Impact of weather parameters on the population dynamics of major sucking pests of acid lime, *Citrus aurantifolia* Swingle

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Abstract

A field experiment was conducted to investigate the seasonal abundance of major sucking pests *viz.*, citrus blackfly, *Aleurocanthus woglumi* Ashby and citrus psyllids, *Diaphorina citri* Kuwayama on acid lime during September 2017 to August 2018. The influence of weather factors on population fluctuation of sucking pests in acid lime ecosystem was recorded that the occurrence of *A. woglumi* and *D. citri* were noticed throughout the study period 35th (1st week of September) to 34th (4th week of August) standard weeks. The population of *D. citri* attained first peak during 40th standard week (1st week of October) with 17.20 nymphs/twig and its second peak during 19th standard week (2nd week of May) recording 17.40 nymphs/twig. The maximum population of *D. citri* could be observed during 34th standard week (4th week of August) with 24.50 nymphs/twig. Then the population of *A. woglumi* gradually increased and reached its first peak during 25th standard week (4th week of June) recording 67.70 nymphs/leaf. The sharp decline in *A. woglumi* population was noticed from 36th standard week (2nd week of September) and again started declining from 26th standard week (5th week of June) to 34th standard week (4th week of August). The correlation studies on the weather parameters with *D. citri* and *A. woglumi* population revealed that the maximum and minimum temperatures, relative humidity showed significant positive relationship with *D. citri*, where as rainfall exhibited non significant relationship with *D. citri* and *A. woglumi*. From the multiple linear regression analysis it is evident that among the weather factors, maximum and minimum temperatures, relative humidity had significant positive correlation with *A. woglumi*. It excretes copious amount of sugary honeydew, which coats leaf surface and fruits surfaces on which heavy growth of sooty mold saprophytic fungi (*Capnodium citri* Berk and Desm) will occur [13]. This fungus is known for growing thick and dark on the leaves results in reduced respiration and photosynthesis. Heavy infestations may cause fast deterioration of plants and yield reduction [10]. It has more than 300 host plants [17], of which citrus is the most preferred host for population buildup [10].

Keywords: Population dynamics, weather parameters, *Aleurocanthus woglumi* and *Diaphorina citri*

1. Introduction

Citrus fruit is rich sources of several nutrients such as fibres, carbohydrates and vitamins, minerals, which are essentially important for the maintenance of human health and growth. Acid lime is cultivated in almost all the states *viz.*, Tamil Nadu, Andhra Pradesh, Maharashtra, Karnataka, Gujarat and Himachal Pradesh. It is widely grown in the southern region of Tamil Nadu also. Citrus is commercially grown throughout India and occupies a place of prime importance among the major fruits of India, which ranks third after mango and banana. India is one of the principal citrus growing countries in the world in an area of 10.55 lakh hectares with the production of 127.46 lakh tonnes annually with the productivity of 9.90 tonnes per hectare [2]. In India, acid lime accounts for about 259,000 hectares with the production of 2,789,000 tonnes. In Tamil Nadu, acid lime occupies an area of 9,880 hectares with the production of 34,510 tonnes annually with the productivity of 3.49 tonnes per hectare [2].

In India, citrus trees are reported to be damaged by several insects and mite species during different stages of crop [6], this causes fruit yield losses 83-95%. [19]. The Citrus blackfly, *Aleurocanthus woglumi* Ashby is considered as agriculturally important insect in several countries due to economic loss that it causes [3]. They suck the sap from the Phloem tissue of leaf and shoots, thereby removing the nutrients and possibly debilitating the plants by injecting toxic saliva [29]. It excretes copious amount of sugary honeydew, which coats leaf surface and fruit surfaces on which heavy growth of sooty mold saprophytic fungi (*Capnodium citri* Berk and Desm) will occur [13]. This fungus is known for growing thick and dark on the leaves results in reduced respiration and photosynthesis. Heavy infestations may cause fast deterioration of plants and yield reduction [10]. It has more than 300 host plants [17], of which citrus is the most preferred host for population buildup [10]. The most preferred host plant of
A. woglumi is the Tahiti lime (Citrus latifolia), when compared to sweet orange (Citrus sinensis) and mango (Mangifera indica) \cite{18}. Fruit set is greatly reduced, losses caused by A. woglumi goes up to 80 per cent and more \cite{9,21}. Citrus psyllids, Diaphorina citri act as carriers of the bacteria Candidatus liberibacter asiaticus that cause fatal citrus disease (citrus greening) \cite{11,14}. D. citri is small sucking insect pest with mottled brown body which remains active from February to October with peak populations in spring and autumn seasons \cite{12}. However, in the altered scenario of orchard management, there is a need to understand the comprehensive information regarding the pest complex and their seasonal abundance. Hence in the present study, investigations was undertaken to document the seasonal activity of pests in the acid lime ecosystem and to adopt a suitable control strategy to supports the insect pests under economic threshold level.

2. Materials and Methods

To study the Impact of abiotic factors on the population dynamics of sucking pests in acid lime ecosystem viz., citrus black fly, citrus psyllids were selected in hot spot area at Kumbakarai village of Periyakulam block, Theni district, Tamil Nadu during September 2017 to August 2018. Acid lime foliage of uniform age was selected @10 Nos per field which were tagged properly/ block and the populations of sucking pests were recorded at regular interval (once in week) in unprotected condition. The weather parameters viz., Maximum and Minimum Temperature (°C), Relative humidity (%), Rain fall (mm) were recorded from automatic weather station facility installed at Periyakulam block of Theni district for working out the correlation between weather parameters and populations dynamics of sucking pests in acid lime orchards in a given standard meteorological week. The data of population dynamics of citrus psyllids and citrus blackfly were subjected to correlation with different weather parameters and analyzed statistically by SAS 9.2 and SPSS 17.0 statistical software package to study influence of abiotic factors on fluctuations in population of citrus psyllids and citrus blackfly on acid lime.

3. Results and Discussion

To study the seasonal incidence of sucking pests in acid lime ecosystem in field condition, field with uniform aged bushes were selected at Kumbakarai village of Periyakulam block, Theni district, Tamil Nadu during September 2017 to August 2018. The possible influence of weather factors on population fluctuation of sucking pests in acid lime ecosystem was recorded at weekly intervals in fixed location. The study revealed that the occurrence of sucking pests of acid lime (Table 1) was noticed throughout the study period 35th (1st week of September) to 34th (4th week of August) standard week.

Initially the population of D. citri was low followed by gradually decreased from 6.50 to 17.20 nymphs/10cm length of twig (Table 1). And then the population of D. citri gradually increased as reached its first peak during 40th standard week (1st week of October) with 17.20 nymphs/twig. Thereafter the population of D. citri was started decreasing from 41st standard week (2nd week of October) to 50th standard week (3rd week of December). Again the D. citri population showed the increasing rate form 4th standard week (4th week of January) to 19th standard week (2nd week of May). Further, the D. citri population indicated an increasing rate of multiplication gradually which reached its second peak during 19th standard week (2nd week of May) recording 17.40 nymphs/twig. Subsequently there was a fluctuation in D. citri population from 4th standard week (4th week of January) to 34th standard week (4th week of August) and the maximum population could be observed during 34th standard week (4th week of August) with 24.50 nymphs/twig. During the present study period, two peaks could be noticed i.e. first peak during 40th standard week (1st week of October) and second peak coinciding with 19th standard week (2nd week of May). The results also revealed that there was a lot of oscillation in D. citri population from 4th January to 34th August standard week because of erratic distribution of weather factors, maximum and minimum temperatures, relative humidity and rainfall by which increasing and decreasing trend of D. citri population was observed (Figure 1). These results agree with the report of Hijam and Sharma \cite{13} who revealed that D. citri population exhibited throughout the year but only adults found surviving during December and February. Two peaks of population (nymphs) were observed, 1st peak during April-May and 2nd peak during August-September. \cite{3} Bhut et al. reported that the highest (1.52) D. citri nymphal population observed on different citrus groups during April and August.

The correlation studies (r) between weather parameters and Diaphorina citri population revealed that (Table 2) the maximum and minimum temperatures exhibited significant positive correlation (r = 0.66 and 0.66 respectively), while relative humidity had positively significant relationship (r = 0.39) with D. citri population, where as rainfall exhibited non significant relationship (r = 0.07) with D. citri in acid lime ecosystem. From the correlation analysis, it is evident that an increase in maximum and minimum temperatures by 1°C resulted in an increase of D. citri population by 1.42 and 0.62 per cent, where as an increase in relative humidity by 1 per cent, there was an increase in D. citri population by 0.50 and while as an increase in rainfall by 1 mm, there was a decrease in D. citri population by 0.02 per cent, respectively. Multiple linear regression analysis (Table 2) was also carried out by taking into account D. citri population as dependent and weather parameters as independent variables. The results revealed that the coefficient of determination was significantly high (R² = 0.165), which implies that these weather factors i.e., maximum temperature, minimum temperature, morning relative humidity, evening relative humidity and rainfall contributes directly towards the population buildup of D. citri in acid lime ecosystem to an extent of 16.5 per cent. From the multiple linear regression analysis it is clear that among the weather factors, maximum and minimum temperatures, relative humidity had significant positive relationship, while rainfall exhibited non significant association with D. citri in acid lime ecosystem. These finding fall in line with the report of \cite{3} Aruna et al., who opined that the nymphal population of D. citri had significant positive correlation with maximum (r=0.47) and minimum temperature (r=0.46), non-significant correlation with rainfall (r=0.26) and non significant negative correlation with relative humidity. Correlation analysis indicated that maximum and minimum temperature, sunshine hours and rainfall were positively correlated with nymphal, adult and mixed population of D. citri but the effect of rainfall on adult population was non-significant, while relative humidity was negatively correlated \cite{13}.

Initially the population of Aleurocanthus woglumi was high followed by gradually decreased from 59.50 to 6.20
nymphs/leaf (Table 1). Then the population of A. woglumi gradually increased as reached its first peak during 25th standard week (4th week of June) recording 67.70 nymphs/leaf. The sharp decline in A. woglumi population was noticed from 36th standard week (2nd week of September) and again started declining from 26th standard week (3rd week of June) to 34th standard week (4th week of August). There was lot of fluctuation in A. woglumi population from 36th standard week (1st week of September) to 34th standard week (4th week of August) and the minimum population could be observed during 2nd standard week (2nd week of January) with 6.20 nymphs/leaf. During the present study period, one peak was recorded, first peak during 25th standard week (4th week of June) (Figure 1). Similarly, [8] Correla observed that the population of A. woglumi peak activity was found during March to October. [15] Medeiros et al., observed that the incidence of A. woglumi was distributed homogeneous on the tree canopies on the two locations. The highest population level of A. woglumi recorded during July - December.

The correlation studies (r) between weather parameters and Aleurocanthus woglumi population revealed that (Table 2) the maximum and minimum temperatures showed significant positive relationship (r = 0.69 and 0.72 respectively), while relative humidity and rain fall had a non significant relationship (r = 0.10 and 0.08 respectively) with A. woglumi population in acid lime ecosystem. From the correlation analysis, it is evident that an increase in maximum and minimum temperatures by 1°C resulted in an increase of A. woglumi population by 2.33 and 3.33 per cent respectively, where as an increase in relative humidity by 1 per cent, there was an increase in A. woglumi population by 0.23 and while as an increase in rainfall by 1 mm, there was an increase in A. woglumi population by 0.10 per cent, respectively. Multiple linear regression analysis (Table 2) was also carried out by taking into account A. woglumi population as dependent and weather parameters as independent variables. The results revealed that the coefficient of determination was significantly high (R² = 0.595), which implies that these weather factors i.e., maximum temperature, minimum temperature contributed directly towards the population buildup of A. woglumi in acid lime ecosystem to the extent of 59.50 per cent. From the multiple linear regression analysis it is evident that among the weather factors, maximum and minimum temperature had significant positive association with A. woglumi, while relative humidity with negative relationship with A. woglumi in acid lime ecosystem. Our findings are in conformity with the reports of [13] Chatterjee et al., the incidence of citrus blackfly (A. woglumi) had a significant positive association with relative humidity and rainfall [11]. Anderson et al., recorded that the temperature found positive and significantly correlation, while rainfall found significant negative correlated with the population of blackfly.

Table 1: Population dynamics of citrus psyllid, Diaphorina citri Kuwayama and citrus blackfly, Aleurocanthus woglumi Ashby in acid lime ecosystem (During September 2017- August 2018).

<table>
<thead>
<tr>
<th>Standard meteorological weeks</th>
<th>Date of Observation</th>
<th>Psyllid No. of nymphs/10 cm length of twig</th>
<th>Blackfly No. of nymphs/ leaf</th>
<th>Standard meteorological weeks</th>
<th>Date of Observation</th>
<th>Psyllid No. of nymphs/10 cm length of twig</th>
<th>Blackfly No. of nymphs/ leaf</th>
</tr>
</thead>
<tbody>
<tr>
<td>35</td>
<td>01 September 2017</td>
<td>6.5</td>
<td>59.5</td>
<td>36</td>
<td>08 September 2017</td>
<td>8.3</td>
<td>53.1</td>
</tr>
<tr>
<td>37</td>
<td>15 September 2017</td>
<td>9.1</td>
<td>44.1</td>
<td>38</td>
<td>22 September 2017</td>
<td>9.5</td>
<td>36.4</td>
</tr>
<tr>
<td>39</td>
<td>29 September 2017</td>
<td>12.4</td>
<td>30.6</td>
<td>40</td>
<td>06 October 2017</td>
<td>17.2</td>
<td>25.1</td>
</tr>
<tr>
<td>42</td>
<td>20 October 2017</td>
<td>11.0</td>
<td>32.4</td>
<td>43</td>
<td>27 October 2017</td>
<td>8.1</td>
<td>33.2</td>
</tr>
<tr>
<td>44</td>
<td>03 November 2017</td>
<td>4.4</td>
<td>35.4</td>
<td>45</td>
<td>10 November 2017</td>
<td>2.0</td>
<td>40.3</td>
</tr>
<tr>
<td>46</td>
<td>17 November 2017</td>
<td>2.0</td>
<td>38.1</td>
<td>47</td>
<td>24 November 2017</td>
<td>1.0</td>
<td>32.7</td>
</tr>
<tr>
<td>49</td>
<td>08 December 2017</td>
<td>0.9</td>
<td>27.7</td>
<td>50</td>
<td>15 December 2017</td>
<td>0.6</td>
<td>17.1</td>
</tr>
<tr>
<td>51</td>
<td>22 December 2017</td>
<td>0.0</td>
<td>11.0</td>
<td>52</td>
<td>29 December 2017</td>
<td>0.0</td>
<td>9.6</td>
</tr>
<tr>
<td>01</td>
<td>05 January 2018</td>
<td>0.0</td>
<td>6.2</td>
<td>02</td>
<td>12 January 2018</td>
<td>0.0</td>
<td>6.2</td>
</tr>
<tr>
<td>03</td>
<td>19 January 2018</td>
<td>0.0</td>
<td>8.6</td>
<td>04</td>
<td>26 January 2018</td>
<td>0.6</td>
<td>12.1</td>
</tr>
<tr>
<td>05</td>
<td>02 February 2018</td>
<td>1.4</td>
<td>16.1</td>
<td>06</td>
<td>09 February 2018</td>
<td>1.4</td>
<td>22.4</td>
</tr>
<tr>
<td>07</td>
<td>16 February 2018</td>
<td>1.8</td>
<td>28.3</td>
<td>08</td>
<td>23 February 2018</td>
<td>2.0</td>
<td>34.7</td>
</tr>
</tbody>
</table>

Table 2: Correlation and multiple linear regression models for weather parameters on Population dynamics of D. citri and A. woglumi in acid lime ecosystem (During September 2017- August 2018).

<table>
<thead>
<tr>
<th>Populations</th>
<th>Correlation Coefficient value</th>
<th>Multiple linear regression equation value</th>
<th>Coefficient of determination (R²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Maxi. Temperature (°C)</td>
<td>Min. Temperature (°C)</td>
<td>Relative Humidity (%)</td>
</tr>
<tr>
<td>Diaphorina citri Kuwayama</td>
<td>0.665**</td>
<td>0.660**</td>
<td>0.391**</td>
</tr>
<tr>
<td>Aleurocanthus woglumi Ashby</td>
<td>0.690**</td>
<td>0.720**</td>
<td>0.103**</td>
</tr>
</tbody>
</table>

**Significant at 1% Probability
*Significant at 5% Probability
4. Conclusion
The population of Diaphorina citri and Aleurocanthus woglumi reached its first peak during 40th standard week (1st week of October) with 17.20 nymphs/twig and during 25th standard week (4th week of June) recording 67.70 nymphs/leaf. The maximum and minimum temperatures showed significant positive relationship, while relative humidity and rain fall had a non significant relationship with Diaphorina citri and Aleurocanthus woglumi population in acid lime ecosystem.

5. References
18. Pena MR, Vendramim JD, Lourençao AL, Silva NM, Yamamoto PT, Gonçalves MS. Ocorrência da moscanegra-doscitros, Aleurocanthus woglumi Ashby...