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Influence of biophysical characters of coconut and oil palm on rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin

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ABSTRACT: A study was carried out on biophysical characters of coconut and oil palm located in different villages of West and East Godavari districts to see their effect on infestation of rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin. The biophysical leaf characters *viz.,* leaflet colour, number of leaflets/leaf, leaflet length (cm), leaflet width (cm), leaflet thickness (mm) and trichomes/cm^2, *etc.,* were studied. It was observed that among all the biophysical characters only two characters *viz.,* length of the leaflet in both coconut (0.923) and oil palm (0.952) exhibited significant positive correlation with pest infestation and thickness of the leaflet in coconut (-0.870) and oil palm (-0.892) showed significant negative correlation whereas leaflet width in case of oil palm (0.978) was found significantly positively correlated with the rugose whitefly infestation.

Keywords: Rugose, coconut, oil palm, biophysical characters

INTRODUCTION

Many species of insect pests are associated with cultivated and wild palms which includes both invertebrates and vertebrates. Of these, red palm weevil, rhinoceros beetle, coconut black-headed caterpillar and slug caterpillar are the most important devastating insect pests of coconut in major coconut-growing areas of the world (Sathiamma *et al.,* 1982, Vidyasagar *et al.,* 1991; Kumara *et al.,* 2015). Major pests of oil palm are red palm weevil, rhinoceros beetle, leaf web worm, psychid, slug caterpillar with a loss estimation on the yields in the range of 20-30% extending to three years after attack (Kalidas, 2012). India is the only country in the Oriental region where the rugose spiraling whitefly, *Aleurodicus rugioperculatus* Martin has been accidentally introduced. Initially, this whitefly was observed in several coconut farms in the Pollachi area of Coimbatore district, Tamil Nadu and first reported in Kottayam from Kerala during July– August 2016 (Sundararaj and Selvaraj, 2017). RSW was originally described from Belize in 2004 on coconut (Martin, 2004) and initially reported from Miami-Dade County, Florida, United States of America from gumbo limbo *Bursera simaruba* (L.) Sarg in 2009 as a pest. RSW is highly polyphagous, found to feed on 118 plant species which include edible plants, palms and weeds and has been classified as a serious threat for coconut cultivation in Florida (Stocks and Hodges, 2012; Kumar *et al.,* 2013). This pest has also been recorded from Kadiyapulanka nurseries in coastal Andhra Pradesh during October-November, 2016. The possible entry to Andhra Pradesh may be through coconut seedlings transported from nurseries in Tamil Nadu and Kerala (Chalapathi Rao *et al*., 2020). Later the pest assumed significance and within a short period of time and has spread to other states, signaling a serious threat to palms, various fruit and ornamental crops, thus indicating the extension of host range and geographical distribution of the pest in the state (Chakravarthy *et al.,* 2017).

The study on infestation of RSW on different crops is hence required to understand the behaviour of the pest and find its peak infestation period, so there is a need to establish eco-friendly control strategies which farmers could adopt for managing insect pests at the farm level. Attraction, feeding and oviposition of the insect pests is coupled with the biophysical characteristics of plants. In this backdrop, biophysical characters are the most attributing characters which are used as primary source of defense by plants against insect pests. Keeping this in view, the present study was undertaken to know the role of biophysical characters of the leaves of host plants on infestation of *A. rugioperculatus*.

MATERIALS AND METHODS

The study was conducted in 10 coconut and five oil palm gardens located at different villages in the districts of East and west Godavari in Andhra Pradesh, India. The plant population in all the gardens ranged from 100 to 150. Total number of leaves and infested leaves were recorded and the per cent infestation was worked out.

Table 1. Studies on influence of biophysical characters of coconut leaves on RSW, *A. rugioperculatus* infestation in Godavari districts, A.P.

Village, District	Petiole colour	Number of leaflets /leaf	Length of leaflet (cm)	Leaflet width (cm)	Leaflet lamina Thickness (mm)	Leaf spiral direction	Crown shape	RSW infestation (%)
Nallajerla – G1, West Godavari	Green	242.30	122.00	3.70	0.38	Right	Hemi-spherical	77.70
Nallajerla – G2, West Godavari	Green	264.00	117.00	5.20	0.49	Right	spherical	74.00
V.R. gudem – G1, West Godavari	Yellow	244.00	129.00	3.50	0.43	Left	Hemi-spherical	81.80
V.R. gudem – G2, West Godavari	Green	252.30	138.00	4.80	0.36	Right	spherical	84.60
V.R. gudem – G3, West Godavari	Yellow	228.30	129.50	4.20	0.51	Left	spherical	56.00
V.R. gudem – G4, West Godavari	Green	260.30	152.00	3.90	0.32	Right	spherical	100.00
Niladripuram – G1, West Godavari	Yellow	249.30	143.00	4.10	0.33	Left	Hemi-spherical	95.00
Ambajipet, East Godavari	Green	245.00	97.00	3.70	0.53	Right	Hemi-spherical	0.00
Nagullanka, East Godavari	Green	233.00	94.00	4.30	0.55	Left	spherical	0.00
Kadiyapulanka, East Godavari	Yellow	250.70	153.00	4.80	0.31	Right	Hemi-spherical	100.00
Mean	-	246.90	127.50	4.22	0.42	-	-	66.90
S.D	-	11.02	20.55	0.55	0.09	-	-	37.60

V.R. gudem – Venkataramannagudem, G- Garden. * - Significant; ** - Highly significant; NS – Non-significant

The leaf characters studied for coconut palms were petiole colour, number of leaflets/leaf, leaflet length (cm), leaflet thickness (mm), leaflet width (cm), trichomes/cm^2, leaf spiral direction, crown shape. In case of oil palm plants the biophysical characters *viz.,* leaf colour, number of leaflets per leaf, leaflet length (cm), leaflet thickness (mm), leaflet width (cm) and trichomes/cm^2 were studied.

For recording the above observations coconut and oil palm gardens with *A. rugioperculatus* infestation were selected and five per cent sample palms/garden were randomly selected. Leaves from each selected palm were randomly selected from the top, middle and lower whorls of the palm. The leaflets were randomly selected from 60 per cent leaflets of each selected leaf @ one each from three levels *i.e.,* top, middle and lower levels of the palm. The biophysical characters of leaves were recorded as per coconut and oil palm crop descriptors. The average values of each character were calculated and data was tabulated.

Petiole color: Petiole colour of the coconut leaf, whether it is "green/ red/ yellow/ brown/ other" was observed based on visual observations and the petiole colour was recorded.

Leaf color, Leaf texture: Leaf color, Midrib color and Leaf texture of the plants was recorded based on visual observations.

Number of leaflets/leaf: Number of leaflets/leaf was recorded by making a count of leaflets present on either side of the leaf.

Leaflet length (cm): Length of the leaflet from the base to the tip of the leaflet was measured by using a measuring tape from four leaflets (two on either side) from the middle portion of the leaf.

Leaflet thickness (mm): The thickness of the leaflet lamina was measured by vernier calipers.

Leaflet width (cm): The width of the leaflet was measured by using a measuring tape from the mid portion of the four leaflets (two on either side) of a leaf.

Leaf spiral direction: The leaf spiral direction of the palms, whether it is left side (younger leaf on the left side of previous inflorescence and bunch hangs to the right side of the leaf) or right side (younger leaf is to right side of previous inflorescence and bunch hangs to left side of the leaf) was observed based on visual observation and the results were recorded.

Table 2. Studies on influence of biophysical characters of oil palm leaves on RSW, *A. rugioperculatus* infestation in West Godavari district, A.P.

Village	Leaf colour	Number of leaflets/leaf	Leaflet length (cm)	Leaflet width (cm)	Leaflet lamina thickness (mm)	RSW infestation (%)
Niladripuram – G1	Green	270.00	115.00	6.00	0.51	95.00
V.R. gudem – G1	Green	258.00	110.00	4.90	0.48	86.50
V.R. gudem – G2	Green	282.00	112.00	5.40	0.49	89.50
Nallajerla – G1	Green	268.00	94.00	5.20	0.39	64.00
Nallajerla – G2	Green	272.00	99.00	5.80	0.43	80.00
Mean	-	270.00	106.00	5.46	0.46	83.00
S.D	-	8.60	9.03	0.44	0.049	11.92

V.R. gudem – Venkataramannagudem, * - Significant; ** - Highly significant; NS – Non-significant

Crown shape: The crown shape of the palms, whether it is "spherical/ hemi-spherical/ X-shaped/ V-shaped/ other" was observed based on visual observation and data was recorded.

Trichomes/cm²: Three leaf bits of 1 cm² size from a single leaflet were cut and observed under 100 x, stereo zoom microscope and the number of trichomes were recorded. The number of trichomes/cm² leaf area on the abaxial surface of the leaflets were counted on selected leaflet samples.

Leaf shape: The shape of the leaf, leaf apex and leaf base were noted as per the crop descriptors.

RESULTS AND DISCUSSION

Data on influence of various bio-physical parameters on RSW infestation are presented in table 1.

Petiole colour

The petiole colour of the coconut leaves from four coconut gardens in Nallajerla (G1 and G2) and V.R. gudem (G2 and G4) villages was found as "green" while "yellow" colour was recorded in three coconut gardens in V.R. gudem (G1 and G3) and Niladripuram (G1) villages of W.G. district. In E.G. district, the leaf petiole was "green" in color in two gardens at Ambajipet, Nagullanka villages and "yellow" color was recorded in a garden at Kadiyapulanka village (Table 1). The analysis of leaf petiole colour data in coconut palms revealed that, there was no significant influence of leaf petiole colour with RSW infestation on *A. rugioperculatus* infestation.

Number of leaflets/leaf

The data on the number of leaflets/leaf of coconut gardens ranged from 228.30 to 264.00 in the villages of W.G. district. The number of leaflets/leaf in case of coconut palms in three gardens at Ambajipet, Nagullanka and Kadiyapulanka villages of E.G. district were recorded as 245.00, 233.00 and 250.70 numbers respectively (Table 1). Correlation studies between number of leaflets/leaf and RSW infestation revealed that, the above parameter was non-significantly correlated with *A. rugioperculatus* infestation (r= 0.542). Palms located in all the locations underwent heavy damage irrespective of the number of leaflets/leaf.

Leaflet length (cm)

From the observations it was found that, the length of the leaflet ranged from 117.00 to 152.00 cm in coconut gardens located at W.G. district. Similarly, the length of the leaflet in three coconut gardens at Ambajipet, Nagullanka and Kadiyapulanka villages of E.G. district was recorded as 97.00, 94.00 and 153.00 cm respectively (Table 1). When the correlation coefficient was worked out for this data it was established that, the length of the coconut leaflet was positively and highly significantly correlated with *A. rugioperculatus* infestation (r= 0.923).

Leaflet width (cm)

The width of the leaflet of coconut leaves was ranged from 3.50 to 5.20 cm in villages of W.G. district. Whereas in three coconut gardens at Ambajipet, Nagullanka and Kadiyapulanka villages of E.G. district the width of the leaflet was 3.70, 4.30 and 4.80 cm, respectively (Table 1). Correlation studies of above data revealed that, the width of the coconut leaflet was non-significantly correlated with *A. rugioperculatus* infestation (r= 0.189).

Leaflet thickness (mm)

Observations recorded on leaflet thickness of coconut leaves was ranged from 0.32 to 0.51 mm in coconut gardens of W.G. district. In E.G. district, 0.53, 0.55 and 0.31 mm thickness of the leaflet was recorded from three coconut gardens at Ambajipet, Nagullanka and Kadiyapulanka villages, respectively (Table 1). Correlation coefficient analysis of the above parameter data revealed that, the thickness of the leaflet was negatively and highly significantly correlated with *A. rugioperculatus* infestation (r= -0.870) which indicates that, with the increase in the thickness of coconut leaflets results in the low infestation of *A. rugioperculatus*.

Leaf spiral direction

The leaf spiral direction recorded in the coconut palms was "right" in four gardens, two each in V.R. gudem (G2 and G4) and Niladripuram (G1 and G2) villages. In case of other two coconut gardens in V.R. gudem village (G1 and G3) and a garden in Niladripuram village of West Godavari district, "left" side leaf spiral direction was recorded. In East Godavari district, "right" side leaf spiral direction was recorded from two coconut gardens one each in Ambajipet and Kadiyapulanka villages and "left" side leaf spiral direction was recorded in a coconut garden at Nagullanka village (Table 1). The results showed that, the leaf spiral direction did not have any influence on *A. rugioperculatus* infestation. However further intensive studies are required to establish the above fact.

Crown shape

The data collected on the crown shape of the coconut palm was "hemi-spherical" in shape from three coconut gardens one each in Nallajerla (G1), V.R. gudem (G1) and Niladripuram (G1) villages and "spherical" crown shape was recorded gardens in Nallajerla (G2) and Venkataramannagudem (G2, G3 and G4) villages. In case of East Godavari district, "hemispherical" crown shape was recorded from coconut palms in two coconut gardens one each in Ambajipet and Kadiyapulanka villages and "spherical" shape of the crown was recorded in coconut garden at Nagullanka village (Table 1). The data revealed that, the shape of the crown did not have any influence on *A. rugioperculatus* infestation.

Trichomes/cm^2

No trichomes were observed on the abaxial surface of the coconut leaves in different locations in both the districts of East and West Godavari.

The biophysical characters of oil palm were given in Table 2.

Leaf colour

The colour of the oil palm leaves in five oil palm gardens located at Niladripuram, V.R. gudem and Nallajerla villages of West Godavari district was found "green" in color (Table 2). Through the studies it was found that leaf colour did not have any influence on RSW infestation.

Number of leaflets per leaf

From the data on the number of leaflets/leaf, it was found that, a range from 258.00 to 282.00 no./leaf were found in five oil palm gardens in surveyed villages of West Godavari district (Table 2). Correlation studies revealed that, the above parameter was non-significantly correlated with RSW infestation (r= 0.166). Palms located in all the locations underwent heavy damage irrespective of the number of leaflets/leaf.

Leaflet length (cm)

The data on length of the leaflet ranged from 94.00 to 115.00 cm in all the oil palm gardens in the surveyed villages of West Godavari district (Table 2). When the correlation coefficient was worked out for this data it was revealed that, the length of the oil palm leaflet was positively and significantly correlated with RSW infestation (r= 0.952).

Leaflet width (mm)

The data on leaflet width from oil palm plants in five gardens revealed that width of the oil palm leaflet ranged from 4.90 to 6.00 cm respectively (Table 2). Correlation studies between the width of the oil palm leaflet and RSW infestation revealed that, the width of the leaflet was positively non-significantly correlated with RSW infestation (r= 0.978) indicating that if the width of the leaflet increased the RSW infestation will also increase, but not at a significant level.

Leaflet thickness (mm)

The data on the thickness of the leaflet of oil palm leaves ranged from 0.39 to 0.51 mm in five surveyed

oil palm gardens of West Godavari district (Table 2). Correlation coefficient analysis of the above parameter data revealed that, the thickness of the leaflet was negatively and highly significantly correlated with RSW infestation (r= -0.892) which indicates that, with the increase in the thickness of oil palm leaflets results in the low infestation of RSW.

Trichomes / unit area

No trichomes were observed on the abaxial surface of the oil palm leaves in surveyed locations in West Godavari district.

Among the two crops studied, the biophysical characters *viz.,* leaflet length and width were found to have positive significant correlation with infestation of RSW, but the thickness of the leaflet was found significantly negatively correlated. Thicker leaflet would complicate the stylet of rugose whitefly to penetrate the epidermis of leaves and interrupt the feeding process. It may be possible reason that may explain the presence of small number of colonies found on thicker leaflets and thus were less preferred for feeding and oviposition by RSW. All the other biophysical characters in plants were found to have no influence on the RSW infestation.

The results obtained are in accordance with Jindal and Dhaliwal (2011) who stated that leaf lamina thickness was negatively correlated with egg laying by whitefly. Similar results were observed by Hasanuzzaman and his co-workers (2016) in the eggplant varieties with thin and less pubescent dark colored leaves having short trichomes are relatively tolerant to whiteflies, and can be planted to overcome the crop loss caused by whitefly. The present findings are in argument with Naqvi *et al.,* (2008) who reported that the leaf area had positive significant effect on whitefly population, whereas leaf thickness, trichome density had no significant effect. Taggar and Gill (2012) also reported that lamina thickness was significantly and positively correlated with whitefly eggs, nymphs and adults. Similarly, Lakshminarayan *et al.* (2008) reported that whitefly-resistant genotypes of green gram possessed thinner leaf lamina. Leaves with thinner lamina both in green gram and black gram might be were less succulent and thus were less preferred by whiteflies for feeding and oviposition.

The bio-physical analysis indicated that characters like length, width and thickness of leaf have got significant impact on RSW infestation. The correlation data of the biophysical characters of both the coconut and oil palm leaves with rugose whitefly infestation is presented in Table 3.

Table 3. Correlation of biophysical parameters of coconut and oil palm leaves with per cent RSW infestation

Character	Correlation coefficient (r)	
	Coconut	Oil palm
Number of leaflets/leaf	0.542	0.166
Length of the leaflets.	0.923**	0.952*
Thickness of the leaflets	-0.870**	-0.892*
Width of the leaflets	0.189	0.978**

CONCLUSION

In many cases, it is obvious that the biophysical characters of the host plant play an important role in conferring resistance to insect pests. Resistance to insects should be given as much emphasis as yield to identify new varieties and hybrids for cultivation by the farmers. The combination of biophysical and biochemical traits can be used as an effective and reliable selection criteria to select resistance plants. The characters/constituents identified as resistant source can be utilized in the breeding programme for development of resistant cultivars.

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