Original Research Article

Geographic information system to study the spatial distribution of cotton pink bollworm, *Pectinophoragossypiella* (Saunders) (Lepidoptera: Gelichiidae) in Jalgaon district, Maharashtra

Abstract

The present study was undertaken to develop risk assessment maps through Geographic Information System (GIS) which is a very powerful tool to organize and process spatial data, making foundation in decision making. The processing and analysis of surveillance data of incidence of *P. gossypiella* was carried out in 'ArcGIS 10.4' software. Studying the pest population distribution using spatio-temporal maps help us to gain the knowledge regarding the tempo of pest population distribution and correlating the same with different weather parameters will help us to understand the factors affecting the population distribution.

Keywords: Geographic information system, insect populations, *Pectinophoragossypiella*, bollworm

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Introduction:

Cotton provides a livelihood to 6–6.5 million farmers and around 60 million people engaged in cotton-related activities in India(DCD, 2017). The country is bestowed with diverse climatic conditions from the North to the South suitable to grow all four cultivated cotton species, *viz.*, *Gossypium herbaceum*, *G.arboreum*, *G. barbadense*, and *G.hirsutum*(Tenguri*et al.*, 2024). The crop covers an area of 123.87 lakh hectare with 123.87 lakh hectare with 405 kgs/ haof productivity (Anonymous, 2024).Maharashtra secures second place in cotton area with 42.29 lakh hectares and production with 84.09 lakh bales (Anon., 2023).In the world, cotton crop is being infested by 1326 insect species (Hargeaves, 1948) and in India, near about 166 arthropod pest species were recorded (Khan and Rao, 1960). Yield losses due to arthropod pests ranged from 20 – 60% and that of insect pests ranged from 50 – 60% (Puri et al., 1999). The major pests are American bollworm,

Helicoverpaarmigera (Hübner), spotted bollworm, *Erias vittella* (Boisduvel), *E. insulana* (Fab.) and pink bollworm, *Pectinophoragossypiella*(Saunders) and tobacco caterpillar, *Spodoptera litura* (Fabricius) and among these, pink bollworm, *P. gossypiella* is the most destructive pest (Ghosh, 2001).

Worldwide, pink bollworm *P.gossypiella* (Saunders) has become economically the most destructive pest of cotton and has known to cause 2.8 to 61.9 per cent loss in seed cotton yield, 2.1 to 47.1 per cent loss in oil content and 10.7 to 59.2 per cent loss in normal opening of bolls (Patil, 2003). Locule damage was noted to an extent of 55 per cent and 35-90 per cent reduction in seed cotton yield have been reported by Narayanan (1962). Agarwal and Katiyar (1979) estimated the yield loss to an extent of 6525 MT annually. Due to concealed nature, it needs frequent insecticide application with limited control. Among alternative strategies available, wide area pest management became most efficient. To develop efficient wide area pest management strategies, it is essential to understand the population dynamics and spatial distribution of the pest, so that control measures can be focussed at specific sites where population densities are thehighest (Emmen, 2004). Geographic information system (GIS) is a very powerful tool which organizes and process spatial data in order to support decision makers **(**Soberón and Peterson, 2005)**.** Its ability to overlay and analyse multiple spatial data layers provides the opportunity to explore the spatial nature of insect populations. There are several reports that support the utility of GIS in studying the spatial distribution of insects for their effective management (Taylor 1984, Midgarden et al 1993, Fariaset al 2004, Boiteau 2005, Garcia 2006, Sciarretta &Trematerra 2006). Hence, the present study was undertaken to develop risk assessment maps through GIS.

Material and Methods:

The study was carried out in Jalgaon district of Maharashtra over an area of approximately 378 ha. The locations of study area wereJamner and Pachora talukas. The CROPSAP (Crop Pest Surveillance and Advisory Project) application was used to record the level of incidence of pink boll worm. Based on the pest density, incidence was categorized as No incidence (no ETL), low incidence (below ETL), near economic threshold level (near ETL), equal to or more than ETL (≥ ETL). This data was stored in CROPSAP web application. Later the data was retrieved in csv format, filtered and processed for construction of distribution maps. Pest surveillance through CROPSAP was carried out for three consecutive seasons from 2022-23 to 2023-24.

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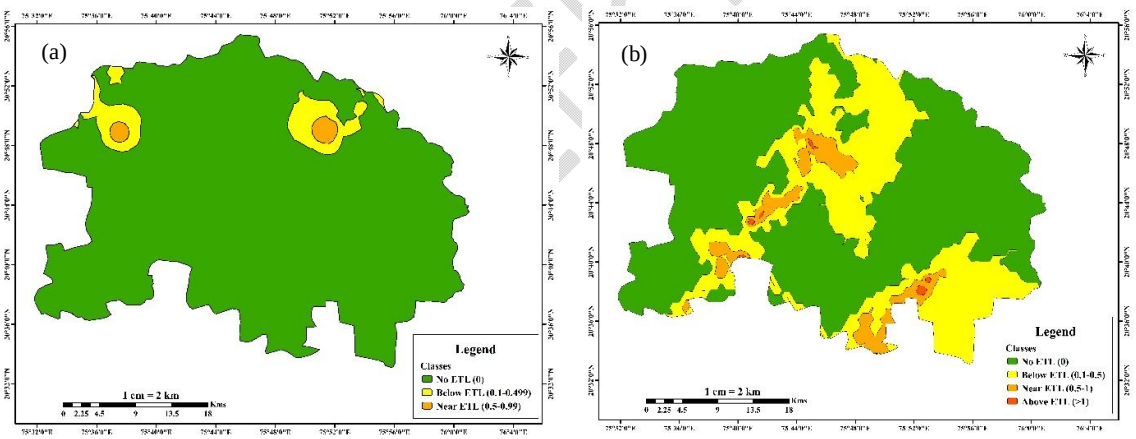
The processing and analysis of surveillance data of *P. gossypiella*was carried out in 'ArcGIS 10.4' software. The data from CROPSAP was added to the GIS environment by 'Add data tool' in the 'ArcGIS' Software. Later, the data sheet was entered into the software with x and y coordinates and Geographic Coordinate System (GCS) 'WGS 1984' was selected. Once the point data were overlaid with the outer boundary, then geostatistical analyst tool was used, in which geostatistical wizard was selected. In geostatistical methods 'kriging' was selected to predict the unsampled locations with known data points. With this kriging method spatial distribution of insect pest map was generated. For the temporal distribution the same method was followed but with different time of incidence. The spatio-temporal distribution maps were generated for two years *viz*., 2022-23 and 2023-24. Distribution maps were constructed to compare the field sample distribution with the distribution maps estimated by kriging. Each sampling point was located and the same colour was used as in the GIS maps. In these maps real values were used.

Results and Discussion:



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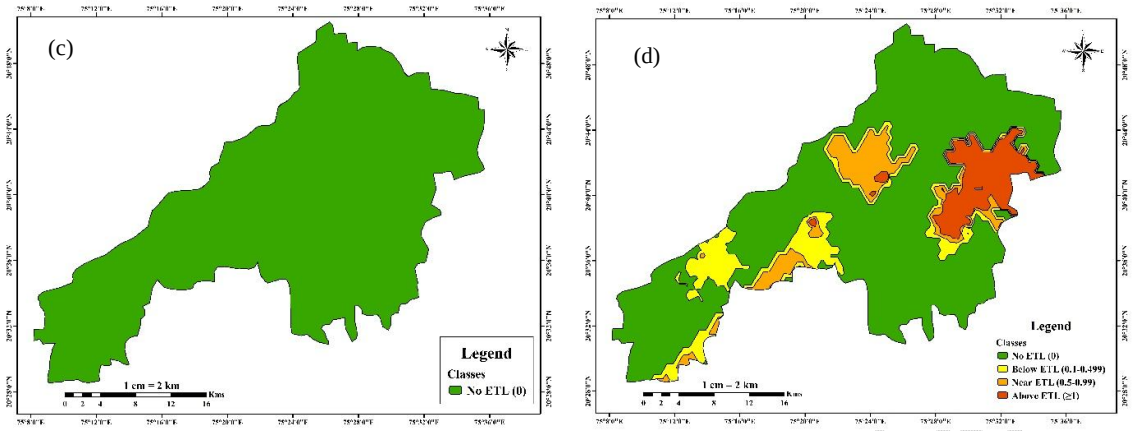

Figure 1. Spatial distribution maps of pink bollworm (*Pectinophoragossypiella*) incidence across two different talukas of Jalgaon district (a) Jamner during 2022-23 (b) Jamner during 2023-24 (c) Pachora during 2022-23 and (d) Pachora during 2023-24

The spatio-temporal maps representing the distribution of *P. gossypiella*indicatedvaried level of incidence across two different years (2022-23 and 2023-24). During 2022-23, the pest was at minimum population in most of the parts of Jamnertaluka and all over Pachorataluka of Jalgaon district (Figure 1a & 1c).However, during 2023-24, greater incidence of *P. gossypiella* on cotton was reported from several villages of Jamnertaluka out of which many of the villages had reported the incidence below ETL. Only few villages recorded the near ETL status and the negligible villages had reported the pest status above ETL (Figure 1b). Even, the Pachora taluka of Jalgaon district recorded the pest incidence to a greater level and many of the villages were found the pest status near and above ETL (Figure 1d). Studying the pest population distribution using spatio-temporal maps help us to gain the knowledge regarding the tempo of pest population distribution and correlating the same with different weather parameters will help us to understand the factors affecting the population distribution (Patil et al., 2017).

Conclusion

The spatio-temporal analysis of *P. gossypiella* population over the two years reveals a notable shift in pest incidence. In 2022-23, the pest population was relatively low in Jamner taluka and across Pachora taluka of Jalgaon district. However, in the subsequent year, 2023-24, there was a marked increase in pest incidence, particularly in several villages of Jamner taluka and throughout Pachora taluka. The incidence levels varied widely, with many villages

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reporting pest levels approaching or exceeding the economic threshold levels (ETL). This shift indicates that factors influencing pest population dynamics, potentially including weather conditions and other environmental parameters, have changed over the period. Further investigation into these correlations is essential for understanding the drivers of pest population changes and for developing targeted management strategies.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

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