



HOST RANGE OF COCONUT RUGOSE SPIRALLING WHITEFLY *ALEURODICUS RUGIOPERCULATUS* MARTIN

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ABSTRACT

Coconut (*Cocos nucifera* L.) is attacked by a wide variety of insect pests of which rugose spiralling whitefly (RSW), *Aleurodicus rugioperculatus* Martin has been causing widespread damage in growing major coconut growing districts of Tamil Nadu since 2016 and has been recorded as an invasive pest in coconut. The pest is expanding its host range in economic field and horticultural crop plants besides weed fauna, posing a real threat to farming community. Extensive survey undertaken in Tamil Nadu during 2018 to 2020 to study the expanding host range of RSW which revealed the presence of the pest in about 67 host plants including coconut. Management of the pest through chemical means is highly difficult and the parasitoid, *Encarsia guadeloupae* has been observed to effectively suppress the pest. Host plants that harbor more *Encarsia* parasitoids (which are referred as banker plants) would help in biosuppression of the pest. Upon studying the host range, it was found that, the RSW was able to complete its life cycle and successfully emerge as adults in only six hosts viz., coconut, teak, banana, guava, maize and Spanish cherry, while five other hosts viz., *Annona muricata*, *A. squamosa*, *A. reticulata*, *Theobroma cacao* and *Ficus religiosa* supported RSW up to its nymphal stage and harboured *Encarsia guadeloupae* parasitoids in larger numbers. These hosts can be used as banker crops in and around coconut plantations so that the emerging parasitoids will aid in biosuppression of the target pest.

Key words: *Aleurodicus rugioperculatus*, host range, *Encarsia guadeloupae*, banker plants, *Annona muricata*, *A. squamosa*, *A. reticulata*, *Theobroma cacao*, *Ficus religiosa*, natural suppression

Coconut (*Cocos nucifera* L.) is attacked by a wide variety of insect pests of which the invasive pest, rugose spiralling whitefly (RSW) *Aleurodicus rugioperculatus* Martin has been causing widespread damage in growing major coconut districts of Tamil Nadu since 2016. The species was first reported in coconut (*Cocos nucifera* L.) during 2004 in Belize, Central America (Martin, 2004), South Florida, United States in 2009 (Stocks and Hodges, 2012) and in Pollachi tract, Tamil Nadu, Coimbatore district, Tamil Nadu during August, 2016 (Shanas et al., 2016; Srinivasan et al., 2016; Sundararaj and Selvaraj, 2017; Selvaraj et al. 2017). Subsequent to its identification and confirmation, the rugose spiralling whitefly (RSW) tended to show its presence in other economic plants and weeds, thus posing a grave danger to the field and horticultural crop plants. The RSW has been known to attack about 118 hosts including cultivated crops and weed flora (Stocks and Hodges, 2012). The vast host range reported by Stocks and Hodges (2012) showed this pest is more attracted to ornamental plants, thus evincing not much interest in the minds of field and horticultural crop researchers. Thus,

literature on the RSW was sparse and in particular, the host range of the species was poorly studied in South East Asia.

With regard to host range, RSW has been identified on 118 plant species including edibles, ornamentals, palms, weeds as well as native and invasive plant species (Francis et al., 2016). Surveys by Shanas et al. (2016) revealed the infestation of RSW in about 17 hosts while Srinivasan et al. (2016) reported a host range of 15 plant species. Preliminary studies conducted by Srinivasan et al. (2016) highlighted a nymphal parasitoid, *Encarsia guadeloupae* Viggiani (Hymenoptera: Aphelinidae), that was providing excellent biosuppression of RSW which have also been reported by Ramani et al. (2002) and Evans (2007) but against *Aleurodicus disperses*. The parasitoid has already been reported on *A. rugioperculatus* from Florida (Kumar et al., 2013) and appears to be a potential biocontrol agent against RSW as 50 to 60% natural parasitisation of the pupae was observed (Shanas et al., 2016). Hence attempts to augment these parasitoids in infested coconut gardens

was made by collecting and redistributing the coconut leaves with parasitized nymphs as an inoculative release in the infested coconut gardens. During the surveys in Coimbatore and Tiruppur districts, the occurrence of *Encarsia* was noticed in hosts other than coconut and banana. These hosts considered as “banker plants” (that invite more of parasitoids and help in natural biosuppression of pest species in crop ecosystems) (Gurr et al., 2017) assume greater importance in the present era of non-chemical pest control. Thus, the present study is intended to explore the host range of RSW, and in the process, identifying hosts that could serve as banker plants for aiding natural suppression of the pest.

MATERIALS AND METHODS

Survey was taken up in the host plants found in the vicinity of coconut plantations in Tamil Nadu Agricultural University campus (11.022 N, 76.927 E) and in coconut gardens in Tamil Nadu during 2018 to 2020. For a particular host plant, a minimum of 25 plants were examined to ascertain the presence of RSW. The host plants were photo-documented using a portable handheld camera. The plants that were considered as host plants include those that were found laden with all the life stages of *A. rugioeperculatus*. The host plants were differentiated into three groups viz., hosts that housed the egg stages and exhibited lack of further development to nymphal stages; hosts that supported up to nymphal stages only where adult emergence failed and hosts that supported the full development of RSW life stages and exhibiting eggs, nymphal and adult colonies of RSW. Consequent to the recording of the host plants and the stage of RSW in the respective host plant, additional observations on the parasitism by *Encarsia guadeloupeae* Viggiani was recorded. This was done by collecting 10-15 leaf samples of the host plant along with the nymphal stage and observing under the microscope. The RSW nymphs showing circular emergence holes are the ones from which the *E. guadeloupeae* adults have emerged. Among such colonies were found blackened nymphal stages which represent RSW nymphs already parasitized by *E. guadeloupeae*. The host plants that house RSW nymphs along with this type of emergence holes/ blackened nymphs and those housing adult parasitoids were also recorded.

RESULTS AND DISCUSSION

The survey for rugose spiralling whitefly (RSW) in and around coconut gardens of TNAU campus

revealed that RSW life stages were observed in 67 host plants including coconut (Table 1). Regarding the host range of the RSW, Francis et al. (2016) reported about 118 host plants belonging to 43 families in the United States. Stocks and Hodges (2012) reported about 95 host plants in Florida, USA. Studies by Shanas et al. (2016) highlighted 12 plant species as host of *A. rugioeperculatus* in Kerala. In Tamil Nadu a total of 15 hosts belonging to 13 families have been reported by Srinivasan et al. (2016). About 9 hosts were recorded by Selvaraj et al. (2017). Out of the hosts recorded during the present studies, 7 belonged to each Fabaceae, 6 in Malvaceae, 5 in Euphorbiaceae, 4 each in Annonaceae and Sapotaceae and 3 each in Araceae, Meliaceae, Poaceae and Rutaceae. Apart from these 26 other families were recorded. A classification on the basis of economic importance of the host plants revealed that the RSW was able to inflict damage in a range of economically important crops. Of the 67 host plants recorded, 17 fell under the ornamental plants category, followed by 14 under fruit crops, 9 under medicinal plants, 5 under vegetables, 4 under fibre crops, 2 each under biofuels, flower crops, green leaf manures, millets, oilseeds, plantation crops and timber crops, besides 1 host each under pulses, avenue trees, fodder crop and tuber crops.

The invasive RSW was first recorded in Tamil Nadu during 2016 (Srinivasan et al., 2016). Within a short span of time i.e. 2 years since its entry, the pest had its host range expanded to about 67 hosts which is a sign of the ability of RSW to survive on different host plants. The expanding host range of RSW should be eyed with greater caution, as their infestation in export-oriented crops may bring various problems in the international trade arena. The ability of RSW to inflict damage in a range of economically important crops viz., ornamental plants, fruit crops, medicinal plants, vegetables, fibre crops, biofuels, flower crops, green leaf manures, millets, oilseeds, plantation crops, timber crops, pulses, avenue trees, fodder crop and tuber crops indicates the pest's invasive ability within a short span of time. Among the 67 host plants, only six hosts supported the full growth and development of RSW viz., *Cocos nucifera*, *Tectona grandis*, *Musa paradisiaca*, *Psidium guajava*, *Zea mays* and *Mimosa elengi*, while five other hosts viz., *Annona muricata*, *A. squamosa*, *A. reticulata*, *Theobroma cacao* and *Ficus religiosa* supported RSW up to its nymphal stage and the remaining 56 hosts were preferred only for oviposition by RSW.

Table 1. Host plants and parasitism of *A. rugiperculatus*

Common name	Scientific name	Family	Economic importance	Life stages	Parasitism by <i>Encarsia guadeloupae</i>
Vilvam/ bael	<i>Aegle marmelos</i> L.	Rutaceae	Medicinal	E	-
Neem	<i>Azadiracta indica</i> L.	Meliaceae	Medicinal	E	-
Camel foot	<i>Bauhinia purpurea</i> L.	Fabaceae	Ornamental	E	-
Orchid tree	<i>Bauhinia</i> sp. L.	Fabaceae	Ornamental	E	-
Alexandrian laurel	<i>Calophyllum inophyllum</i> L.	Clusiaceae	Medicinal	E	-
Jack bean	<i>Canavalia ensiformis</i> L.	Fabaceae	Vegetable	E	-
Karanda	<i>Carissa carandas</i> L.	Apocynaceae	Fruits	E	-
Star apple	<i>Chrysophyllum cainito</i> L.	Sapotaceae	Fruits	E	-
Citrus	<i>Citrus limon</i> L.	Rutaceae	Fruit	E	-
Ivy gourd	<i>Coccinea grandis</i> L.	Cucurbitaceae	Vegetable	E	-
Sunnhemp	<i>Crotalaria juncea</i> L.	Fabaceae	Green manure	E	-
Purple yam	<i>Dioscorea alata</i> L.	Dioscoreaceae	Vegetable	E	-
Wood apple	<i>Feronia elephantum</i> Corr.	Rutaceae	Fruit	E	-
Banyan	<i>Ficus benghalensis</i> L.	Moraceae	Ornamental	E	-
Fernleaf tree	<i>Filicium decipiens</i> Wight & Arn.	Sapindaceae	Ornamental	E	-
Gliricidia	<i>Gliricidia sepium</i> Jacq.	Fabaceae	Green leaf manure	E	-
Wild cotton	<i>Gossypium armourianum</i> Kear.	Malvaceae	Fibre	E	-
Wild cotton	<i>Gossypium gossypoides</i> Standley	Malvaceae	Fibre	E	-
Cotton	<i>Gossypium hirsutum</i> L.	Malvaceae	Fibre	E	-
Wild cotton	<i>Gossypium robinsonii</i> F. Muell.	Malvaceae	Fibre	E	-
Sunflower	<i>Helianthus annuus</i> L.	Asteraceae	Oilseeds	E	-
Hibiscus	<i>Hibiscus rosa-sinensis</i> L.	Malvaceae	Ornamental	E	-
Indian elm	<i>Holoptelea integrifolia</i> Roxb.	Ulmaceae	Ornamental	E	-
Morning glory	<i>Ipomoea purpurea</i> L.	Convolvulaceae	Ornamental	E	-
Jatropha	<i>Jatropha curcas</i> L.	Euphorbiaceae	Biofuel	E	-
Spicy Jatropha	<i>Jatropha integerimma</i> Jacq.	Euphorbiaceae	Medicinal	E	-
Malabar nut	<i>Justicia adhatoda</i> L.	Acanthaceae	Medicinal	E	-
Lab lab	<i>Lablab purpureus</i> L.	Fabaceae	Pulses	E	-
Mahua	<i>Madhuca longifolia</i> L.	Sapotaceae	Medicinal	E	-
Mango	<i>Mangifera indica</i> L.	Anacardiaceae	Fruits	E	-
Tapioca	<i>Manihot esculenta</i> L.	Euphorbiaceae	Tuber	E	-
Sapota	<i>Manilkara zapota</i> L.	Sapotaceae	Fruits	E	-
Green Malabar Neem	<i>Melia dubia</i> Cav.	Meliaceae	Medicinal	E	-
Indian Beech Tree	<i>Milletia pinnata</i> L.	Fabaceae	Biofuel	E	-
Noni	<i>Morinda citrifolia</i> L.	Rubiaceae	Medicinal	E	-
Moringa	<i>Moringa oleifera</i> L.	Moringaceae	Vegetable	E	-
Nerium	<i>Nerium oleander</i> L.	Apocynaceae	Flower	E	-
Proso millet	<i>Panicum miliaceum</i> L.	Poaceae	Millet	E	-
Avocado	<i>Persea americana</i> Mill.	Lauraceae	Fruits	E	-
Lacy tree	<i>Philodendron bipinnatifidum</i> Schott.	Araceae	Ornamental	E	-
Philodendron Lemon lime	<i>Philodendron hederaceum</i> var <i>aureum</i>	Araceae	Ornamental	E	-

(contd.)

Indian gooseberry	<i>Phyllanthus emblica</i> L.	Phyllanthaceae	Fruits	E	-
False Asoka tree	<i>Polyalthia longifolia</i> Sonn.	Annonaceae	Avenue tree	E	-
Money plant	<i>Pothos</i> sp. L.	Araceae	Ornamental	E	-
Castor	<i>Ricinus communis</i> L.	Euphorbiaceae	Oilseed	E	-
Rose	<i>Rosa</i> sp. L.	Rosaceae	Flower	E	-
Indian sandal wood	<i>Santalum album</i> L.	Santalaceae	Timber	E	-
Soapnut	<i>Sapindus emarginatus</i> Vahl.	Sapindaceae	Medicinal	E	-
Asoka tree	<i>Saraca asoca</i> Roxb.	Caesalpinioideae	Ornamental	E	-
Chekurmanis	<i>Sauropus androgynous</i> (L.) Merr.	Euphorbiaceae	Vegetable	E	-
Paradise tree	<i>Simarouba glauca</i> DC.	Simaroubaceae	Ornamental	E	-
Mahogany	<i>Swietenia macrophylla</i> King.	Meliaceae	Ornamental	E	-
Jamun	<i>Syzigium cumini</i> (L.) Skeels	Myrtaceae	Fruits	E	-
Yellow bells	<i>Tecoma stans</i> (L.) Juss.	Bignoniaceae	Ornamental	E	-
Tree marigold	<i>Tithonia diversifolia</i> (Hemsl.) A. Gray	Asteraceae	Ornamental	E	-
Cumbu Napier hybrid	<i>Pennisetum glaucum</i> L. x <i>Pennisetum purpureum</i> Schum.	Poaceae	Fodder	E	-
Sour sop	<i>Annona muricata</i> L.	Annonaceae	Fruits	E, N	+++
Custard apple	<i>Annona reticulata</i> L.	Annonaceae	Fruits	E, N	++
Sugar apple	<i>Annona squamosa</i> L.	Annonaceae	Fruits	E, N	+++
Cocoa	<i>Theobroma cacao</i> L.	Malvaceae	Plantation	E, N	+++
Peepal	<i>Ficus religiosa</i> L.	Moraceae	Ornamental	E, N	++
Coconut	<i>Cocos nucifera</i> L.	Arecaceae	Plantation	E, N, A	+++
Teak	<i>Tectona grandis</i> L.	Lamiaceae	Timber	E, N, A	-
Banana	<i>Musa paradisiaca</i> L.	Musaceae	Fruits	E, N, A	++
Guava	<i>Psidium guajava</i> L.	Myrtaceae	Fruit	E, N, A	-
Maize	<i>Zea mays</i> L.	Poaceae	Millets	E, N, A	+
Spanish Cherry	<i>Mimusops elengi</i> L.	Sapotaceae	Ornamental	E, N, A	-

E - Hosts supporting up to egg stage; E,N – Hosts supporting both egg and nymphal stages, E,N- Hosts supporting egg, nymphal and adult stages; + denotes – presence (number of + denotes their relative abundance); - denotes absence

Fortunately, only in six host plants, the RSW was able to complete its life stage and successfully emerge as adults viz., coconut, teak, banana, guava, maize and Spanish Cherry. Among them coconut & banana house the parasitoid in larger numbers and aid in natural suppression of the pest. The hosts viz., *Annona muricata*, *A. reticulata*, *A. squamosa*, *Theobroma cacao* and *Ficus religiosa*, which also housed parasitoids in larger numbers should be viewed in a positive perspective in that, these hosts could be used as banker crops in and around coconut plantations so that the emerging parasitoids will aid in biosuppression of the target pest. The concept of banker plants has been suggested by Gurr et al. (2017) who suggests that banker plants provide shelter and serve as a source habitat and attract parasitoids and predators in the main crop so as to suppress the target pest population. The successful parasitism by *E. guadelopae* in coconut

and banana deserves special mention as management of the invasive RSW through any other mean in these crops will be extremely difficult. Five host plants, viz., *Annona muricata*, *A. reticulata*, *A. squamosa*, *Theobroma cacao* and *Ficus religiosa* supported the growth and development up to nymphal stages only and in all these hosts, the aphelinid parasitoid, *Encarsia guadelopae* were found in significant numbers. These hosts may serve as eco-feast crops / banker plants and could be utilized as border/ bund crops. Once established these plants will serve as ‘parasitoid banks’ and help in biosuppression of RSW in the main crop viz., coconut.

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AUTHOR CONTRIBUTION STATEMENT

D. Nandhini: Executed survey, documented host plants and helped documenting draft.

T. Srinivasan: conceived idea, designed research, assisted identification of host plants and drafted the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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