

## Original Research Article

### Geographic information system to study the spatial distribution of cotton pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelichidae) in Jalgaon district, Maharashtra

Comment [SA1]: Correct the spelling

#### Abstract

The present study was undertaken to develop risk assessment maps through Geographic Information System IS. Geographic information system (GIS) is which is a very powerful tool to which organizes and process spatial data, making foundation in order to support decision making. Its ability to overlay and analyze multiple spatial data layers provides the opportunity to explore the spatial distribution of 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. The data 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. 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.

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Comment [SA4]: It future utility of the GIS for entomology especially for IPM You need to add  
1 Results of the study  
2 conclusion statement

Keywords: Geographic information system, insect populations, *Pectinophora gossypiella*, bollworm

#### 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*. Add new reference as it repeat of the first reference (DCD, 2017). 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

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pests are American bollworm, *Helicoverpa armigera* (Hübner), spotted bollworm, *Earias vittella* (Boisduvel), *E. insulana* (Fab.) and pink bollworm, *Pectinophora gossypiella* (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 the highest (Emmen, 2004). Geographic information system (GIS) is a very powerful tool which organizes and process spatial data in order to support decision makers. Its ability to overlay and analyze 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.

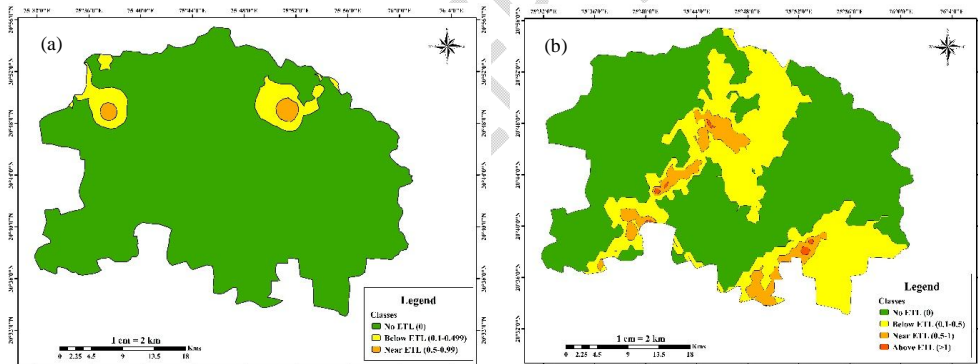
### **Material and Methods:**

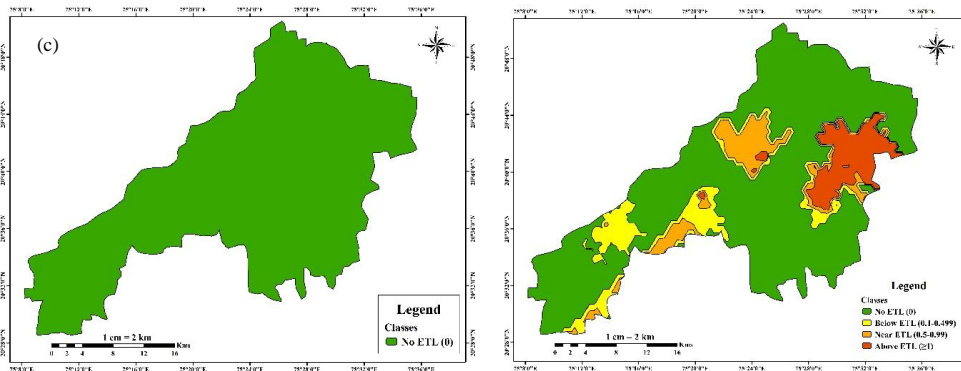
The study was carried out in Jalgaon district of Maharashtra over an area of approximately 378 ha. The locations of study area were Jamner and Pachora talukas. The CROPSAP (Crop Pest Surveillance and Advisory Project) application was used to record the level of incidence of pink boll worm. Based on the 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 ( $\geq$  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. gossypiellaw* 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:





**Figure 1.** Spatial distribution maps of pink boll worm (*Pectinophora gossypiella*) 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* indicated varied 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 Jamner taluka and all over Pachora taluka of Jalgaon district (Figure 1a & 1c). However, during 2023-24, greater incidence of *P. gossypiella* on cotton was reported from several villages of Jamner taluka 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

Using the pest surveillance reports of two years, the spatio-temporal maps were generated for *P. gossypiella* to know the spatial trend of the pest in different time interval for the site-specific pest management. The incidence of the pest was negligible during 2022-23 and but was high during 2023-24 in the both Jamner and Pachora talukas of Jalgaon district.

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Comment [SA9]: Where is the out put of correlation results

Comment [SA10]: Discussion section?

Comment [SA11]: No future prospects should be the part of results

The correlation studies with various weather parameters might help the further study related to the distribution and the factors affecting the distribution.

**Comment [SA12]:** Clearly define a single conclusion statement rather repeating the results

## References:

Agarwal R. A. and Katiyar, K. N. 1979. An estimate of losses of Kapas seed due to bollworms on cotton in India. *Indian Journal of Entomology*, 41(4): 143- 148.

**Comment [SA13]:** Follow the journals guidelines

Anonymous, 2023. Textile data – Ministry of textiles. <https://www.texmin.nic.in/sites/default/files/Annexure-I-%20Cotton%20Production%20and%20consumption%20in%20Major%20countries.pdf>

Anonymous, 2024. Crop Report - Cotton Association of India. 1-9. [60812075be2fd6e9e85b5ce3064df5c2.pdf \(caionline.in\)](https://www.caionline.in/60812075be2fd6e9e85b5ce3064df5c2.pdf).

Boiteau, G. 2005. Within field spatial structure of Colorado potato beetle (Coleoptera: Chrysomelidae) populations in New Brunswick. *Environmental Entomology*, 34: 446-456.

DCD. 2017. Status paper of Indian cotton. Directorate of Cotton Development (DCD), Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare (DAC & FW), Government of India, 1–211, <https://www.nfsm.gov.in/StatusPaper/Cotton2016.pdf>.

Emmen, D. 2004. La agricultura de precision: una alternativa para optimizar los sistemas de produccion. *Invest. Pens. Crít.*, 2: 68-74.

Farias, O. S., Roberto, R., Lopes, J. and Perecin, D. 2004. Geostatistical characterization of the spatial distribution of *Xylella fastidiosa* sharpshooter vectors on citrus. *Neotropical Entomology*, 33: 13-20

Garcia, F. J. M. 2006. Analysis of the spatio-temporal distribution of *H. armigera* (Hub.) in tomato field using a stochastic approach. *Biosystems Engineering*, 93: 253-259

Ghosh, S. K. 2001. GM Crops: Rationally irresistible. *Current Science*, 6: 655-660.

- Hargreaves, H. 1948. List of recorded cotton insects of the world. *Commonwealth Institute of Entomology, London*, 41: 50.
- Khan, Q. and Rao, V.P. 1960. Insects and mites. In: Cotton in India: a monograph. *Indian Central Cotton Committee, Bombay*, 217-301.
- Midgarden, D. G., Youngman, R. R. and Fleischer, S. J. 1993. Spatial analysis of counts of western corn rootworm (Coleoptera: Chrysomelidae) adults on yellow sticky traps in corn: Geo-statistics and dispersion indices. *Environmental Entomology*, 22: 1124-1133.
- Narayanan, E. S. (1962). Biology and method of control of some important insect pests of cotton in India. *Indian Central Cotton Committee Publication, Bombay*, 44.
- Patil, S. B. 2003. Studies on management of cotton pink bollworm, *Pectinophora gossypiella* (Saunders) (Lepidoptera: Gelechiidae). *Ph. D. Thesis (unpublished) submitted to University of Agricultural Sciences, Dharwad (India)*.
- Puri, S.N., Murthy, K.S. and Sharma, O.P. 1999. Integrated pest management for sustainable cotton production. In: Handbook of cotton, Sundaram, V. (Ed.). *Indian Society of Cotton Improvement, CIRCOT, Mumbai*, 233-45.
- Sciarretta, A. and Trematerra, P. 2006. Geostatistical characterization of the spatial distribution of *Grapholitamolesta* and *Anarsialineatella* males in an agricultural landscape. *Journal of Applied Entomology*, 130:73-83.
- Taylor, L. R., 1984. Assessing and interpreting the spatial distributions of insect populations. *Annual Review of Entomology*, 29: 321-357.