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Influence of Biophysical Characters of Oil Palm Accessions on the Intensity of Invasive Whitefly Species, Rugose Spiralling Whitefly (*Aleurodicus rugioperculatus* Martin) and Bondar Nesting Whitefly (*Paraleyrodes bondari* Peracchi)

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ABSTRACT: Investigations were carried out to assess the influence of biophysical characters of oil palm accessions on the incidence of invasive whitefly species, rugose spiralling whitefly, *Aleurodicus rugioperculatus* Martin and bondar's nesting whitefly, *Paraleyrodes bondari* Peracchi. The biophysical characters of leaf *viz.*, petiole colour, number of leaflets per leaf, leaflet length (cm), leaflet width (cm), leaflet thickness (mm), crown shape, leaf spiral direction and trichomes/cm^2 from twelve oil palm accessions were studied. The correlation studies revealed that among all the biophysical characters, leaf length (r = 0.941) and width of the leaflet (r = 0.895) showed highly significant and positive correlation with RSW and BNW intensity in all the oil palm accessions whereas thickness of the leaflet (r = -0.830) showed highly significant and negative correlation with RSW and BNW intensity.

Keywords: Oil palm accessions, Biophysical characters, intensity of invasive white fly species.

INTRODUCTION

Oil palm (*Elaeis guineensis* Jacq.) is native of West Africa and is the crop of present and future vegetable oil economy of the world as well as India. Palm oil contributes 70% of total vegetable oil import and is one of the cheapest oil due to high productivity per hectare (Kalidas *et al.*, 2014). In India, oil palm covers an area of 0.3 million hectares with production of 1.2 million tonnes. In India, Andhra Pradesh, Karnataka and Tamil Nadu are major oil palm growing states. Oil palm covers an area of about 0.15 million hectares in Andhra Pradesh and production of 1.1 million tonnes.

In India, about 60 insect species were reported to infest oil palm (Dhileepan, 1991; 1992; Kalidas, 2011) of which many were found be responsible for yield loss. The pests which are common to both coconut and palmyrah were found migrating to oil palm.

In the recent years, severe incidence and infestation of invasive rugose spiralling whitefly (RSW) *Aleurodicus rugioperculatus* Martin (Hemiptera: Aleyrodidae) was found on oil palm in Andhra Pradesh and Karnataka states in India. The dangerous invasive pest has been first reported from India in Tamil Nadu (Sundararaj and Selvaraj 2016) on coconut (*Cocos nucifera* L.) at Pollachi, Tamil Nadu in India during August 2016 (Sundararaj and Selvaraj 2017). In Andhra Pradesh, it was first reported at Kadiyapulanka nursery gardens, East Godavari district during late December 2016 (Chalapathi Rao *et al*., 2018).

Whiteflies belonging to the genus, *Paraleyrodes* were recorded on coconut from Kerala (Invasive pest alert-CPCRI). The genus *Paraleyrodes* includes *P. bondari* Peracchi (Bondari nesting whitefly- BNWF) and *P. minei* Iaccarino (nesting whitefly NWF) under the subfamily Aleurocidinae. At present, all the whitefly species found to coexist on coconut, oil palm and other plantation crops in South India.

The coconut and oil palm farmers and traders are worried about the current status of the whitefly complex in south India and its management as it has become major threat to production and productivity of coconut and oil palm.

Host plant resistance (HPR) is the economically sound technique to reduce pest link damage as well as to protect the environment from adverse effects of pesticides. Identification of accessions/ genotypes with resistance to invasive whitefly species is one of the effective and eco-friendly alternate methods for combating the pest. The morphological and biophysical characteristics of oil palm are associated with attraction, feeding and oviposition of the pest. Therefore, identification of important biophysical characteristics from insect resistant genotypes is most practical significance.

Development of high yielding as well as tolerance cultivar of oil palm against invasive whitefly species require knowledge of the existing genetic variation and also the extent of association among resistance contributing characters. These are the rationale approaches to understand the nature and magnitude of their relationship on resistance in oil palm. The crop exhibits rich genetic diversity and scope for improvement for various horticultural traits. Heritability is the heritable portion of phenotypic variance. It is a good index of the transmission of characters from parents to offspring (Falconer, 1981).

Moore and Alexander (1987) suggested size and colour to be factors, with round and dark green fruits showing better tolerance against coconut mite than the elongated fruits and of other colours.

In coconut, plant resistance or tolerance to coconut eriophyid mite, *Aceria guerreronis* could be attributed to traits such as tepal aestivation in female flowers, the shape of the developing fruits, growth rate and pattern of fruit enlargement (Niral *et al.,* 2010) whereas the distance between the perianth and nut surface of the Sri Lanka Yellow Dwarf × Sri Lanka Tall (YDT) as the most probable morphological feature that would impart tolerance to coconut mite infestation (Perera *et al.*, 2013).

Among the biophysical leaf characters *viz.*, leaflet colour, number of leaflets/leaf, leaflet length (cm), leaflet width (cm), leaflet thickness (mm) and trichomes/cm^2, thickness of the leaflet attributed as resistance trait in coconut and oil palm (Susmitha *et al.*, 2021).

Efficacy to test of four bio-pesticides *Iceriya fumosorosea* NBAIR pfu-5, *Leucaniella lecanii*, *Baeuveria bassiana*, *Metarhizium anisopliae* were evaluated against nymphs and adults of rugose spiraling whitefly, *A. rugioperculatus* (Homoptera: Aleyrodidae) on coconut palms showed that *I. fumosorosea* NBAIR pfu-5was found to be superior in reducing the population of nymphs and adults of RSW among the tested biopesticides.

Azadirachtin 10000 ppm @ 1 ml/l had recorded with lowest number of RSW nymphs per leaflet and *I. fumosorosea* NBAIR pfu-5 @ 5 g/l recorded with lowest number of adults, incidence and intensity under high incidence (> 20 spirals per leaflet) of RSW (Raghuteja *et al.*,2024).

Impact of *A. rugioperculatus* incidence was noticed on nitrogen content of coconut leaflets and reflected in the form of nut yield reduction in Godavari Ganga hybrid and ECT coconut palms at Kalavalapalli plantations (Viswanadha Raghuteja *et al* ., 2024)

An understanding of different biophysical characters involved in attributing resistance are essential to the plant breeder in the development of resistant varieties against invasive whitefly species. Hence, the present investigation was carried out to identify the oil palm accessions for resistance against rugose spiralling whitefly and bondar nesting whitefly on the basis biophysical characters.

MATERIAL AND METHODS

The study was conducted at ICAR-IIOPR, Pedavegi with twelve oil palm accessions *viz.*, EC 869395, EC 869404, EC 869406, EC 869408, EC 869414, EC 869397, EC 869399, EC 869403, EC 869407, EC 869409, EC 869412 and EC 869413 were selected which are available in germplasm block during 2021-22. Five years age three unsprayed palms from each accession were selected by simple random technique to record the observations. In each palm, four leaves located in four directions *i.e.*, North, South, East and West were selected to record the data.

Data was recorded on the biophysical characters of leaves *viz.*, petiole colour, number of leaflets per leaf, leaflet length (cm), leaflet thickness (mm), leaflet width (cm), leaf spiral direction, crown shape, trichomes/cm^2. The biophysical characters of leaves were recorded as per oil palm crop descriptor.

Petiole colour. Petiole colour of the oil palm leaf whether it is green/red/yellow/brown/other was observed based on visual observations and was recorded.

Number of leaflets per leaf. Number of leaflets per leaf was recorded by making a count of leaflets present on either side of the leaf, likewise from four leaves and the average was calculated.

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 and value was presented in centimeter.

Leaflet thickness (mm). The thickness of the leaflet lamina was measured using digital vernier caliper and readings were expressed in millimeter.

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 and value was presented in centimeter.

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 data was recorded.

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

Trichomes/cm^2. Three leaf bits of 1 cm^2 size from a single leaflet were cut and observed under 40x magnification using a stereo zoom microscope and the number of trichomes were observed. The number of trichomes/cm^2 leaf area on the abaxial surface of the leaflets was counted on selected leaflet samples.

Pest Intensity (%). The pest intensity per cent was worked out with the following formula:

$$\text{Intensity \%} = \frac{\text{No.of leaflets infested with whitefly complex per leaf}}{\text{Total no.of leaflets per leaf}} \times 100$$

Statistical Analysis. Statistical analysis after appropriate transformation of data was undertaken (Gomez and Gomez, 1976). Simple RBD analysis was carried out for the data recorded on RSW and BNW population in different oil palm accessions. Correlation analysis was undertaken to find out the correlation of the biophysical characters with the pest intensity.

RESULTS AND DISCUSSION

Studies were conducted to assess the influence of biophysical characters of oil palm *viz*., petiole colour, number of leaflets per leaf, leaflet length (cm), leaflet width (cm), leaf lamina thickness (mm), leaf spiral direction, crown shape and trichomes/cm^2 in twelve oil palm accessions.

Petiole colour. The petiole colour of the oil palm leaves was found as "green" in all the twelve accessions *viz.*, EC 869395, EC 869404, EC 869406, EC 869408, EC 869414, EC 869397, EC 869399, EC 869403, EC 869407, EC 869409, EC 869412 and EC 869413 (Table 1).

Through the analysis of leaf petiole colour data in oil palm accessions, it was found that the petiole colour do not have any significant influence on RSW and BNW infestation (Table 1).

Number of leaflets per leaf. Observations on the number of leaflets per leaf ranged from 146.67 to 169.67 in twelve oil palm accessions. The maximum number of leaflets per leaf was recorded in EC 869409 as 169.67 per leaf followed by EC 869412, EC 869414 and EC 869408 as 168.17, 162.67 and 162.17 respectively. The minimum number of leaflets per leaf was recorded in EC 869406 as 146.67 per leaf followed by EC 869399, EC 869395 and EC 869404 as 150.42, 150.92 and 152.33 respectively (Table 1).

From the correlation studies between number of leaflets per leaf and pest intensity (RSW and BNW), it was evidenced that, the number of leaflets per leaf was non-significantly correlated with pest intensity (r = 0.250). However, palms located in the germplasm block VII were infested with RSW and BNW irrespective of number of leaflets per leaf.

Leaflet length (cm). From the data collected on twelve oil palm accessions, the length of the oil palm leaflet ranged from 53.54 to 75.78 cm. The maximum length of the leaflet was recorded in EC 869395 as 75.78 cm followed by EC 869403, EC 869404 and EC 869406 as 72.88, 70.46 and 69.43 cm respectively. The minimum length of the leaflet was recorded in EC 869413 as 53.54 cm followed by EC 869399, EC 869408 and EC 869412 as 59.60, 60.43 and 60.46 cm respectively (Table 1).

Correlation study unveiled the significant and positive correlation between length of the leaflet and pest intensity (RSW and BNW) (r = 0.941) which indicated that with an increase in length of leaflet, the intensity of pest increases.

Leaflet width (cm). Observations on the width of the leaflet from twelve oil palm accessions revealed that the leaflet width ranged from 3.29 to 3.96 cm. The maximum width of the leaflet was recorded in EC 869395 as 3.96 cm followed by EC 869403, EC 869404 and EC 869406 as 3.80, 3.79 and 3.58 cm respectively. The minimum width of the leaflet was recorded in EC 869413 as 3.29 cm followed by EC 869399, EC 869408 and EC 869397 as 3.42, 3.46 and 3.46 cm respectively (Table 1).

Table 1: Influence of Biophysical characters of oil palm on the intensity of Rugose spiralling whitefly and Bondar nesting whitefly.

Accession no.	Petiole colour	Number of leaflets/leaf	Leaflet length (cm)	Leaflet width (cm)	Leaflet lamina thickness (mm)	Leaf spiral direction	Crown shape	Pest Intensity (%)
EC 869395	Green	150.92	75.78	3.96	0.31	Right	Hemi-spherical	77.65
EC 869404	Green	152.33	70.46	3.79	0.39	Left	Spherical	66.17
EC 869406	Green	146.67	69.43	3.58	0.42	Right	Hemi-spherical	62.16
EC 869408	Green	162.17	60.43	3.46	0.53	Left	Spherical	56.01
EC 869414	Green	162.67	68.74	3.51	0.47	Right	Spherical	61.23
EC 869397	Green	154.50	63.93	3.46	0.56	Right	Hemi-spherical	58.29
EC 869399	Green	150.42	59.60	3.42	0.58	Left	Spherical	42.71
EC 869403	Green	161.83	72.88	3.80	0.35	Left	Spherical	72.84
EC 869407	Green	157.17	66.23	3.50	0.52	Right	Hemi-spherical	59.76
EC 869409	Green	169.67	63.82	3.48	0.57	Left	Hemi-spherical	57.36
EC 869412	Green	168.17	60.46	3.46	0.48	Right	Spherical	44.68
EC 869413	Green	159.50	53.54	3.29	0.59	Right	Spherical	42.12
Mean	-	**158.00**	**65.44**	**3.56**	**0.48**	-	-	-
S.D	-	7.24	6.36	0.19	0.09	-	-	-
Correlation	-	**0.250^{NS}**	**0.941****	**0.895****	**-0.830****	-	-	-

* - Significant; ** - Highly significant; NS – Non-significant.

Correlation coefficient worked out between width of the leaflet and pest intensity (RSW and BNW) was found to be positive and highly significant (r = 0.895) which indicated that the pest intensity increases with an increase in the width of leaflet.

Leaflet lamina thickness (mm). The thickness of the leaflet lamina of oil palm leaves was ranged from 0.31 to 0.59 mm. The maximum thickness of the leaflet was recorded in EC 869413 as 0.59 mm followed by EC 869399, EC 869409 and EC 869397 as 0.58, 0.57 and 0.56 mm respectively. The minimum thickness of the leaflet was recorded in EC 869395 as 0.31 mm followed by EC 869403, EC 869404 and EC 869406 as 0.35, 0.39 and 0.42 mm respectively (Table 1).

Correlation coefficient analysis of leaflet lamina thickness and pest intensity revealed that, the correlation was negative and highly significant (r = -0.830) which indicated that the intensity of pest decreases with an increase in leaf lamina thickness.

Leaf spiral direction. In general, the arrangement of leaves in palms will be in spiral form and the direction of leaf spiral will be either right side or left side of the palm which will be designated as leaf spiral direction “right or left”.

From the data recorded in all the oil palm accessions, the leaf spiral direction was right in seven accessions *viz.,* EC 869395, EC 869406, EC 869414, EC 869397, EC 869407, EC 869412 and EC 869413 and the leaf spiral direction was left in five accessions *viz.,* EC 869404, EC 869408, EC 869399, EC 869403 and EC 869409 (Table 1).

The analysis data indicated that the leaf spiral direction had no significant influence on the pest intensity. However to establish the above fact further intensive studies are required.

Crown shape. The crown shape of oil palm accessions was found to be spherical and hemispherical. Among the twelve oil palm accessions, the crown shape was “spherical” in seven accessions *viz.*, EC 869404, EC 869408, EC 869414, EC 869399, EC 869403, EC 869412 and EC 869413 and the crown shape was “hemispherical’ in five accessions *viz.*, EC 869395, EC 869406, EC 869397, EC 869407 and EC 869409 (Table 1).

From the results obtained, it was revealed that the shape of the crown had no significant influence on the pest intensity.

Trichomes/cm^2. No trichomes were observed on the abaxial surface of oil palm leaves in all the twelve oil palm accessions.

A thorough examination of the data on all the physical characters *i.e.*, petiole colour, number of leaflets per leaf, leaflet length (cm), leaflet width (cm), leaf lamina thickness (mm), leaf spiral direction, shape of the crown, trichomes /cm^2 inferred that, the colour of the petiole, leaf spiral direction and crown shape of the oil palm do not showed any influence on the incidence of RSW and BNW in all the oil palm accessions. The intensity of pest ranged from 42.12 to 77.65 per cent in the twelve oil palm accessions irrespective of the petiole colour, leaf spiral direction and crown shape of the oil palm.

Among the other biophysical characters in investigation, number of leaflets per leaf was found non-significantly and positively correlated with RSW and BNW infestation in all the oil palm accessions. The characters, length and width of the leaflet showed highly significant and positive correlation with RSW and BNW infestation in all the oil palm accessions. However thickness of the oil palm leaflet was found highly significantly and negatively correlated with RSW and BNW infestation.

Present studies on the influence of biophysical characters of oil palm accessions on the intensity of whitefly complex revealed that, among all the biophysical characters only three characters *viz*., length, width and thickness of the leaflet showed significant influence on the intensity of RSW and BNW either in a positive or negative way. Longer leaflets with more width would attract more whitefly adults for egg laying and leading to more number of spirals and high pest incidence. Leaves with thick leaf lamina would interfere with whitefly stylet penetration into the epidermis of leaves and interrupt the feeding process results in low pest population. The other parameters do not have any significant influence on RSW and BNW infestations in all the oil palm accessions.

The results obtained in the present investigation are in accordance with Chinnabbai *et al.* (2021) who reported that less thickened shoot, more number of trichomes on leaf lamina and shoot, medium plant height, plant spread, medium fruit length, low fruit diameter, low pedicel and calyx lengths contributed to confer resistance against shoot and fruit borer in brinjal genotypes. Sushmitha *et al.* (2019; 2021) stated that leaflet length was positively and significantly correlated with RSW incidence in coconut and oil palm crops.

The present investigations are in agreement with the findings by Amin *et al*. (2014) who reported that the higher leaf area (63.53cm^2/leaf) and leaf trichome (256.7/25 mm^2) had lower shoot and fruit infestation in brinjal genotypes.

The results are in agreement with Jindal and Dhaliwal (2011) who reported that leaf lamina thickness was negatively correlated with egg laying by whitefly. The present findings are in line with Taggar and Gill (2012) who reported that leaf lamina thickness was significantly and positively correlated with whitefly eggs, nymphs and adults. 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. Shukla *et al.* (2017) observed that round fruits having higher fruit girth were more prone to infestation compared to long fruits with more fruit length and less fruit girth. Fruits having short calyx were more resistant than those with long calyx and it clearly demonstrated that genotypes consisting of long calyx were more susceptible than those with short calyx helping the neonate larvae to hide and get easily into the fruit through the soft tissue below the calyx (Rameshkumar *et al*., 2019).

CONCLUSIONS

Among the different biophysical characters studied, the length and width of the leaflet were found highly significant and positive correlation with pest intensity. Thickness of leaflet showed a strong and negatively significant correlation with pest intensity and the character number of leaflets per leaf was non-significant but positively correlated with pest intensity.

FUTURE SCOPE

In the development of improved varieties of oil palm, the biophysical characters of leaf interfered with low pest intensity will be helpful in future breeding programme.

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