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R Vishnupriya
Associate Professor, Department of Agricultural Entomology, Tamil Nadu Agricultural University Coimbatore, Tamil Nadu, India

G Umapathy
Professor (Entomology), Department of Sericulture Forest College and Research Institute, Mettupalayam, Tamil Nadu, India

Sheela Venugopal
Assistant Professor (Entomology), Agricultural Research Station, Bhavanisagar, Tamil Nadu, India

V Manivannan
Assistant Professor (Agronomy), Controllerate of Examination Tamil Nadu Agricultural University Coimbatore, Tamil Nadu, India

Correspondence
R Vishnupriya
Associate Professor, Department of Agricultural Entomology, Tamil Nadu Agricultural University Coimbatore, Tamil Nadu, India

Phytochemical interaction between Coconut, *Cocos nucifera* L., and perianth mite, *Aceria guerreronis* Keifer

R Vishnupriya, G Umapathy, Sheela Venugopal and V Manivannan

Abstract
The present study was carried out to understand the host-mite interaction and the biochemical changes induced in the mite infested coconut nuts during December, 2012- November, 2013 at Tamil Nadu Agricultural University, Coimbatore. Biochemical analysis of the mite infested perianth tissues in comparison with healthy perianth tissues were carried out and results revealed that there was significant decrease in moisture content and chlorophyll content to an extent of 15.1 and 23.7 per cent, respectively. Total sugars and total free amino acids showed a significant increase of 12.4, and 83.8 per cent in mite infested tissues, respectively. Similarly pest induced defensive components such as phenols, peroxidase and IAA oxidase enzyme activities were also found to be more with 55.3, 39.2 and 42.9 per cent increase over healthy tissues, respectively. Among the major nutrients tested, nitrogen was found to be 18.9 per cent more in mite infested tissues, on contrast, phosphorus was found be drastically low with 60 per cent decrease due to mite feeding. Significant loss in calcium, magnesium, iron and copper were also observed to an extent of 66.7, 80.0, 51.8 and 18.8 per cent, respectively due to mite infestation.

Keywords: coconut, eriophyid, *Aceria guerreronis*, perianth, biochemical changes

1. Introduction
Coconut is extensively grown in about 105 countries of the world with the total production of 69,836 million nuts annually with a productivity of 10345 nuts/ ha [1]. In Tamil Nadu, coconut is grown in an area of 4.60 lakh hectares with a total production of 617 million nuts with the productivity of 13,423 nuts/ha [2]. Among the phytophagous mites reported to attack coconut leaves and nuts, the perianth mite, *Aceria guerreronis* Keifer (Eriophyidae:Acari) feeding on tender nuts cause heavy damage in all coconut growing regions of Tamil Nadu [3]. Hundreds of white coloured worm- like mites are seen beneath the perianth. In India, the outbreak of this nut infesting eriophyid mite was first reported from Ernakulam district of Kerala during 1998-99 [4] followed by the reports from Pollachi and Udumalpet taluks of Coimbatore district in Tamil Nadu during 1999-2000 [3].

The mite being microscopic, vermiform and white in colour infests and develops on the meristematic tissues of the growing nuts under the perianth by desapping the soft tissues of the buttons [4]. Initially, triangular yellow patches close to perianth are seen. Later on, extremely large population feeds on the nuts causing scarring and distortion resulting in premature button drop [4]. The mites hatch from the egg and become adult within 10 days and hence population can build up rapidly, often producing thousands of mites in several clusters on a single nut [3]. Intensive damage leads to formation of longitudinal fissures and splits on the outer surface of the husk. Sometimes gummy exudate is seen oozing from the affected surface [4]. The estimated loss of copra varied from 10 - 30 per cent. The present study was contemplated to know the host-mite interaction and to understand the biochemical changes in the mite infested coconut nuts.

2. Materials and Methods
Ten random samples of the healthy and mite infested four month old coconut buttons were collected from coconut trees grown at Coconut gardens of Tamil Nadu Agricultural University, Coimbatore during 2012-13 and the meristematic tissues of the perianth region was cut to carry out the biochemical analysis.

The initial weight of the samples were recorded and then dried in a hot air oven at 105° C until a constant weight was obtained and expressed as percentage of moisture content. In the fresh samples chlorophyll a, chlorophyll b and total chlorophyll contents were estimated following the method suggested by [5] and expressed in mg/g fresh weight. Total sugar content was determined by anthrone method [6] and expressed in percentage. Reducing sugar was determined following [7] method and expressed in percentage. Total free amino acid was determined following [8] method and expressed as mg/g of sample. The method described by Malik and Singh [9] was followed for the estimation of phenols and expressed as mg /100 g of material. The IAA oxidase activity was estimated following the method described by [10] and expressed as µg of unoxidised auxin /g / hr. The method described by Putter [11] was followed for estimation of peroxidase activity and expressed as change in optical density.

The samples were dried in a hot air oven at 60 °C, powdered in a Willy Mill and utilized for further analysis. The dried samples were subjected to analysis of macro, secondary, micro nutrients and crude protein content. Nitrogen content in the sample was estimated by micro-kjeldahl method as per the procedure given by [12]. This was expressed as percentage on dry weight basis. Total phosphorus content was estimated by triple acid digestion extract using photoelectric colorimeter with blue filter as described by [13]. The phosphorus content was determined by referring to a standard curve and computed value was expressed in percentage. Total potassium in the sample was estimated from triple acid extract using flame photometer [13] and the content was expressed in percentage. Crude protein content was calculated by multiplying the N content [14] with the factor 6.25. Micronutrients *viz*., iron, manganese, copper and zinc were estimated from the triacid extracts using the Atomic Absorption Spectrophotometer.

3. Statistical Analysis

Each observation was replicated ten times and percentage analysis and paired't' test were applied to analyze the means of the data using MS excel software application [15].

4. Results and Discussion

There was significant decrease in the moisture content between the healthy and mite infested tissues. The moisture content was 27.2 per cent in healthy and 23.1 per cent in mite infested tissues with a decrease of 15.1 per cent. The symptom of cracking and shrinking of the nut might be attributed to the significantly low moisture content of the infested nut. The total chlorophyll content was 0.039 mg in healthy tissue and was reduced to 0.029 mg in mite infested tissue, thereby showed a decrease of 23.7 per cent. The chlorophyll a was 0.024 mg/g and 0.017 mg/g in the healthy and mite infested tissue respectively, with a decrease of 30.3 per cent due to mite feeding. The chlorophyll b was 0.014 mg/g and 0.012 mg/g in healthy and mite infested tissue respectively, with a decrease of 14.3 per cent due to mite feeding (Table 1). The browning of tissues in the infested nut might be the result of reduction in chlorophyll content.

Table 1: Moisture content, chlorophyll a, b and total chlorophyll content of healthy and mite infested coconut tissues

Particulars	Moisture content (%)	Chlorophyll a (mg/g)	Chlorophyll b (mg/g)	Total chlorophyll (mg/g)
Healthy tissues	27.2	0.024	0.014	0.039
Infested tissues	23.1	0.017	0.012	0.029
% increase (or) decrease	-15.1	-30.3	-14.3	-23.7
S.E	0.877	0.0002	0.0006	0.002
't' value	4.672*	47.369*	2.978*	4.697*

* Significant at 5%

The total sugars and reducing sugars were increased in mite infested tissue by 12.4 and 17.4 per cent, respectively. The total sugar content was significant with 4.26 per cent in healthy tissue as against 4.79 per cent in mite infested tissue. The reducing sugars were non- significant with 2.07 per cent in the healthy tissue and 2.43 per cent in mite infested tissue (Table 2). There was significant increase in total free aminoacids, phenol and crude protein content in mite infested tissue. Total free amino acid content was 371µg/g in the healthy tissue and it was 682µg/g in the mite infested tissue, which was an increase of 83.8 per cent due to mite feeding. The phenol content was found to be 1008 mg/100g in the healthy tissue and 1565 mg/100g in the mite infested tissue with an increase of 55.3 per cent due to mite feeding. The crude protein content was 6.65 per cent in healthy tissue and 7.88 per cent in mite infested tissue with an increase of 18.9 per cent due to mite feeding (Table 3). The increase in total sugars might be due to the accumulation of carbohydrates in the area infested by the pest [16]. Increase in protein content and phenols revealed the role of phenols and protein components in pest induced host plant defense [17]. Similar changes in the total phenols and total free amino acids in jasmine due to feeding by *Aceria jasmini* Chan was reported by earlier workers [18].

Table 2: Total sugar and reducing sugar content of healthy and mite infested coconut tissues

Particulars	Total sugars (%)	Reducing sugars (%)
Healthy tissues	4.26	2.07
Infested tissues	4.79	2.43
% increase (or) decrease	+12.4	+17.4
S.E	0.199	0.191
't' value	2.659*	1.883^{NS}

* Significant at 5%; NS Non-Significant

Table 3: Total free amino acid, phenol and crude protein content of healthy and *Aceria* mite infested coconut tissues

Particulars	Total free amino acid (µg/g)	Phenol (mg /100g)	Crude protein (%)
Healthy tissues	371	1008.000	6.65
Infested tissues	682	1565.500	7.88
% increase (or) decrease	+83.8	+55.3	+18.9
S.E	50.80	47.71	0.384
't' value	6.122*	11.685*	3.254

Significant at 5%

There was significant difference in peroxidase and IAA oxidase activity between healthy and mite infested tissues. The peroxidase activity increased in the mite infested tissue by 39.2 per cent and the changes observed in the healthy tissue was 0.217OD/min/g of the sample as against 0.302/min/g of the mite infested sample. The IAA oxidase activity was 0.105 µg of unoxidised auxin /g /hr in healthy tissue and 0.150 µg of unoxidised auxin /g /hr in the mite infested tissue with 42.9 per cent increase in mite infested sample (Table 4). Similar observations were made in cotton red spider mite, *Tetranychus urticae* Koch in which increased peroxidase activity in mite damaged plants was noticed [19]. Increase in peroxidase and IAA activity indicated the biotic and abiotic stress induced plant responses [18, 20].

Table 4: Peroxidase and IAA oxidase activity of healthy and mite infested coconut tissues

Particulars	Peroxidase (ΔOD /min g)	IAA oxidase (µg of unoxidised auxin/ g/ hr)
Healthy tissues	0.217	0.105
Infested tissues	0.302	0.150
% increase (or) decrease	+39.2	+42.9
S.E	0.008	0.007
't' value	10.877*	6.545*

* Significant at 5%

Among the macro nutrients, there was significant increase in the total nitrogen and decrease in the total phosphorus and total potassium in mite infested tissue (Table 5). The nitrogen content was 1.06 per cent in the healthy tissue and it was 1.26 per cent in the mite infested tissue and thus an increase of 18.9 per cent was observed. The phosphorus content was 0.36 per cent in the healthy tissue and 0.14 per cent in mite infested tissue with a decrease of 60.0 per cent due to mite feeding. The potassium content was 2.01 per cent in the healthy tissue and it was 1.97 per cent in mite infested tissue with a decrease of 2.10 per cent due to mite feeding. Similar studies on the relationship between *A. guerreronis* damage and nutrient levels in coconut revealed that an increase in foliar nitrogen increased the mite damage with a negative relationship between the mite damage and potassium level [21]. However, Sithanantham and his co-workers [21] observed increased percentage of all the macronutrients nitrogen, phosphorus and potassium in sugarcane leaf sheath affected by *Aceria sacchari* Chan. The reason might be due to the differences in the host plant tissues taken for analysis.

Table 5: Macro nutrient content of healthy and mite infested coconut tissues

Particulars	Total nitrogen (%)	Total phosphorus (%)	Total potassium (%)
Healthy tissues	1.06	0.36	2.01
Infested tissues	1.26	0.14	1.97
% increase (or) decrease	+18.9	-60.0	-2.1
S.E	0.061	0.020	0.137
't' value	3.254*	10.609*	0.313^{NS}

* Significant at 5%; NS -Non- Significant

Significant loss in secondary nutrients was observed in mite infested tissue. The calcium content was 0.24 per cent in the healthy tissue and 0.08 per cent in infested tissue and a decrease of 66.7 per cent was observed due to mite feeding. The magnesium content was 0.12 per cent in the healthy tissue and it was 0.02 per cent in the mite infested tissue, with a decrease of 80.0 per cent due to mite feeding (Table 6).

Table 6: Secondary nutrient content of healthy and mite infested coconut tissues

Particulars	Calcium (%)	Magnesium (%)
Healthy tissues	0.24	0.12
Infested tissues	0.08	0.02
% increase (or) decrease	-66.7	-80.0
S.E	0.013	0.009
't' value	12.233*	10.551*

* Significant at 5%

Among the micronutrients, iron and copper content was reduced by 51.8 per cent and 18.8 per cent respectively, whereas manganese content increased by 34.3 per cent due to mite attack. Zinc was not traced in the sample studied. The iron, manganese and copper contents in the healthy tissue were 28.40 ppm, 7.00 ppm and 1.60 ppm respectively while they were13.70 ppm, 9.40 ppm and 1.30 ppm in the mite infested samples (Table 7). In coconut, the perianth beneath which the mites flourish might provide a suitable niche and nutrient bank for the mite development. The macronutrients except nitrogen, all secondary nutrients and micronutrients except manganese were observed to decrease in infested nuts which signified the depletion of nutrients due to mite feeding. Reduction in the level of micronutrients might be due to intake by mites for its growth and development. This is in agreement with findings made in leaf coating mite, *Cisaberoptus kenyae* Keifer of mango [23]. A similar trend was observed in the depletion of micronutrients in jute affected by *Polyphagotarsonemus latus* (Banks) [24], depletion of iron and zinc in ribbed gourd infested by *Tetranychus ludeni* [25], iron and zinc in pineapple affected by *Dolichotetrancyhus*

floridanus [26].

Table 7: Micro nutrient contents of healthy and mite infested coconut tissues

Particulars	Iron (ppm)	Manganese (ppm)	Copper (ppm)	Zinc (ppm)
Healthy tissues	28.40	7.00	1.60	NT
Infested tissues	13.70	9.40	1.30	NT
% increase (or) decrease	-51.8	+34.3	-18.8	-
S.E	1.932	0.729	0.093	-
't' value	7.609*	3.292*	3.216*	-

* Significant at 5%; NT – Not traceable

5. Conclusion

The biochemical, physiological and nutrient factors of the host plant interact in the process of morphogenetic changes in the infested nuts which must be correlated with the ultimate size and weight of the nut and copra. Therefore, nutrition management must be adopted with enhanced doses of macronutrients, secondary nutrients and micronutrients to augment the depletion of nutrients due to mite feeding for getting good nut yield and better price for the copra.

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