Pest Management in Horticultural Ecosystems
Vol. 29, No.1 pp 21-25 (2023)
DOI Number:10.5958/0974-4541.2023.00003.6

Information and communication technology (ICT) based e-Pest surveillance for assessment of population dynamics of sucking pests on Orange in Maharashtra, India

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ABSTRACT: Continuous and systematic pest surveillance can prevent epidemic situations of any pest by detecting damage before a higher pest population is firmly established. This study generated valuable data on the population dynamics of sucking pests of orange over the seasonal months from 2012 to 2022 with the aid of applied information and communication technology tools. The majority of the pests under current study showed their seasonal activity throughout the monitoring period. July to December months were the peak periods of infestation by majority of orange pests. The study on the seasonal incidence revealed *Diaphorina citrii* and *Dialeurodes citri* having their peak infestation in the month of September and October. November and December were the congenial months for extensive infestation by *Brevipalpus phoenicis*. The population dynamics of *Aleurocanthus woglumi* showed their peak incidence in the month of August and October whereas *Scirtothrips citri* were most abundant in August, September and March. The data so generated in this study would help in the forecast of the pests and helpful in devising an effective IPM strategy for their management.

Keywords: wide-area pest surveillance, ICT, seasonal incidence, forecast, pest management

INTRODUCTION

Citrus (L.) is one of the world's most economically important fruit crops, belonging to the Rutaceae subfamily Aurantioideae. It is found throughout the world's tropical and subtropical climates and is thought to have originated in Southeast Asia, specifically northeast India, the Malayan archipelago, China, Japan, and Australia (Moore, 2001). Citrus (*Citrus* spp.) fruits are among the most important fruits grown in over 52 different countries. Brazil and China are the largest producers followed by US, India and Mexico (FAO, 2020). *Citrus tangerina* (Orange, tangerine or santra), *Citrus sinensis* (sweet orange or Mosambi) and *Citrus limon* (lemon) are the most important citrus fruits grown in India. The citrus orchards encounter high prevalence of pests in India. Around 250 species of insects and mites have been reported to infest different citrus varieties in India (Wadhi and Batra, 1964). Major citrus pests include citrus psylla, blackflies, whiteflies, thrips, leaf miners, scales, bark eating caterpillars, fruit-sucking moths, fruit flies, mites etc. (Ahuja and Chattopadhyay, 2015).

Citrus Psylla, *Diaphorina citrii*, Citrus blackfly, *Aleurocanthus woglumi* and Citrus whitefly, *Dialeurodes citri* suck the sap from newly developed leaves, delicate shoots, and flowers, curling their edges and causing dieback and defoliation (Lima *et al.,* 2018). Citrus thrips, *Scirtothrips citri* and mites, *Brevipalpus phoenicis* are known to cause rind disorder and lowers the market value (Kaur *et al.,* 2020). Information regarding the population dynamics of each pest in a specific ecological niche should be taken into account for designing of an eco-friendly pest management programme. Site-specific research is even more crucial because it is well known that weather variability has a substantial impact on the dynamics of pest populations. That is the reason why this current study was carried out to investigate the population dynamics of sucking pests of orange pests in which we compiled a list of sucking pests that are affecting orange trees in Maharashtra based on study carried out from 2012 to 2022. This is a step toward examining the abundance of sucking pest fauna in orange as well as their seasonal occurrence in order to develop effective mitigation strategies against these pests and thereby enhance the citrus fruit production.

MATERIALS AND METHODS

Operational Plan of Pest Surveillance

The investigation was carried out during the crop-growing seasons from 2012 to 2022. The pest surveillance programme was implemented in the four districts of

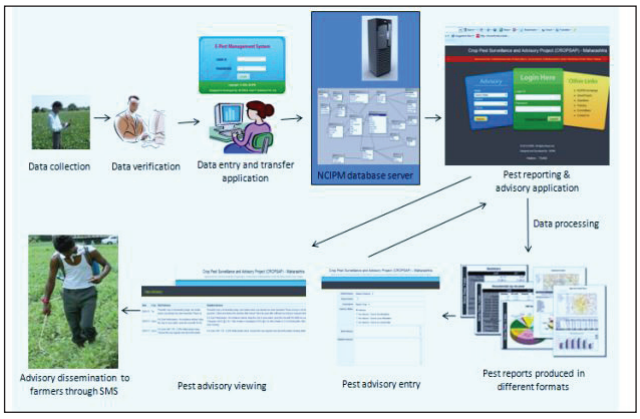

Fig. 2. Structure of ICT-based pest surveillance

Maharashtra, namely Akola, Amaravati, Buldhana, Nagpur, Vardha and Washim (Fig. 1) and it was made possible through the use of information technology, which aided in the development of an e- pest surveillance programme by recording pest activity data with the assistance of scouts and pest monitors employed by the Department of Horticulture, Govt. of Maharashtra.

Selection of orchards and trees

Two fixed orchards were chosen by a scout and in each orchard, 4 trees were examined by picking one tree from each direction viz., East (E), South(S), West (W) and North (N). The orchard with at least one acre was selected for observation in a fixed survey (Ahuja and Chattopadhyay, 2015).

ICT based pest surveillance

A three-tier architecture-based system was developed consisting of three functional components viz., a mobile app for data collection, a central database and a web-based pest reporting and advisory application. The structure and arrangement of components of the system is shown in Fig. 2. This system was developed in consideration of the challenges of pest surveillance and internet connectivity in remote areas of the state. The pest scouts were trained to capture pest observations from farmers' fields through mobile app. The app had the inbuilt ability to automatically sync the gathered

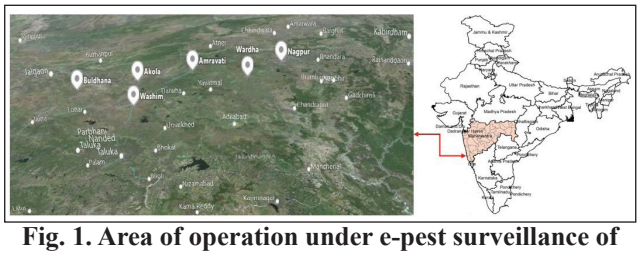

Fig. 1. Area of operation under e-pest surveillance of Orange in the state of Maharashtra, India

data to the central database maintained at the National Research Centre for Integrated pest management, New Delhi as and when the device entered an area with an internet connection. Data formats were devised for pest surveillance in consultation with crop experts to record pest observations from the fields. Location details of the field and insect pests information were major components of these data formats which were incorporated in the mobile app. Each field was assigned a unique ID and its geo-spatial coordinates were also recorded by the mobile app while capturing pest information from the field. SQL 2012, ASP.net, Android Studio and XML technologies were used to create the system (Ahuja and Chattopadhyay 2015).

Method of observations in monitoring

Weekly observations of the number of citrus psylla (nymphs and adults) per 10 cm shoot were recorded on four selected shoots per tree in each selected orchard. Similarly, number of whiteflies and blackflies (both nymphs and adults) per 10 leaves per tree were recorded weekly, whereas the total number of leaves observed are 40 per orchard while in recording the observations of the thrips population, one terminal branch was selected and each selected branch was tapped and the number of thrips fallen were recorded. A total of 4 branches were tapped from each tree and there was a total of 16 branches from an orchard are observed for documenting the data. For monitoring the mite population, the total number of infested leaves/fruits per 20 leaves/fruits per tree was examined and recorded where the total number of observed leaves/fruit is 80 per orchard (Ahuja and Chattopadhyay, 2015).

Statistical analysis

Statistical analysis was done by using the seasonal incidence data of sucking pests in orange obtained during the study period from 2012 to 2022. The data generated was subjected to analysis of variance (ANOVA) and the statistical procedures were performed using the R programme. Figures for the percentage of total infestation and mean seasonal abundance were graphically drawn using Google Colab by exploring the Matplotlib library of the Python program.

RESULTS AND DISCUSSION

Trends in Seasonal incidence of citrus psylla: The results revealed a significant difference with September having the highest infestation of psylla (19.17 psylla per tree) followed by October (12.71 psylla). The August month had 9.01 psylla per tree while the November had 9.45 psylla per tree. There were no significant differences

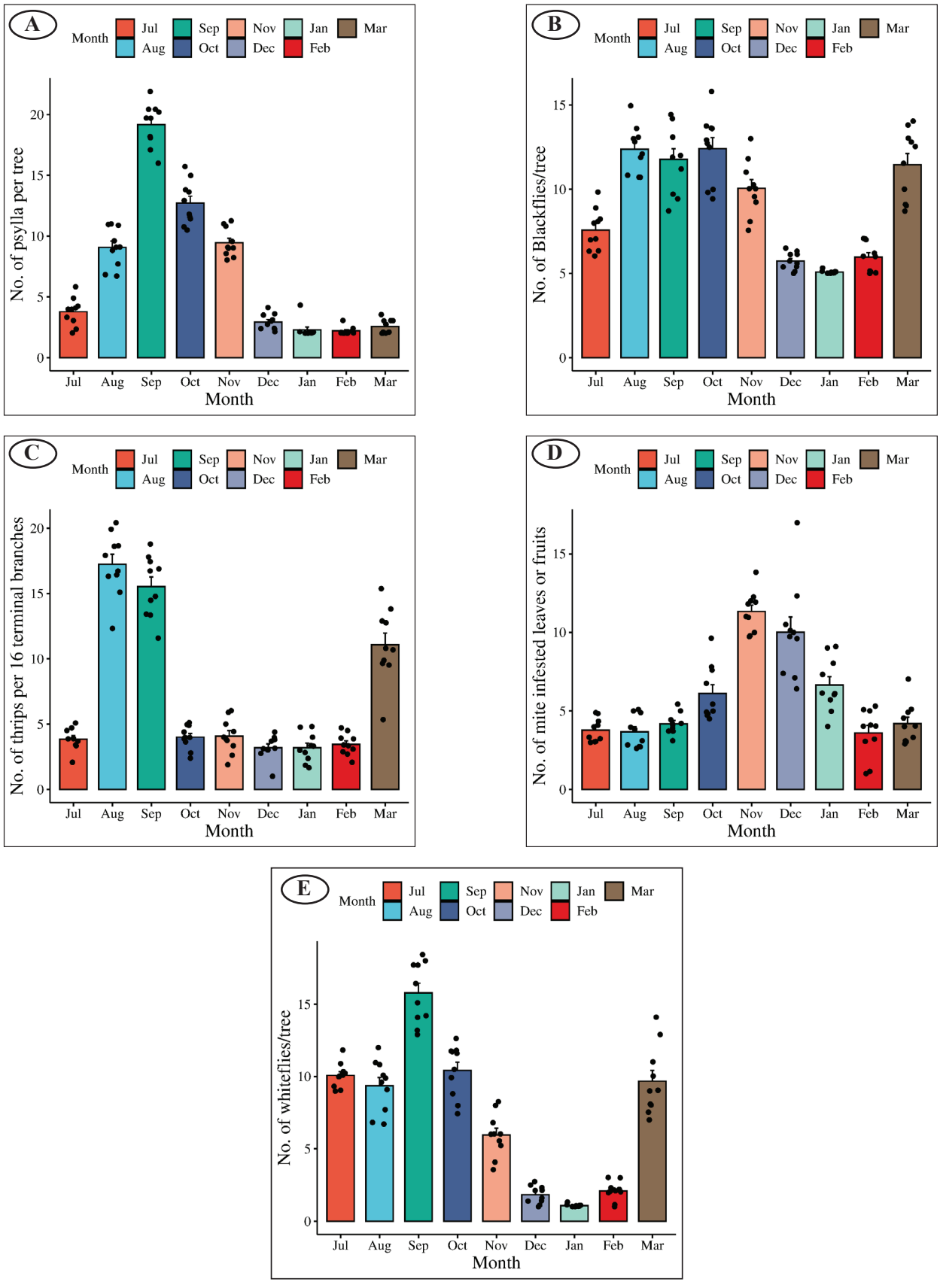

Fig. 3. Seasonal incidence of sucking pests in the studied Orange orchards from 2012 to 2022. (A) Psylla, (B) Blackfly, (C) Thrips, (D) Mites, (E) Whiteflies

Table 1. Trends in Seasonal incidence of insect pests in a particular month of orange growing seasons of the years from 2012 to 2022 in the state of Maharashtra, India

Month	Psylla	Blackfly	Thrips	Mites	Whiteflies
July	3.775 d	7.575 c	3.848 c	3.775 d	10.075 b
August	9.071 c	12.37 a	17.24 a	3.671 d	9.371 b
September	19.17 a	11.77 ab	15.52 b	4.176 cd	15.776 a
October	12.71 b	12.41 a	4.000 c	6.116 bc	10.416 b
November	9.457 c	10.05 b	4.078 c	11.33 a	5.957 c
December	2.933 d	5.733 cd	3.192 c	10.01 a	1.833 d
January	2.282 d	5.082 d	3.194 c	6.642 b	1.082 d
February	2.204 d	5.964 d	3.448 c	3.594 d	2.084 d
March	2.559 d	11.45 ab	11.07 b	4.195 cd	9.675 b

Note: Means in the same row followed by the same letters are not significantly different (P > 0.05) using the Shapiro-Wilk normality test

in other months of the study years (Fig. 3A and Table 1). Our results are consistent with previous reports where psylla peaked in September at 8.1 per 5 cm branch and then dropped to 0.1 per 5 cm branch in February. Psylla populations were higher during the rainy season and lower during the post-rainy and winter seasons (Krishna Kumar *et al.,* 2021). Furthermore, oranges have been shown to have their highest populations between September and November (Chatterjee *et al.,* 2000) while in orange the population peaked in September and November and then began to decline in December and January (Sahu and Mandal, 1997).

Trends in Seasonal incidence of citrus blackfly: The blackflies were observed with seasonal activity started in July and lasting until October with its activity peaking again in March. October had the highest infestation (12.41 blackflies per tree) followed by August (12.37 blackflies). In September, there were 11.77 blackflies per tree and in March, there were 11.45 blackflies per tree. There were no significant differences found in other months of the study years (Fig. 3B and Table 1). Our results were consistent with previous reports where infestations peaked in August and then declined in September. In addition, the population increased in October and decreased in November (Krishna Kumar *et al.,* 2021). Blackfly numbers increased rapidly between July and September along with relative humidity and precipitation (Chatterjee *et al.,* 2000) while peak populations of blackflies occurred in June, July and October (Poovizhiraja *et al.,* 2019).

Trends in Seasonal incidence of citrus thrips: The results revealed a significant difference between the thrips and the highest infestation observed in August (17.24 thrips per 16 terminal branches) followed by September (15.52 thrips) and March (11.07 thrips). There were no significant differences found in other months of the study years (Fig. 3C and Table 1). Several previous studies obtained the same results with activity noted in the first week of March and continuing through the last week of May. The population shows an increasing trend with increasing temperature (Kaur *et al.,* 2020) and constant peaks have been observed between March and April (Sharma *et al.,* 2007).

Trends in Seasonal incidence of citrus mite: The incidence data of citrus mite revealed that November had the highest infestation (11.33 mite-infested leaves and fruits per 20 leaves or fruit) followed by December (10.01). No significant infestation was detected during the remaining months of the study years (Fig. 3D and Table 1). The current results agreed with those of Kaur *et al.* (2020) who reported that citrus mite emergence started from May but peak infestations were recorded in November and December. Bhullar *et al.* (2015) documented the prevalence of citrus mite from November to February.

Trends in Seasonal incidence of citrus whiteflies: The data showed that whitefly activity started in July (10.07 whiteflies per tree) and continued to increase in August (9.3 whiteflies) but the highest infestation was recorded in September (15.77/tree) followed by October (10.41/tree). Infestation decreased in winter and increased sharply again in March (9.6/tree) (Fig. 3E and Table 1). Similarly, whiteflies showed their high percentage frequency in September (23.8%), followed by October (15.7%) and again in March (14.6%) (Fig. 4E). Similar past carried-out investigations showed two peaks, first in March-April and then again in September-October (Kumar *et al.* 2001). Citrus whiteflies were more

prevalent in the first week of January, second week of March and October (Lekurwale *et al.,* 2017).

In conclusion, It is crucial to have a thorough understanding of the population dynamics and damage potential of sucking pests of orange in order to develop appropriate management techniques. Although similar studies have been conducted earlier, this is the first of its kind including continuous pest monitoring from 2012 to 2022. The present findings on population dynamics have far-reaching implications for pest management in orange orchards.

REFERENCES

Ahuja, D. B. and Chattopadhyay, C. 2015. Pests of Fruit Trees (Citrus, Banana, Mango, Pomegranate and Sapota) E-Pest Surveillance and Pest Management Advisory. ICAR-National Research Centre for Integrated Pest Management, New Delhi and State Department of Horticulture, Pune (Maharashtra): 124

Bhullar, M., Sharma, R. and Kaur, P. 2015. Bulletin on mites infesting agri-horticultural crops in Punjab and their management. AINP on Agricultural Acarology, PAU, Ludhiana: 1-29.

Chatterjee, H., Jaydeb, G. and Senapathi, S. 2000. Influence of important weather parameter on population fluctuations of major insect pests of mandarin orange at Darjeeling district of West Bengal. *Journal of Entomological Research,* **24**(3): 229-233.

FAO. 2020. Citrus fruit fresh and processed Statistical bulletin.

Kaur, R., Bhullar, M., Sharma, D. and Kaur, P. 2020. Seasonal abundance and effect of Thrips and Mites damage on fruit quality characteristics of Kinnow. *Journal of Entomology and Zoology Studies*, **8**: 1327-35.

Krishna Kumar, S., Balasubramanian, P. and Rajesh, T. 2021. Seasonal incidence of insect pests on Khasi mandarin in East Khasi Hills districts of Meghalaya. *Journal of Entomology and Zoology Studies,* **9**(2): 103-109.

Kumar, R. 2001. Management of citrus whitefly, *Dialeurodes citri*. M.Sc. (Agric.) Thesis. Punjab Agricultural University, Ludhiana, Punjab.

Lekurwale, R. and Kadam, D. 2017. Seasonal incidence and management of citrus whitefly (*Dialeurodes citri*). *Pesticide Research Journal,* **29**(1): 75-81.

Lima, B., Almeida, J., Moreira, J. and Bittencourt, M. 2018. Entomopathogenic fungi associated with citrus blackfly (*Aleurocanthus woglumi*) in Southern Bahia. *Arquivos do Instituto Biologico,* **84**: 91-98.

Moore G. A. 2001. Oranges and lemons: clues to the taxonomy of Citrus from molecular markers. *Trends in Genetics*, **17**(9): 536-540.

National Horticulture Board Statistics (NHB). 2020.

Poovizhiraja, B., Chinniah, C., Murugan, M. and Balamohan, T. 2019. Population dynamics and seasonal incidence of major sucking pests of acid lime. *International Journal of Current Microbiology and Applied Sciences,* **8**(5): 386-393.

Rathod, A., Shah, K., Kotak, J. and Talaviya, J. 2020. Population dynamics of leaf miner, *Phyllocnistis citrella* infesting sweet orange. *Journal of Entomology and Zoology Studies,* **8**(3): 1519-1521.

Sahu, S. and Mandal, S. 1997. Population fluctuation of citrus psylla, *Diaphorina citri*. *Journal of Interacademicia,* **1**:329-332.

Sharma, D. 2007. Activity and control of citrus thrips, *Scirtothrips citri* on Kinnow. *Agricultural Research Journal*, 44: 59-62.

Sharma, P., Singh, N., Bhardwaj, A., Vennila, S., Bhagat, S. and Kumar, K. 2014. ICT based pest management system for sustainable pulse production: case study. In Sustainable Practices: Concepts, Methodologies, Tools, and Applications: 566-580.

Wadhi, S. and Batra H. 1964. Pests of tropical and sub-tropical fruit trees. In: Entomology in India. *Indian Journal of Entomology*: 227-260.

MS Received: 09 May 2023
MS Accepted: 11 June 2023