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Biochemical Changes in Relation to Infestation of *Tetranychus ludeni* Zacher on the Leaves of Chilli *(Capsicum frutescens)*

SNEHASIS BARMAN AND SANJIB GHOSHAL*

Postgraduate Department of Zoology, Bangabasi College
Kolkata 700009, India
**Correspondence*

Abstract

The present study showed that the significant depletion of important organic, minerals and inorganic compounds occurred due to mite infestation in the leaves of chilli. Among organic compounds, chlorophyll, total protein, phenol and total carbohydrate were selected for the study. Among minerals, Mg, Zn, Cu and Fe were selected and among inorganic materials nitrate and nitrite were selected. It was found that amount of chlorophyll, total protein, total carbohydrate, Mg, Zn, Cu, Fe, nitrate and nitrite were reduced by 15.36, 19.08, 17.54, 11.93, 23.15, 32.32, 16.20, 20.19, 23.23% respectively. It was found that the amount of phenol increased by 21.21% due to mite feeding.

Key words : Biochemical changes, Infestation, *Tetranychus ludeni* , Chilli leaves.

Several insects and arachnids are known to cause serious damage to many of the economically important plants. Some of them are responsible for the significant yield loss directly or indirectly. Mites are a group of arachnid arthroped. They are the most important and significant pests of crops causing serious yield losses. Insect pests have received sufficient attention in India, mites have remained neglected probably due to their microscopic size, even though they have the potentiality of causing extensive damage to the agricultural and horticultural crops. A good number of plant mites are injurious pests of agricultural and horticultural crops causing considerable yield loss to the farmers : 50—80% in chilli due to *Aceria mangiferi* ; 27—39% on chilli due to *Polyphagotarsomenus* latus ; 15-30% in red gram due to *Aceria cajani ;* 5-11% on tea due to Oligonychus caffeae ; 10—15% in vegetables due to spider mites; 30% in litchi due to *Aceria litchi* ; 20-25% in paddy due to *Oligonychus oryzae* ; 20-30% in sugar cane due to *Oligonychus indicus ;* 13-30% in brinjal, 23-25% on lady's finger due to spider mites (1). The financial loss due to mite feeding in one instance may be as high as Rs 8,616.63 per ha in brinjal. Since very little or nothing is known as to what extent the feeding of different mite influences changes in the biochemical components of leaves of chilli, it was thought to undertake a preliminary study on this aspect.

Methods

The estimation of chlorophyll was done following the method of Arnon (2). Total carbohydrate was estimated using anthrone reagent following the method of Hedge et al. (3). Phenol was estimated following the method of spies (4). Before analysis, fresh uninfected leaves were collected to serve as control and those were processed separately for analysis. The control plants have to demite, by using an effective acaricide, throughout the entire period of study.

Quantitative estimation of minerals like Mg, Cu, Zn, will be made by digesting the oven-dried samples in concentrated HNO_3. Before analysis, fresh uninfected healthy leaves (treated with acaricide) were collected to serve as control and those were processed separately for analysis.

Heavily infested leaves as well as uninfested healthy leaves of Chilli were collected. Out of those leaves (both uninfested and infested), 20 grams each of uninfested leaves and heavily infested leaves are subjected to oven drying for about 3 hours at 105 C for complete drying of leaves. Infestation status of the leaves can be easily concluded by the examination of damage sympotoms, due to mite feeding, by hand lens.

The whole experiments were repeated five times. The results obtained during the study were statistically analyzed for inference.

Table 1. Increase or decrease of organic compounds in the leaves of chilli leaves due to mite feeding (10—20 mites per 4.0 sq. inch leaf area ; 1 inch = 25.4 mm). (i) = Percentage increase, (d) = Percentage decrease, n = number of experiments.

Name of organic components	Control (amount ± SD) (n = 5)	Infested (amount ± SD) (n = 5)	Percentage of decrease or increase percent ± SD) (n = 5)
Chlorophyll	6.9 ± 0.33 mg/g	5.84 ± 0.89 mg/g	15.36 (d)
Total protein	33.37 ± 0.98 μg/g	27.00 ± 0.53 μg/g	19.08 (d)
Total carbohydrate	17.27 ± 0.86 mg/100 mg sample	14.24 ± 0.63 mg/100 mg sample	17.54 (d)
Phenol	2.31 ± 0.41μg/g	2.80 ± 0.44 μg/g	21.21 (i)

Results and Discussion

A marked depletion in percentage content of organic, inorganic compounds and minerals were recorded in chilli leaves (Tables 1 and 2). The amount of chlorophyll was found to be 6.9 ± 0.33 mg/g in while contid, infested leaves 5.84 ± 0.89 mg/g. Hence the decreased was 15.36%.

The total protein was 33.37 ± 0.98 μg/g in control while the infested leaves was 27.00 ± 0.53 μg/g. Therefore, the depletion of total protein was recorded to be 19.08%. Phenol in uninfested healthy leaves was 2.31 ± 0.41μg/g while in infested leaves the value was 2.80 ± 0.44 μg/g. Therefore, the increase of phenol was 21.21%. Total carbohydrate content in the uninfested healthy leaves was 17.27 ± 0.86 mg/100 mg while in infested leaves it was 14.24 ± 0.63 mg/100 mg. The percentage of decrease in total carbohydrate content in chilli leaves due to mite feeding was 17.54.

The marked depletion of mineral content was observed in chilli leaves due to mite infestation. The magnesium in uninfested healthy leaves was 33.43 ± 0.67 μg/ml while in infested leaves the value was 29.44 ± 0.33 μg/ml. Therefore, the decrease of magnesium was 11.93%. The uninfested healthy leaves showed 39.00 ± 0.43 μg/ml of iron while infested leaves showed 32.68 ± 0.75 μg /ml, and decrease was 16.20%.

Nitrate compounds in uninfested healthy leaves were 3.07 ± 0.92 μg/g while in infested leaves the value was 2.45 ± 0.08 μg/g showing decrease in nitrate compounds by 20.19%. Nitrite compound in uninfested healthy leaves was 4.84 ± 0.79 μg/g and infested in leaves it was 3.72 ± 0.49 μg/g, thus of decrease was 23.23%.

Zinc (Zn) in the uninfested healthy leaves was 2.85 ± 0.34 μg/ml while in infested leaves the value of 2.19 ± 0.78 μg/ml, thus the decrease of zinc was 23.15% . Copper (Cu) in uninfested healthy leaves was 0.99 ± 0.65 μg /ml while in infested leaves the value was 0.67 ± 0.34 μg/ml with the decrease by 32.32%.

The mites are known to cause various biochemical changes including changes in minerals, inorganic and organic compounds in plants leadings to their physiological and morphological changes (5-7). The decrease in chlorophyll content is due to mechanical

Table 2. Changes of minerals and inorganic components of chilli leaves due to mite feeding (10—20 mites per 4.0 sq inch leaf area ; 1 inch = 25.4 mm). (D) = Percentage decrease, n = Number of experiments.

Name of minerals and inorganic components	Control (amount ± SD) (n = 5)	Infested (amount ± SD) (n = 5)	Percentage of decrease / increase (percent ± SD) (n = 5)
Mg	33.43 ± 0.67 μg/ml	29.44 ± 0.33 μ g/ml	11.93 (D)
Zn	2.85 ± 0.34 μg/ml	2.19 ± 0.78 μg/ml	23.15 (D)
Cu	0.99 ± 0.65 μg/ml	0.67 ± 0.34 μg/ml	32.32 (D)
Fe	39.00 ± 0.43 μg/ml	32.68 ± 0.75 μg/ml	16.20 (D)
Nitrate	3.07 ± 0.92 μg/g	2.45 ± 0.08 μg/g	20.19 (D)
Nitrite	4.84 ± 0.79 μg/g	3.72 ± 0.49 μg/g	23.23 (D)

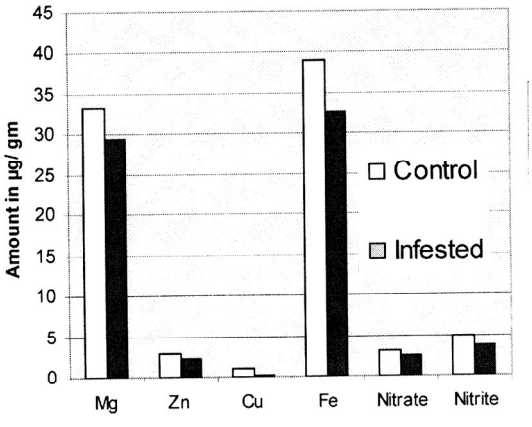

Figure 1. Depletion of minerals, nitrate and nitrite in mango leaves due to mite infestation.

damage of chloroplasts of leaves caused by mite feeding or it may be due to decoloration of chloroplasts. According to Tomezynsk and Kropzynska (8) the water stress induced by mite feeding may have an influence on chlorophyll metabolism of injured cells or due to cell disturbances and removal of chloroplasts. Kolodoziej et al. (9) indicated positive correlation between increases in mite density with decrease of chlorophyll.

Contrary to this, some earlier workers indicated that damage to chlorophyll due to mite feeding was quite low even in high mite density (10—12). Chatterjee and Gupta (13) reported chlorophyll damage to the extent of 33.62% on *Luffa acutangula* due to infestation of *Tetranychus ludeni.* Nangia et al. (14) reported chlorophyll loss on different varieties of mulberry due to feeding of *Eotetranychus suginamensis* as 153.75% on MS variety, 185.00% in S-54 variety, 74.50% in Mysore local variety and 12.60% in RFS 175 variety. They attributed this depletion due to their break down by proteolytic enzymes secreted by mites and subsequent utilization by the mites. Goyal and Sadana (15) reported chlorophyll loss as 63.12% mg/m^2 on Coleus sp. infested by *Brevipalpus obvatus* and Sumangala and Haq (16) reported it as 47% over uninfested leaves in case of *Eichhornia crassipes* due to feeding of *Eutetranychus orientalis.* The chlorophyll loss was low in the present case. Chlorophyll loss due to mite feeding was also reported by earlier workers (17, 18). Ghoshal et al. (19) reported chlorophyll loss of 13.45 ± 0.00% in jute (*Corchorus capsularis* Linn.) due to the infestation of mite *Polyphagotarsonemus latus* (Banks).

In the present study, the increase in phenolic compounds was observed as 21.21%. Similar observation on increase of phenolic compounds was also reported by Kielkiewiez (20) and found increase in the upper and lower epidermis after mite feeding though its reduction was observed in palisade parenchyma. Ghoshal et al. (19) reported increase of phenol compounds by 8.20 ± 0.00% in jute (*Corchorus capsularis* Linn.) due to the infestation of mite *Polyphagotarsonemus latus* (Banks).

The total protein reduction by 19.08% was indeed high. Similar observation was recorded by Nangia et al. (14) where depletion varied from 57.50% in Mysore local variety of mulberry leaves to 38.80% in RFS-175 variety, due to feeding of *Eotetranychus suginamensis.* Many workers (21—22) also made similar observations i.e. reduction of protein due to feeding by different species of mites. Ghoshal et al. (19) reported depletion of total protein by 42.00 ± 0.00% in jute (*Corchorus capsularis* Linn.) due to the infestation of mite *Polyphagotarsonemus latus* (Banks).

Total carbohydrate, decrease was alarmingly high i.e. 17.54%. Similar observation was made by Nangia et al. (14) where the decrease was reported to be 12.30% in MS variety, 17.55% in S-54 variety, 19.10% in Mysore local variety and 12.70% in RFS-175 variety of mulberry due to feeding on *Eotetranychus suginamensis.* Usha et al. (23) reported total reduction of total sugar, reducing sugar and non-reducing sugar level, in plants due to mite infestation, Ghoshal et al. (19) reported depletion of total carbohydrate by 56.22 ± 0.00% in jute (Corchorus capsularis Linn.) due to the infestation of mite *Polyphagotarsonemus latus* (Banks).

The depletions of minerals like magnesium, zinc, copper and iron were 11.93, 23.15, 32.32, 16.20% respectively in the present study. The iron and zinc depletions were reported to be 66.4 and 70% on Luffa acutangula due to feeding of *Tetranychus ludeni* (13) which were much higher as compared to observation made in the present work. Golek (6). Sadana and Goyal (22) reported changes in calcium, potassium and magnesium contents of leaves and the results obtained in the present study are in conformity with these. Das (24) reported reduction in iron and zinc contents by 42.9 and 31.11% respectively in *Dolichotetranychus*

floridanus on pineapple and those results are also on much higher side as compared to those obtained in the present study, since zinc is an important mineral, the present loss of 23.15% is really alarming. Ghoshal et al. (19) reported depletion of magnesium, zinc copper and iron by 8.33 ± 0.00, 22.22 ± 0.00, 13.88 ± 0.00, and 8.66 ± 0.00%, respectively in jute (*Corchorus capsularis* Linn.) infested by *Polyphagotarsonemus latus* (Banks).

In nitrate and nitrite, the percentage reductions were 20.19 and 23.23% respectively as compared to 51.1 and 3.12% in Luffa acutangula by feeding of *Tetranychus ludeni* (13). Ghoshal et al. (19) reported depletion of nitrate and nitrite by 25.73 ± 0.00 and 19.35 ± 0.00% respectively in jute (*Corchorus capsularis* Linn.)due to the infestation of mite *Polyphagotarsonemus latus* (Banks).

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