Indian Journal of Entomology Online published Ref. No. e24354 DoI. No.: 10.55446/IJE.2024.1354

E-PEST SURVEILLANCE FOR ASSESSMENT OF SEASONAL OCCURRENCE OF ORANGE PESTS IN MAHARASHTRA

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ABSTRACT

Monitoring of incidence and intensity of pests over the crop season is crucial for effective pest management. ICT (Information and communication technology) not only enables the assimilation of pest databases over space and time, but also aids in the rapid processing of data to make pest management decisions using the available knowledge base and essential inputs that can be mobilised and adopted for plant protection on wide area basis. This study generated valuable data on the population dynamics of orange pests 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. The study on the seasonal incidence revealed bark eating caterpillar *Inderbela* sp. having their peak infestation during September and October whereas January to March were observed as prime months for fruit sucking moths *Othreis* sps to reach their peak prevalence and damage. The citrus leaf miner *Phyllocnistis citrella* population dynamics showed two peaks in August and September. The data generated in this study would help in the forecast of the pests and helpful in devising an effective IPM strategy.

Key words: Pest surveillance, seasonal incidence, monitoring, crop season, plant protection, population dynamics, peak infestation, damage, forecast, pest management, *Inderbela*, *Othreis*, *Phyllocnistis*

Citrus contains many of the world's most important fruit crops (Dugo and Di Giacomo, 2002). 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 (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). *Phyllocnistis citrella* is a serious insect pest that causes significant damage to citrus orchards and seasonal occurrence indicated that citrus miners were active throughout the year (Prabhudev et al., 2021). *Othreis* spp. (*Eudocima*) are pests of Indian fruit crops and these moths feed on citrus, orange and pomegranate in Maharashtra (Shendge and Chavan, 2019). *Inderbela* sp. found to infest citrus, litchi, mango and guava and many other plant hosts. Nagpur Mandarin recorded higher (62.4%) infestation of the bark caterpillars under unmanaged conditions (Shivankar and Rao, 2004). Information regarding the population dynamics of pest in a specific ecological niche should be taken into account for designing of an ecofriendly IPM. 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 orange pests which compiled the damage from 2012 to 2022. This is a step toward examining the intensity of damage over seasonal months 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

The investigation was carried out during seasons from 2012 to 2022. The pest surveillance programme was implemented in four districts of Maharashtra, namely Akola, Amaravati, Buldhana, Nagpur, Vardha and Washim using 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.

Two fixed orchards were chosen by a scout and in each orchard four 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).

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. 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 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 geospatial 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).

For the leaf miner, weekly observations of the number of leaves mined/ 5 leaves/ tree were documented. Similarly, 10 spots were selected by moving diagonally across the field and collected all the dropped fruits which were further examined for fruit damage by fruit-sucking moths on the basis of punctured fruits at each location. Counting the number of infested trees caused by the bark eating caterpillar was done by assessing the 25 trees at random (Ahuja and Chattopadhyay, 2015). Statistical analysis was done using the seasonal incidence data obtained during 2012 to 2022. The data generated was subjected to ANOVA using the R programme.

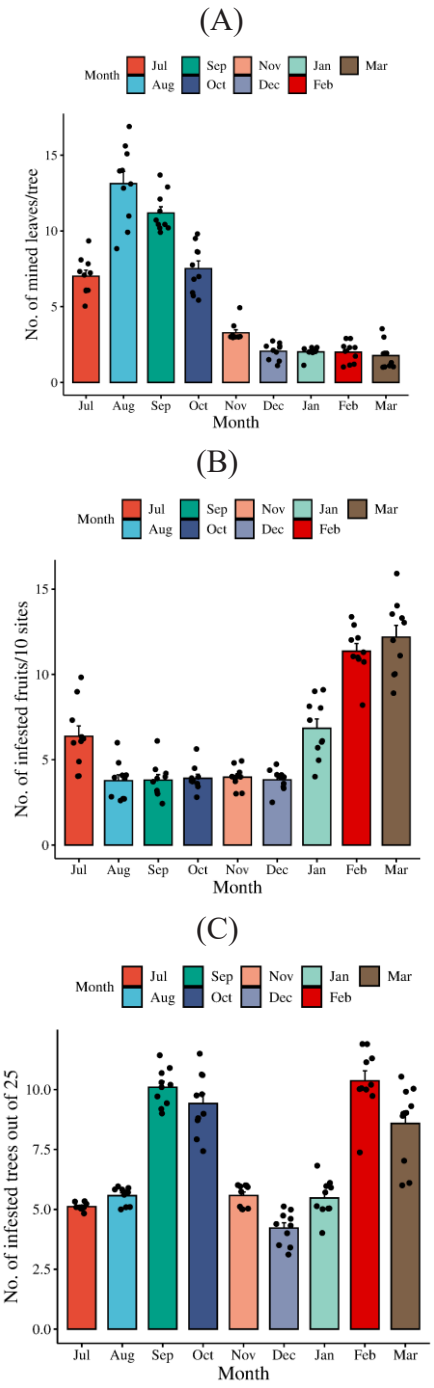
RESULTS AND DISCUSSION

Results revealed that during August highest miner infestation was observed (13.11 leaves mined/ tree) followed by September (11.18 mined leaves). In July, there were 7.01 mined leaves/ tree while in October, there were 7.51 mined leaves/ tree (Fig. 1A). In terms of incidence, the seasonal activity of miners was found highest in August (26.3%), followed by September (22.4%) (Fig. 2A). Similar results have also been reported where miner infestation was relatively higher in September (Rathod, 2020), while in Maharashtra the miner peaked in September, October, November and January (Prabhudev et al., 2021; Krishna Kumar et al., 2021). Mafi and Ohbayashi (2004) observed two peaks in July and October as well as March and October. For fruit sucking moths March had the highest infestation (12.18 infested fruits/ 10 sites) followed by February (11.36 infested fruits). There was a significant moth infestation in January and July with 6.84 and 6.37 infested fruits, respectively (Fig. 1B). Observed incidence of moths was maximum in March (21.7%), February (20.3%) and January (12.2%) (Fig. 2B). Previous findings also reported the presence of moths throughout the year. Moth activity peaked in May and June but declined from September to February (Leong and Kueh, 2011). During the rainy season, *O. fullonica* populations are significantly larger (Ngampongsai et al., 2005) whereas large numbers of *O. coronata* were caught between March and June (Boonyrat et al., 1986).

Incidence in February had the highest infestation of bark-eating caterpillars (10.36 infested trees/ 25 trees). There was a significant infestation in September followed by October (Fig. 1C). Observed incidence of caterpillars was highest in February (16.1%), followed by September (15.7%) and October and 14.6% (Fig. 2C). Previously results showed 52.9% caterpillar infestation (Thakur et al., 2012) and up to 76% infestation in Maharashtra (Rao and George, 2018). The larval population of *I. quadrinotata* has three peaks, which have been documented in February, August and November (Sasidharan and Varma, 2008) with September to October being the most active period (Sunita and Rajesh, 2017). Thus, it is crucial to have a thorough understanding of the population dynamics and damage potential of orange pests in order to develop appropriate management techniques.

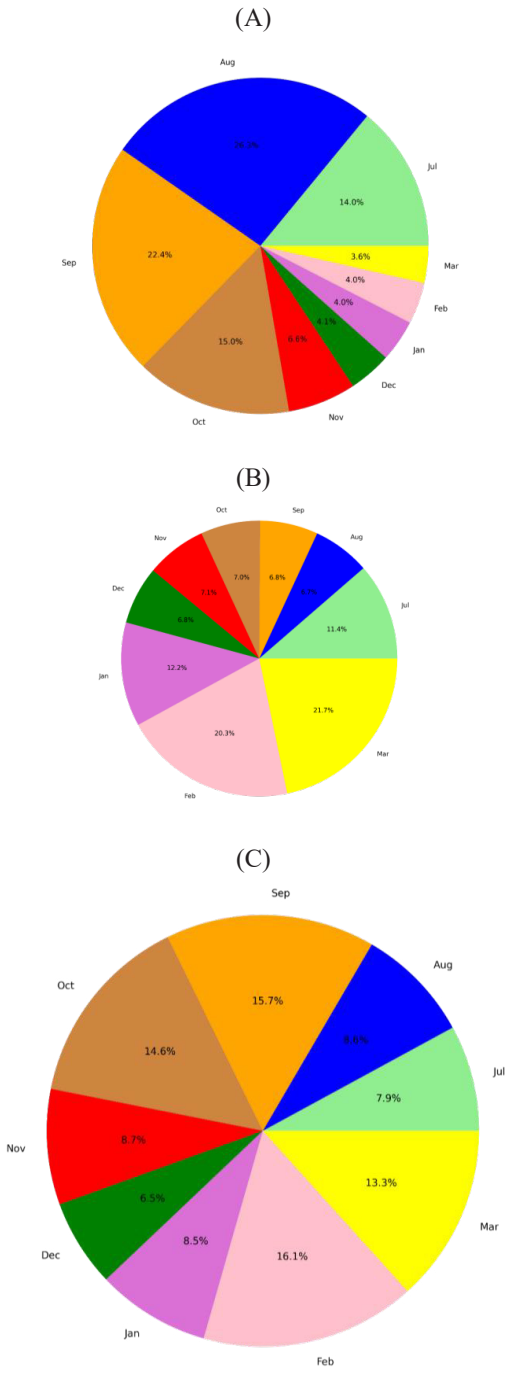
ACKNOWLEDGEMENTS

This research work was supported by the grants from Commissionerate of Agriculture and the Deputy Director of Horticulture, Government of Maharashtra, India under the Horticulture Pest Surveillance and Advisory Project (HORTSAP). The authors acknowledge the support from the faculty and technical staff of ICAR-CCRI Nagpur, BSKKV Dapoli, MPKV Rahuri, VNMKV Parbhani and PDKV Akola, Maharashtra. The authors thank all the pest scouts, data



(A) Leaf miner, (B) Fruit sucking moths, (C) Bark eating caterpillar

Fig. 1. Seasonal incidence of insect pests (2012 to 2022)



(A) Leaf miner, (B) Fruit sucking moths, (C) Bark eating caterpillar

Fig. 2. Incidence (seasonal activity) and damage due to pests (Orange orchards 2012 to 2022)

entry operators, research scholars, skilled and unskilled staff who participated in this study.

FINANCIAL SUPPORT

No funding received.

AUTHOR CONTRIBUTION STATEMENT

Project administration, conceptualization, methodology, investigation by Niranjan Singh and Devaramane Raghavendra; formal analysis, preparation of original draft, writing review and editing by K.B. Ramesh, Niranjan Singh, Devaramane Raghavendra, and Subhash Chander; All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

No conflict of interest.

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(Manuscript Received: June, 2023; Revised: January, 2024;
Accepted: March, 2023; Online Published: April, 2024)
Online First in www.entosocindia.org and indianentomology.org Ref. No. e24354