Morphological resistance of certain tea clones to red spider mite (Oligonychus coffeae) in tea

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Abstract

Certain morphological attributes of tea leaf varieties TV1, TV6 and TV10 were studied to understand their resistance against the red spider mite Oligonychus coffeae Nietsner which acts as a decap towards the tea economy of India. Varietal studies revealed that TV1 the resistant variety is highly palatable by the mite in comparison to TV6 and TV10. Life parameters of O. coffeae viz., fecundity showed significant positive correlation with length of leaf axil \(r = 0.71169^\text{**}\) and \% leaf area damage \(r = 0.83574^\text{**}\). Similarly, hatching of O. coffeae also showed significant positive correlation with \% leaf area damage \(r = 0.69839^\text{**}\).

Keywords: Oligonychus coffeae, life parameters, resistance, morphological attributes, damage

1. Introduction

Due to the inherent extensive monoculture habitat of tea in India and also almost in all the districts of Assam tea bushes harbour various pests which plagues various parts of the tea bush causing uncontrolled damage [2]. More than 300 insect and mite pests [3] sustain themselves in the monoculture habitat and plague various parts like root, stem, leaf and bud causing 7-10\% loss in the yield [3]. Mites are regarded as perennial pests of tea, and one of such most debilitating pests of tea plants after Helopeltis sustaining themselves in the monoculture habitat is Oligonychus coffeae [23]. As such O. coffeae is one of the most destructive pests today infesting the tea estates of North eastern parts of India reducing yield and quality of tea and causing serious economic loss. O. coffeae also follows a great reproductive capacity and breeds at an alarming rate owing to its short life cycle and is a major constraint in the tea industry and they are the most difficult to eradicate. The quality and taste of tea is sensitive to chemical pesticides and so there is an increased interest in the use of eco friendly methods as well as exploiting the inherent resistance present in the different cultivars to devise suitable IPM strategies for the management of the different pests and diseases of tea as well as O. coffeae. With this aim the present investigation was carried out to study comparative morphological characteristics amongst three tea clones.

2. Methodology

In the year 2010-2013 tea clones TV1, TV6 and TV10 released from Tocklai Experimental Station, Jorhat was selected to study their morphological characteristic conferring their resistance to the red spider mite, O. coffeae. Freshly collected fourth leaf from the top of the tea plant were used for various morphological experiments. The comparative morphological characters viz. leaf length, leaf width, leaf angle, leaf area, leaf axil length, per cent leaf area damage and trichome density of the three tea clones were analysed as suggested by earlier workers [26, 17, 27]. The relationship between life parameters of the three tea varieties was determined by correlation and regression analysis.

3. Results

3.1 Length of leaf blade and leaf width

In the present investigation no significant varietal difference for length of leaf blade was observed, it is also evident from the results (Table 1) that the largest width of leaf was recorded in TV6 followed by TV10 and TV1. The results of correlation studies (Table 2) suggested that length \((r = -0.53417^*, R^2=0.7839\) and \(r = -0.62794, R^2=0.3943\) and width\((r = -0.88537^**, R^2=0.7839\) and \(r = -0.75244^**, R^2=0.5662\) showed significant negative correlation with fecundity and hatching. The magnitude of the relationship for length of leaf blade was
expressed by the equations $y=138.42-4.9594x$ and $y=168.93-7.3491x$ and the magnitude of the relationship for width of leaf blade was expressed by the equations $y=123.26-7.6248x$ and $y=125.82-8.1685x$.

### 3.2 Leaf angle

Amongst the three clones studied the leaf angle was greatest in TV6, followed by TV1 and TV10. The leaf angle (Table 2) of the respective clones however did not show any correlation with fecundity and hatching ($r = 0.48758$ and $r = -0.16862$).

### 3.3 Leaf area

Varietal difference was observed for leaf area showing maximum leaf area in TV 6 followed by TV10 and TV1 (Table1). While studies of leaf area (Table 2) showed significant negative correlation with fecundity and hatching percentage of *O. coffeae* ($r = -0.83310**$ and $r = -80299**$). The magnitude of the relationship for width of leaf blade was expressed by the equations $y=114.5-67.397x$, $R^2=0.6941$.

### 3.4 Leaf thickness

Observations on leaf thickness (Table1) revealed no significant difference. The attribute of leaf thickness presented in Table 2 show negative significant correlations with fecundity.

### 3.5 Percent leaf area damage

Investigations made on per cent leaf area damage (PLAD) on different portions of leaf by *O. coffeae* as depicted on Table1 show that the highest damage was made by *O. coffeae* in TV1 followed by that in TV10 and the least damage shown was in TV6 cultivars and positive correlation of PLAD (Table 2) was shown with fecundity and per cent hatching ($r = 0.83574**$, $R^2=0.4875$ and $r = 0.69839**$). The magnitude of the relationship for width of leaf blade was expressed by the equation $y=30.944+1.2147x$.

### 3.6 Length of leaf axil

The length of leaf was the largest in TV1 (55.80°), followed by TV6 (44.40°) and TV10 (41.00°). As depicted in Table 2 for correlation studies the length of leaf axil show significant correlations with fecundity ($r = 0.71169**$, $R^2=0.5065$). The regression equation for leaf axil was expressed by the equation $y=57.582-16.161x$.

### 3.7 Trichome density

The density of trichomes or leaf hairiness was more in TV6 followed by TV10 and TV1 (Table 1). However significant negative correlation between the trichome density with fecundity and hatching (Table 2) was observed ($r = -80298**$, $R^2=0.6544$ and $r = -80299**$). The magnitude of the relationship for width of leaf blade was expressed by the equations $y=0.0709-82.545x$.

### 4. Discussion

Leaf form and size play a significant role in phytophagy [22, 23]. Tea cultivars vary in their leaf geometry (length: breadth ratio) and the plant architecture may help in attraction and accumulation of a large number of phytophagous herbivores [3]. In this study the length: width ratio determines the preference, smaller the ratio more the preference (Table 1). This confirms the suggestion made earlier by Banerjee (1987) [3]. Spider mites construct three dimensional webs for egg deposition [6, 13]. If the leaf blade is long there are less eggs and low hatching this means spider mites prefer low length: width ratio not only for feeding but also for laying eggs. There was significant difference in the length of leaf among the TV clones, being longest in TV10 followed by TV1 and TV6 but negative significant correlation with fecundity of *O. coffeae* was observed as certain deterrents on the leaf surface may also be present for insect feeding and oviposition. This may corroborate that leaf size selection by phytophagous insects is an important criteria for its accumulation [4]. In this study the length of leaf blade and leaf area was the largest in TV6, followed by TV10 and smallest width and leaf area were in TV1 and results showed a negative significant correlation of leaf width with fecundity. This indicates *O. coffeae* tends to feed in larger leaves but unable to continue its generation. Broader leaf may lack gripping surface to lay eggs. Physicochemical factors along with visual apparent may be helpful in searching for leaf size and shape, which may be in line with this study [10, 1]. Leaf thickness or toughness was greatest in TV6 followed by TV10 and TV1. Thickness of leaf may provide resistance as lower densities of feeding was observed in thick TV6 leaves than thin and moderate TV1 and TV10 leaves. The cuticle of TV1 is thin enough to pierce and caused damaged by *O. coffeae* which confirms the findings of Hanna et al. [12] that toughness and hardness are the major mechanical defences of plants and leaves with thin cuticle are infested more easily by tetanychida. Similarly, cases may arise for stylet penetration of mite, *O. coffeae* into the TV clones for more feeding and fecundity. Thus thickness of leaf may reduce the incidence of *O. coffeae* attack. It is reported that *O. coffeae* mostly invade the upper tea leaf surface in comparison to other tea pests which also invades the stem [18]. Various workers corroborated that the deflected tip and incurved margins of the upper leaf surface show damage symptoms [6, 10, 27] which is in conformity with this study as selection of leaf axil for study against *O. coffeae* damage revealed greatest leaf axil length in TV1 followed by TV6 and TV10 with significant correlations with fecundity. Thus narrow and curved leaves of TV1 may favour more egg laying and web building for protection of eggs. The present study thus reveal clonal variation in leaf axil length for its relation against *O. coffeae* damage. Our observations revealed leaves with long axil, thinness and forming angle around 45° are preferred by the red spider mite. In this study the leaf angle of TV clones is greatest in TV10, moderate in TV1 and smallest in TV6 with no correlation with fecundity. This indicates that leaf angle varies in resistant, moderate and susceptible clones but do not play a role in fecundity. Leaf angle favour high light interception for using the nutrients and superior light efficiency is more in traits with erect leaves [31]. The present finding reports narrow and erect leaves with moderate leaf angle in TV1, which may be favourable for higher light interception for preparation of suitable nutrients and *O. coffeae* damage. Long, thin and simple nonglandular trichomes on the upper surface was found in this study with greatest density on leaves of TV6, followed by TV10 and lowest density was observed in TV1 which confirm the latter workers [15, 7]. This study is in line with Parnell et al. [25] showing consistent relationship of hairiness with degree of jassid resistance towards cultivars of *Gossypium*. Increased density of trichomes for increased oviposition of *T. urticae* may be consistent with this study [9]. Luczynski et al. [10] observed that increase in density of nonglandular trichomes decreased egg laying of *T. urticae* which may be in line with this work. The present investigation revealed density of trichomes in the three TV clones to be negatively correlated with fecundity indicating partial fecundity and oviposition of *O. coffeae*. Larval contact with higher trichome density was partially responsible for less infestation [29]. Hence, less density of trichomes in TV1 may be partially responsible for feeding and
indicating protective function of trichomes and the negative correlation studies of trichome density may hence be responsible for partial oviposition and fecundity of *O. coffeae*. This study shows that trichome density has a negative relationship with feeding and oviposition (Table 2). However this study contradicts that the presence of pubescence encourage egg laying of *Typhlodromus pyri* [24].

### Table 2: Correlation of biological characters of *O. coffeae* on various biophysical characters of leaf of TV clones

<table>
<thead>
<tr>
<th>Biophysical characters</th>
<th>Fecundity</th>
<th>% Hatching</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length of leaf blade</td>
<td>$r = -0.53417^*$</td>
<td>$r = -0.62794^*$</td>
</tr>
<tr>
<td>Width of leaf blade</td>
<td>$r = -0.88537^**$</td>
<td>$r = -0.75244^**$</td>
</tr>
<tr>
<td>Leaf thickness</td>
<td>$r = -0.56881^*$</td>
<td>$r = -0.68149^*$</td>
</tr>
<tr>
<td>% leaf area damage</td>
<td>$r = -0.83310^*$</td>
<td>$r = -0.80299^*$</td>
</tr>
<tr>
<td>Length of leaf axil</td>
<td>$r = 0.48758$</td>
<td>$r = -0.47796$</td>
</tr>
</tbody>
</table>

| Trichome density      | $r = -0.80898^*$ | $r = -0.47796$ |

** indicates significance at 1% level  
* indicates significance at 5% level  
r=correlation coefficient

### Table 1: Comparison of certain physical leaf characters amongst the three TV clones

<table>
<thead>
<tr>
<th>Clones Physical characters (mean±SD)</th>
<th>Leaf blade (dm)</th>
<th>Leaf thickness (µm)</th>
<th>Leaf area (dm²)</th>
<th>Leaf area damage (%)</th>
<th>Length leaf axil (dm)</th>
<th>Leaf angle (degrees °)</th>
<th>Trichome density (no/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV1</td>
<td>12.450±0.465</td>
<td>37±2.739</td>
<td>92.68±2.704</td>
<td>1.190±0.273</td>
<td>44.400±12.057</td>
<td>0.466±0.038</td>
<td>92.68±2.704</td>
</tr>
<tr>
<td>TV6</td>
<td>12.400±2.634</td>
<td>46±2.050</td>
<td>79.52±0.916</td>
<td>0.750±0.149</td>
<td>55.800±8.651</td>
<td>0.730±0.075</td>
<td>79.52±0.916</td>
</tr>
<tr>
<td>TV10</td>
<td>13.25±0.735</td>
<td>39±2.195</td>
<td>81.94±4.706</td>
<td>0.690±20.22</td>
<td>41.100±9.422</td>
<td>0.655±0.061</td>
<td>81.94±4.706</td>
</tr>
</tbody>
</table>

### References


