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Biochemical Composition of Sugarcane Leaf Sheath due to Feeding by Sugarcane Blister Mite, *Aceria sacchari* Chan.

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The sugarcane blister mite, *Aceria sacchari* Chan. is one of the most prevalent host specific mites infesting sugarcane leaf sheath. This mite induces discoloured blisters on the inner surface of leaf sheath which supports hundreds of mites within the spongy tissue. Biochemical investigations carried out in the susceptible sugarcane cultivar revealed that there was increase in moisture content, decrease in chlorophyll, total sugars, reducing sugars, significant increase in total free amino acids, phenols, crude protein content and peroxidase activity. Among the nutrients, nitrogen, phosphorus and potassium contents were found to be increased, while calcium, magnesium, iron, manganese, and copper were depleted due to mite feeding.

Key words: Sugarcane blister mite, *Aceria sacchari*, Biochemical Changes,leaf sheath.

Sugarcane is the largest cultivated crop and it is cultivated worldwide in about 23.8 million hectares, in more than 90 countries with an average production of 1.69 billion tonnes. India is the second largest global producer, and it is cultivated in about 4.09 million ha with a production of about 283 million tonnes and an average yield of 72.6 MT ha^{-1}(www.http://en.wikipedia.org/wiki/Sugarcane). Apart from insects and diseases, sugarcane is prone to the attack of four species of eriophyid mites and one among them is the sugarcane blister mite, *Aceria sacchari* Chan. (Muthukrishnan, 1956; Channabasavanna, 1966). In the past, this mite received relatively much attention from acarologists in India. Much work has been done on its biology, varietal susceptibility and biochemical changes (Sithanantham and Velayutham, 1981; Sithanantham *et al.,* 1975). The blister mite induces formation of blisters of varying size and shape on the inner surface of leaf sheaths. The tissue of the blister becomes spongy and each blister supports hundreds of mites in all stages of development. Blisters show out in the form of discoloured, slightly raised patches on the outer surface of leaf sheath. In order to verify the possible effects of feeding of this eriophyid mite on the biochemical and nutrient composition of sugarcane leaf sheath, the present studies were conducted.

Materials and Methods

Studies were conducted at the Department of Agricultural Entomology, Tamil Nadu Agricultural University, Coimbatore during 2011- 2012. Ten random samples of the healthy and mite infested leaf sheaths were collected from sugarcane (*cv*.CO 86032) grown at the Sugarcane Breeding Institute, Coimbatore.

The initial weight of the samples were recorded and 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 Yoshida *et al.* (1971) and expressed in mg g^{-1} fresh weight. Total sugar content was determined by anthrone method (Hedge and Hofreiter, 1962) and expressed in percentage. Reducing sugar was determined following Somogyi (1952) method and expressed in percentage. Total free amino acid was determined following Moore and Stein (1948) method and expressed as mg/g of sample. The method described by Malik and Singh (1980) 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 Gordon and Weber (1951) and expressed as µg of unoxidised auxin g^{-1} hr^{-1}. The method described by Putter (1974) 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 leaf sheath sample was estimated by micro-kjeldahl method as per the procedure given by Bremner (1965). 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 Jackson (1973). The phosphorus content was determined by referring to a standard curve and computed value was expressed in percentage. Total potassium in the leaf sheath sample was estimated from triple acid extract using flame photometer (Jackson, 1973) and the content was expressed in percentage. Protein content of leaf sheath was calculated by multiplying the N

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content (Humphries, 1956) of leaves with the factor 6.25. Micronutrients *viz*., iron, manganese, copper and zinc were estimated from the triacid extracts using the Atomic Absorption Spectrophotmeter. Percentage analysis and paired 't' test were applied to analyse the data (Gomez and Gomez, 1994).

Results and Discussion

There was significant difference in moisture content between healthy and mite infested leaf sheath (Table 1). The moisture content was 16.3 per cent in healthy leaf sheath and 28.9 per cent in infested leaf sheath, exhibiting an increase of 77.30 per cent due to mite feeding. Thus sheath moisture content was found to favour development of mites. Agarwal (1969) reported that in sugarcane, sheath moisture and sheath thickness were responsible for development of mite colonies in the susceptible varieties.

Table 1. Moisture content, chlorophyll a, chlorophyll b and total chlorophyll content of healthy and *Aceria sacchari* infested sugarcane leaf sheaths

Particulars	Mois -ture content (%)	Chlor -ophyll a (mg g^{-1})	Chloro -phyll b (mg g^{-1})	Total chloro -phyll (mg g^{-1})
Healthy leaf sheath	16.3	0.046	0.033	0.079
Infested leaf sheath	28.9	0.034	0.025	0.065
% increase/ decrease	+77.3	-26.09	-24.24	-17.72
S.E	1.611	0.003	0.002	0.005
't' value	7.818*	3.567*	2.895*	2.816*

* Significant at 5%

Significant decrease in total chlorophyll content was noticed in mite infested leaf sheath to a tune of 17.72 per cent. The total chlorophyll content was 0.079 mg/g in healthy leaf sheath and 0.065 mg/g in mite infested leaf sheath. The chlorophyll a and b contents varied significantly between healthy and mite infested leaf sheath. Healthy leaf sheath had 0.046 mg/g and 0.033 mg/g of chlorophyll a and b respectively, whereas in mite infested leaf sheath it was 0.034 mg/g and 0.025 mg/g of leaf sample respectively with a reduction of 26.09 per cent of chlorophyll a and 24.24 per cent of chlorophyll b (Table 1).These results indicate that the decrease in the chlorophyll content might be due to mechanical damage of chloroplasts by mite feeding. Ghoshal *et al*., (2005) also reported chlorophyll loss due to feeding by yellow mites *Polyphagotarsonemus latus* (Banks) in jute.

The total sugars and reducing sugars decreased significantly due to mite feeding. Total sugars in healthy leaf sheath were 4.54 per cent and 3.41 per cent in infested leaf sheath with a decrease of 24.89 per cent. Reducing sugars were 1.73 per cent in healthy leaf sheath and 1.18 per cent in mite infested leaf sheath with a decrease of 31.79 per cent (Table 2). A faster breakdown of the sugars serve as substrate for the increased respiration or conversion into organic acids which lead to the synthesis of amino acids and phenols. Similar trend was observed by Usha *et al.* (1999) in French bean affected by two spotted spider mite, *Tetranychus urticae*.

Table 2. Total sugars and reducing sugars of healthy and *Aceria sacchari* infested sugarcane leaf sheaths

Particulars	Total sugars (%)	Reducing sugars (%)
Healthy leaf sheath	4.54	1.73
Infested leaf sheath	3.41	1.18
% increase /decrease	-24.89	-31.79
S.E	0.259	0.115
't' value	4.353*	4.776*

* Significant at 5%

Significant increase in total free amino acids, phenols and crude protein were observed due to mite feeding (Table 3). Total free amino acids content was 367 mg/g in healthy leaf sheath and 672 mg/g in mite affected leaf sheath exhibiting an increase of 83 .1 per cent. Phenols were 97.80 mg/100g of the healthy leaf sheath and 127.04 mg/100g in the mite attacked leaf sheath showing an increase of 29.89 per cent due to mite feeding. Crude protein content varied between healthy and mite affected leaf sheaths. The crude protein content was 4.18 per cent in healthy leaf sheath as against 5.56 per cent in mite affected leaf sheath with an increase of 32.83 per cent. (Table 3).These results suggest that the oxidative process taking place in the plants to fight against herbivory. Similar changes in the total phenols and total free amino acids in jasmine due to feeding by *Aceria jasmini* Chan. was observed by Rajagopal *et al*. (1970).

Table 3. Total free amino acid, phenols, and crude protein content of healthy and *Aceria sacchari* infested sugarcane leaf sheaths

Particulars	Total free amino acid (mg/g)	Phenols (mg $100g^{-1}$)	Crude protein (%)
Healthy leaf sheath	367	97.800	4.18
Infested leaf sheath	672	127.040	5.56
% increase/ decrease	+83.11	+29.89	+32.83
S.E	42.323	6.557	0.281
't' value	7.206*	4.446*	4.894*

* Significant at 5%

The peroxidase activity was significant with an increase of 57.61 per cent in mite affected leaf sheath. In healthy leaf sheath it was 0.703 and 1.108 in mite affected leaf sheath. There was no significant change in the IAA oxidase between healthy leaf sheath and mite affected leaf sheath with values of 0.185 and 0.180 respectively. IAA oxidase activity decreased marginally to an extent of 2.70 per cent due to mite feeding (Table 4). The increase in peroxidase activity suggest the role in biotic and abiotic stress (Zhang and Kirkham, 1994).

Table 4. Peroxidase and IAA oxidase activity of healthy and *Aceria sacchari* infested sugarcane leaf sheaths

Particulars	Peroxidase (ΔOD $min^{-1}g^{-1}$)	IAA oxidase (µg of unoxidised auxin $g^{-1}hr^{-1}$)
Healthy leaf sheath	0.703	0.185
Infested leaf sheath	1.108	0.180
% increase/ decrease	+57.61	-2.70
S.E	0.020	0.015
't' value	20.734*	0.344^{NS}

* Significant at 5% , NS-Non-significant

There was significant increase in total nitrogen, phosphorus and potassium content in mite affected leaf sheath. The total nitrogen was 0.67 per cent in healthy leaf sheath and 0.89 per cent in mite affected leaf sheath, with an increase of 32.83 per cent. The total phosphorus contents were 0.202 per cent and 0.275 per cent in healthy and mite affected leaf sheaths, respectively, with increase of 36.13 per cent due to mite feeding. The total potassium contents were 1.050 per cent and 1.293 per cent in healthy and mite affected leaf sheaths, respectively, with increase of 23.76 per cent due to mite feeding (Table 5).

Table 5. Macro nutrient content of healthy and *Aceria sacchari* infested sugarcane leaf sheaths

Particulars	Total nitrogen (%)	Total phos -phorus (%)	Total potas -sium(%)
Healthy leaf sheath	0.67	0.202	1.050
Infested leaf sheath	0.89	0.275	1.293
% increase / decrease	+32.83	+36.13	+23.76
S.E	0.044	0.008	0.062
't' value	4.894*	8.469*	3.972*

* Significant at 5%

There was significant depletion of secondary nutrients like calcium and magnesium due to mite feeding. Calcium content in the healthy leaf sheath was 0.28 per cent and it was 0.20 per cent in mite affected leaf sheath with a decrease of 28.57 per cent. The magnesium content decreased to 50.0 per cent due to mite feeding, with 0.096 per cent in healthy leaf sheath and 0.048 per cent in mite affected leaf sheath (Table 6). This findings agree with Sithanantham *et al*., (1975), who observed increased percentage of nitrogen, phosphorus and potassium in sugarcane leaf sheath affected by *Aceria sacchari* Chan. than healthy leaf sheath and also depletion of secondary nutrients calcium and magnesium to a tune of 18.2 per cent and 75.0 per cent, respectively in mite affected.

The micronutrients also might have got depleted due to mite feeding, with a significant decrease of 50.0 per cent, 38.46 per cent, 66.67 per cent of iron, manganese and copper contents, respectively.

Table 6. Secondary nutrient content of healthy and *Aceria sacchari* infested sugarcane leaf sheath

Particulars	Calcium (%)	Magnesium (%)
Healthy leaf sheath	0.28	0.096
Infested leaf sheath	0.20	0.048
% increase /decrease	-28.57	-50.00
S.E	0.025	0.010
't' value	3.137*	4.810*

* Significant at 5% level

The iron content was 6.20 ppm and 3.10 ppm in the healthy and mite affected leaf sheaths, respectively. The manganese content was 14.30 ppm in healthy leaf sheath and 8.80 ppm in mite affected leaf sheath. The copper content was 0.90 ppm in the healthy leaf sheath and 0.30 ppm in the mite affected leaf sheath (Table 7).The depletion of the micronutrients suggest the intake by mites for growth and development. Similar finding was reported in mango leaf coating mite, *Cisaberoptus kenyae* Keifer by Abou-Awad *et al.* (2012).

Table 7. Micro nutrient content of healthy and *Aceria sacchari infested* sugarcane leaf sheath

Particulars	Iron (ppm)	Manga-nese (ppm)	Copper (ppm)	Zinc (ppm)
Healthy leaf sheath	6.20	14.30	0.90	NT
Infested leaf sheath	3.10	8.80	0.30	NT
% increase / decrease	-50.00	-38.46	-66.67	-
S.E	0.254	0.819	0.049	-
't' value	12.190*	6.708*	12.233*	-

* Significant at 5%. NT-Non-traceable

In conclusion, the changes in biochemical composition of sugarcane leaf sheath due to mite feeding suggest their role in defense mechanism. In the present studies, the role of oxidative enzyme activity and changes in the nutrient content require in depth studies on the mite-host relationship that paves way to overcome the deficiencies caused by mite feeding and improve the sugar yield in canes.

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