Russell (Homoptera: Aleyrodidae) in India. Biocontrol News and Information 23(2): 55-62.

Selvaraj K, Gupta A, Venkatesan T, Jalali S K, Ballal C R, Sundararaj R. 2017. First record of invasive rugose spiraling whitefly *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) along with parasitoids in Karnataka. Journal of Biological Control 31(2): 74-78

Selvaraj K, Sundararaj R, Sumalatha B V. 2019. Invasion of the palm infesting whitefly, *Aleurotrachelus atratus* Hempel (Hemiptera: Aleyrodidae) in the Oriental region. Phytoparasitica 47(3): 327-332

Shishehbor P, Brennan, P A. 1995. Parasitism of *Trialeurodes ricini* by *Encarsia formosa*: Level of parasitism, development time and mortality on different host plants. Entomophaga 40(3-4): 299-305

Sundararaj R, Selvaraj K, Vimala D, Venkatesan T. 2020. Whiteflies (Hemiptera: Aleyrodidae) of India. Indian insects: Diversity and science. S Ramani, P Mohanraj, H M Yeshwanth (eds.) CRC Press, Tayler & Francis, UK. pp. 103-120.

Sundararaj R, Selvaraj K. 2017. Invasion of rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae): a potential threat to coconut in India. Phytoparasitica 45(1): 71-74.

Tamò C, Ricard I, Held M, Davison A C, Turlings T C J. 2006. A comparison of naive and conditioned responses of three generalist endoparasitoids of lepidopteran larvae to host-induced plant odours. Animal Biology 56: 205-220.

Turlings T C J, Benrey B. 1998. The effects of plant metabolites on the behavior and development of parasitic wasps. Écoscience 5: 321-333.

Turlings T C J, Wäckers F. 2004. Recruitment of predators and parasitoids by herbivore-injured plants. Advances in insect chemical ecology. R Carde, J G.Millar (eds.). Cambridge University Press, Cambridge. pp. 21-75.

Vet L E M, Dicke M. 1992. Ecology of infochemical use by natural enemies in a tritrophic context. Annual Review of Entomology 37: 141-172.

Vet L E M., Van Lenteren, J C, Woets J. 1980. The parasite-host relationship between *Encarsia formosa* (Hymenoptera: Aphelinidae) and *Trialeurodes vaporariorum* (Homoptera: Aleyrodidae) IX. A review of the biological control of the greenhouse whitefly with suggestions for future research. Zeitschrift für Angewandte Entomologie 90(1-5): 26-51.

Zhang F, Toepfer S, Riley K, Kuhlmann U. 2004. Reproductive biology of *Celatoria compressa* (Diptera: Tachinidae), a parasitoid of *Diabrotica virgifera* (Coleoptera: Chrysomelidae). Biocontrol Science and Technology 14: 5-16.

(Manuscript Received: February, 2021; Revised: April, 2021;
Accepted: April, 2021; Online Published: July, 2021)
Online published (Preview) in www.entosocindia.org Ref. No. e21037