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SEASONAL INCIDENCE OF RUSTY THRIPS *CHAETANOPHOTHRIPS SIGNIPENNIS* WITH APPLIED ICT-BASED PEST SURVEILLANCE IN BANANA

Niranjan Singh[1], Devaramane Raghavendra[1]*, K B Ramesh[2] and Subhash Chander[1]

[1]ICAR-National Research Centre for Integrated Pest Management, New Delhi 110012, India
[2]ICAR-Indian Institute of Vegetable Research, RRS, Sargatia 274406, Uttar Pradesh, India
*Email: d.raghvendra@icar.gov.in (corresponding author): ORCID ID 0000-0002-2571-024X

ABSTRACT

Under the study, pest surveillance with applied ICT in Banana (*Musa* sp.) was carried out to assess seasonal activity and damage due to rusty thrips *Chaetanophothrips signipennis* (Bagnall) from 2012-2022. Wide-area pest surveillance was carried out in major banana growing areas of Maharashtra, using ICT tools for the timely and correct observation of pest activity. The ten seasonal year's data on the rusty thrips monitoring revealed that August and September are the peak months for severe incidence. The results documented that, September is the plausible month for peak incidence with fruit damage ranging from 26-50%. Heatmap, cluster dendrogram and principle component analysis also confirm the severity of thrips during August and September. The initiation of management options before the onset of August and September may greatly help the farming community.

Key words: *Musa* sp., wide-area pest surveillance, ICT tools, rusty thrips, *Chaetanophothrips signipennis*, fruit damage, heatmap, IPM, seasonal incidence, activity

The domestication of banana originated mostly in Southeast Asia. The banana (*Musa acuminata*) is one of the world's most important starch crops. India is the world's leading banana producer, accounting for one third of total banana production followed by China, Philippines, Brazil and Ecuador (FAO, 2022). Farmers in India and other western, central, eastern and coastal regions of Asia are sustained by the banana industry and it is typically grown by small-scale farmers in India (Padmanaban and Mustaffa, 2010). Globally, the interventions of diseases, insects and animals have significant negative impact on banana production, decreasing both the quality and quantity of fruits produced (Blomme et al., 2020). Insect pests have escalated into a major problem which hinders the ability of banana crop to provide better profit (Dar and Mir, 2016). Maintaining high quality of fruits is a top concern for producers considering the current situation of increased productivity in banana.

The quality and quantity of banana are constrained by the attack of various insect pests, mites, nematodes and diseases. Nearly 57 insect pests and mites were reported to infest banana and plantains in India (https://nrcb.icar.gov.in/album/). A red rust thrips, *Chaetanophothrips signipennis* (Bagnall) (Thripidae: Thysanoptera affects the aesthetic value of fruits and thereby lowers the selling prices at the wholesale and retail markets. Rust thrips infestation does not reduce banana yield but reduces fruit quality, resulting in lower market value (Padmanaban and Mustaffa, 2010; Bisane et al., 2018). Banana, anthurium and dracaena are the primary hosts for rust thrips, though they have also been observed to infest immature orange fruits, mandarin, peas and tomato (Hara et al., 2002). Asia is reported to have a diverse distribution of rust thrips, mainly in India, Indonesia, Sri Lanka, Java and the Philippines. The countries viz., Brazil, Honduras, Costa Rica, West Indies, Trinidad, Tobago, Puerto Rico USA, Panama, Oceania, New Guinea, Australia and South Wales in the western hemisphere also have infestation records (Schotman, 1989).

ICT deployed pest surveillance system not only brings the necessary convergence in measuring pests for a fair comparison, but also tends to make the pest scenario understood in real time for rapid recommendations of need based pest management via advisory alerts. (Vennila et al., 2014). In order to comprehend changing pest scenarios, ICT will continue to play a significant role in understanding the influence of climate changes on crop-pest interactions and formulation of crop protection forecasts and policies. The correct identification of pests and a basic understanding of them are necessary for managing crop loss. Empowerment of the local farming community to control pest issues on banana plantations at the early stages of attack may stop the spreading of pests to other

areas. The annual and seasonal incidence of rusty thrips was examined in the current study to determine changes in their trends of occurrence and prevalence.

MATERIALS AND METHODS

Extensive surveys were carried out in every Maharashtra region that grows banana where the growing seasons from 2012 to 2022 served as the timeframe. Pest monitoring has been put into place in four Maharashtra districts: Hingoli, Jalgaon, Nanded, and Solapur. Information technology enabled the development of e-pest surveillance by gathering information on pest activity through the use of scouts and pest monitors waged by the Government of Maharashtra. 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. Pest experts from State agencies viewed the pest reports generated by web based reporting and advisory application for the data recorded and submitted the appropriate decisions of pest management into to the system. SQL 2012, ASP. net, Android Studio and XML technologies were used to create the system (Ahuja and Chattopadhyay, 2015).

In the process of orchard selection, two fixed orchards were chosen by one scout. Twenty plants in the shoot stage were chosen and examined for rusty thrips damage on the developing fingers. Observations were made on three hands in each bunch, one on each of the top, middle, and bottom hands. On each hand, ten fingers were scored at random. Thrips damage was measured on a scale of 1-5 by the extent of the damage. Thrips Score scale: 1= Healthy, 2=1 to 25% of fruit damage, 3=26 to 50% of fruit damage, 4=51 to 75% of fruit damage, 5=76% and above of fruit damage (Ahuja and Chattopadhyay, 2015). Statistical analysis was done by using the seasonal incidence of banana rusty thrips obtained during the study from 2012 to 2022. Data were analysed by one-way ANOVA and the statistical procedures were performed using the R programme. Line graphs and pie charts were drawn using Google Colab by exploring the Matplotlib library of the Python program. Heatmap, cluster dendrogram and principal coordinate analysis were plotted using R software (ver. 4.2.2) to visualize the seasonal incidence over 2012 to 2022.

RESULTS AND DISCUSSION

The seasonal incidence of one or more months under the current investigating years from 2012 to 2022 were found to be not the same. Hence Shapiro-Wilk normality test was carried out and the results of ANOVA showed significant difference among the thrips that infested banana. The data revealed that the highest infestation was during September with a thrips score scale of 3 (26-50% of fruits damaged) followed by August with a scale of thrips 2 (1 to 25% of fruits damaged) (Fig. 1A; Table 1). The Seasonal activity and damage of rusty thrips in terms of percentage infestation observed to be highest in the month of September (37.6%) followed by August (26.2%) (Fig. 1B). The Heatmap depicts the highest infestation of thrips in the month of August and September by forming closely set patches of blue and violet colour respectively for all the years under study (Fig. 2). August and September months together grouped in a single clade upon cluster dendrogram and their by signifies highest infestation of thrips (Fig. 3). Principle coordinate analysis also revealed that the seasonal occurrence and damage due to thrips was more during August and September compared to other months under study (Fig. 4).

A key component of effective IPM is pest monitoring. Although monitoring is an easy process, it must be carried out regularly with the right procedures. The current investigation was carried out for monitoring the seasonal activity and damage due to banana rusty thrips. The data of the ten cropping seasons under rusty thrips monitoring revealed that August (1-25%) and September (26-50%) are the peak months for severe incidence. These results are consistent with previous study involving three-year investigation on surveillance of red rust thrips by a team of researchers from All India Coordinated Research Project on Tropical Fruits which revealed peak damage during August. The infestation displayed up to 30% of symptoms from August to November in 2009-11 and up to 35% of symptoms were recorded in August as well as October at fruit bearing stage at Jalgaon, Maharashtra (Anonymous, 2011). The present findings on thrips incidence are supported by a report from the Fruit Research Station in Gandevi, India, which shows that fruit damage caused by rusty thrips started in June and continued until October. The higher fruit damage reported in September during the fruiting

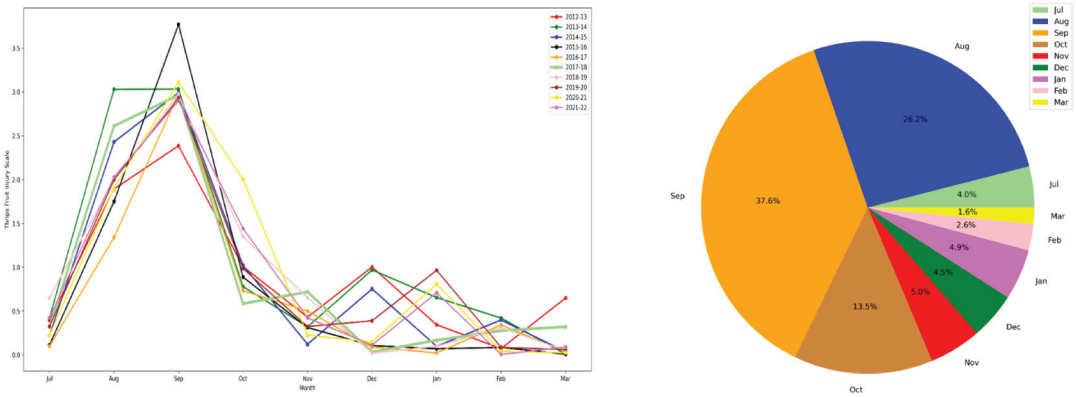

Fig. 1. A-B Seasonal activity and damage of rusty thrips in banana (2012-2022)

Table 1. Seasonal incidence of banana rusty thrips (2012-2022; Maharashtra, India)

S. No.	Month	Mean of seasonal incidence (score scale)
1	July	0.3196[d]
2	August	2.0981[b]
3	September	3.0044[a]
4	October	1.0797[c]
5	November	0.4034[d]
6	December	0.3629[d]
7	January	0.3944[d]
8	February	0.2042[d]
9	March	0.1286[d]

Means in same row followed by same letters not significantly different ($p > 0.05$; Shapiro-Wilk normality test)

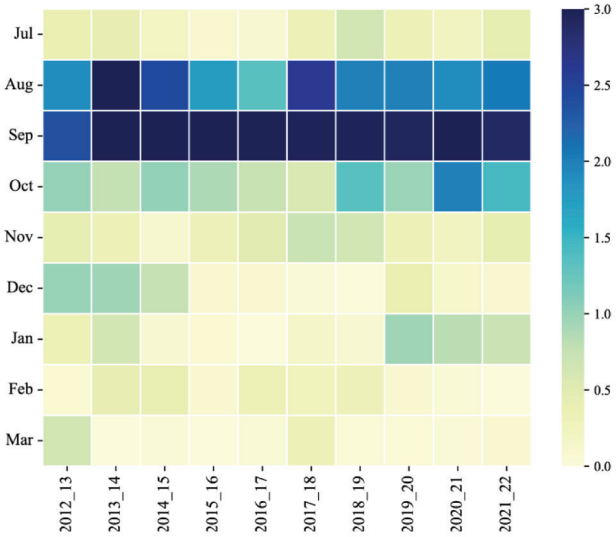

Fig. 2. Heatmap depicting the seasonal activity (2012-2022)

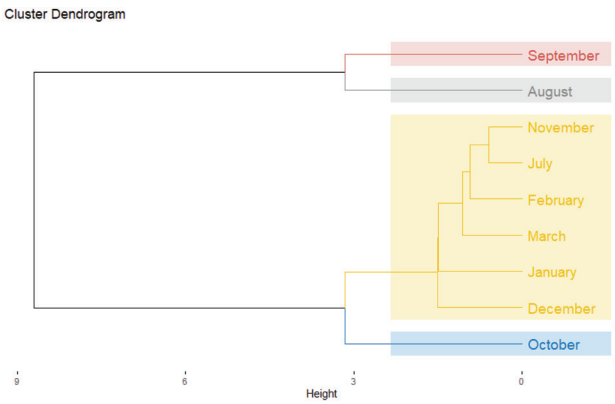

Fig. 3. Cluster dendrogram depicting seasonal activity and damage (2012-2022)

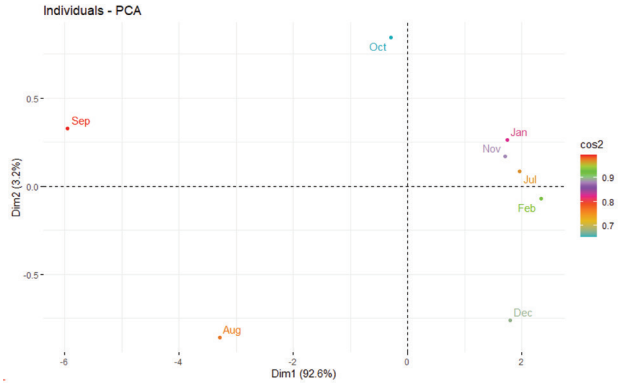

Fig. 4. Principal component analysis seasonal activity and damage (2012-2022)

stage ranges from 11.32%-13.39% (Anonymous, 2015). On the other hand, Padmanaban and Mustaffa (2010) reported the peak damage during June as well as July in Tamil Nadu. However, in the Piura region of Peru, this pest has a seasonal nature and the high temperatures from December to March contribute to its development (Manrique-Silupu et al., 2021).

A recent survey reported that rust and flower thrips were emerging pests in few pockets of Surat and Navsari. There was decrease in fruit infestation due to rust thrips with minor variation of damage recorded on cv. Grand Naine. The maximum incidence was reported in Surat district (19.3%), while minimum in Anand

district (6.2%). Other districts like Navsari (15.6%), Bharuch (12.7%), Narmada (10.6%), Valsad (7.2%) and Vadodara (7.0%) also showed symptoms during August and September and the symptoms observed on mature fruits (Anonymous, 2021). Similarly, the blemished fruits due to rust thrips infestation was noticed in surveyed parts of Surat at maturity stage of fruits (Anonymous, 2020), whereas 15-20% blemished fruits with increased fruit infestation recorded during 2019 in few villages of Surat, Navsari and Bharuch during August-September (Anonymous, 2019). In conclusion, this study showed seasonal activity and damage by rusty thrips in particular months over the banana growing season in Maharashtra, India. The study unravels the peak incidence periods of rusty thrips. The launch of management options before the onset of August and September for red rust thrips may greatly help the farming community in saving banana crop from rusty thrips.

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AUTHOR CONTRIBUTION STATEMENT

Project administration, funding acquisiton, methodology, investigation, analysis, writing of the manuscript, review and editing of the manuscript (Niranjan Singh, D Raghavendra); Analysis, writing of the manuscript, review and editing of the manuscript (Ramesh K B); Review and editing of the manuscript (Subhash Chandra).

CONFLICT OF INTEREST

No conflict of interest.

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