



Seasonal incidence of *Deudorix isocrates* on pomegranate during Mrig Bahar in Niphad, Nashik (MS, India)

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Abstract

Pomegranate (*Punica granatum L.*) is an important fruit crop in India. In Maharashtra, Nashik is leading in production, where the Mrig Bahar season (June–July) is vital. However, the pomegranate fruit borer, *Deudorix isocrates*, poses a significant threat, causing yield losses of 40–90% by infesting developing fruits. This study, conducted in Niphad Tehsil of Nashik district, during Mrig Bahar, studied the seasonal incidence of *D. isocrates* in two pomegranate orchards, monitored egg/larvae counts and fruit infestation rates (15–34% in Orchard 1, 12–25% in Orchard 2) across Standard Meteorological Weeks (SMW) 22–48. Weather parameters like temperature (20.1–36.1°C), rainfall (89.8–230 mm), and humidity (74.5–89%) were correlated with infestation levels.

Rainfall and humidity were shown to be significantly associated with a higher infestation, peaking at SMW 31–38 (230 mm rainfall, 82.5% humidity, 34% and 25% infestation), according to Principal Component Analysis (PCA), which showed that the first two components explained 91.4% of the variance. There was a modest negative correlation between temperature and infestation, with higher temperatures indicating less infection. Temperature has a negative influence on infection, whereas rainfall and humidity positively increase it, according to linear regression models for both orchards that obtained an R² of 1.00.

Keywords: Pomegranate, *Deudorix isocrates*, PCA, mrig bahar, seasonal incidence

Introduction

Pomegranate (*Punica granatum L.*) is a highly valued fruit crop with significant economic and medicinal importance (Vilahur & Badimon.). In recent years, its cultivation has gradually increased across India. In 2020–21, approximately 2.78 lakh hectare area was planted with pomegranates, yielding approximately 31.87 lakh metric tons. Maharashtra emerged as the leading producer, contributing 17.48 lakh metric tons from 1.62 lakh hectares. Pomegranate crop is particularly suitable for small-scale farmers in dry and semiarid regions because of its ability to tolerate severe weather conditions.

India is the second largest producer of pomegranate, with significant cultivation occurring in Maharashtra, Gujarat, Karnataka, Rajasthan, and Andhra Pradesh. During the financial year 2023–24, India exported 72,011 metric tons of pomegranates valued at USD 69.08 million to markets including the UAE, Bangladesh, Nepal, the Netherlands, Saudi Arabia, Sri Lanka, Thailand, Bahrain, and Oman (Pomegranate India, 2023) [16]. Within Maharashtra, pomegranate cultivation is concentrated in districts such as Solapur, Nashik, Ahmednagar, Pune, Sangli, Dhule, Latur, Osmanabad, Jalna, Parbhani, Aurangabad, Beed, and Satara. *Deudorix isocrates* is a widely distributed pest in India, affecting pomegranate crop severely in key producing states such as Maharashtra, Gujarat, and Karnataka. It also infests other fruits, including guava, aonla, litchi, peach, pear, ber, and sapota (Cocuzza *et al.* 2016, Balikai, Kotikal, & Prasanna, 2011) [3, 5]. The larvae bore into developing and

matured fruits, fed internally, and made them commercially useless. The pomegranate fruit borer poses a major challenge to production, with estimated yield losses ranging from 40 to 90% (Kumar & Singh, 2023; Bharti, Rana, & Kumar, 2021) [4, 11, 16].

Pomegranate cultivation in Maharashtra follows three fruiting seasons (Bahars) Ambe (January–February), Mrig (June–July), and Hasta (September–October). Among these, Mrig Bahar is particularly significant in Nashik, where *D. isocrates* and other pests are more active, causing considerable damage to fruit development (Jain *et al.*, 2022) [9]. Research indicates that the life cycle of *D. isocrates* lasts approximately 63.92 ± 2.87 days on pomegranates, aligning with the fruiting season and allowing multiple generations to cause damage (Kumar *et al.*, 2017) [13]. Understanding the effects of seasonal and weather conditions on the occurrence of *D. isocrates* is crucial for developing effective pest management strategies (Mallikarjun & Pal., 2022) [14]. Moderate temperature and humidity are ideal conditions for the growth and reproduction of *D. isocrates* (Dewangan & Gupta., 2023) [7]. Weather parameters, such as temperature, humidity, and rainfall, have a significant impact on the life cycle and population dynamics of *D. isocrates*, influencing its incidence and severity (Kumar & Sharma, 2021) [11]. Pomegranate cultivars are widely grown in the Nashik District due to favorable weather conditions and well-drained soil conveniently contribute to the steady growth of pomegranate cultivation. According to the report, Nashik produces 500,000 metric tons of pomegranate annually

(Department of Agriculture, Maharashtra, 2022) [6]. The varieties cultivated are Bhagwa and Ganesh, which have high yields and qualities. The comprehensive data is lacking for the specific context of Mrig Bahar in the Nashik region, particularly in the Niphad Tehsil.

Considering the economic importance of pomegranates and the significant threat associated with *D. isocrates*, it is essential to study its seasonal incidence. This study aimed to investigate the seasonal incidence of *D. isocrates* in pomegranates during Mrig Bahar in the Niphad District through weekly monitoring of fruit infestation rates and correlation with weather parameters such as temperature, humidity, and rainfall.

Material and Methods.

The present study on the seasonal incidence of *D. isocrates*, on pomegranate (*Punica granatum* L.) was conducted in Niphad Tehsil, Nashik District, Maharashtra, India, during the Mrig Bahar season. The study was carried out in two randomly selected pomegranate orchards to study eggs or larvae incidence and its correlation with weather parameters. In each orchard, five randomly selected trees were chosen for study.

The number of egg and larvae per tree was recorded by counting the egg or larvae inside or on the flower bud and infested fruits, and the average number of egg or larvae per tree was calculated and correlated with weather parameters. Fruit infestation percentage was determined using Abbott’s formula (1925) [2]:

$$\text{Fruit Infestation (\%)} = \frac{\text{Number of Infested Fruits} \times \text{Total Number of Fruits Observed}}{100}$$

The number of infested fruits per orchard was calculated based on the total observed fruits and the percentage of

infestation. Weather data, including temperature, relative humidity, and weekly total rainfall, were collected from the agricultural department in Niphad Tehsil. This data used to analyse the correlation between weather factors and the seasonal incidence of *D. isocrates* on pomegranate. The statistical analysis done in R 4.4.0 Software.

Result and discussion

During the study period from SMW 22 to 48, the recorded temperature, rainfall, and humidity data revealed a clear influence of these weather parameters on the infestation levels of *D. isocrates* in both orchards. The highest average maximum temperature was observed during SMW 22–26 at 36.1°C, while minimum temperatures dropped to 20.1°C in SMW 39–48. Rainfall reached its peak at 230 mm during SMW 31–38, accompanied by elevated humidity levels of 82.5%, creating optimal conditions for pest development (Khandare *et al.*, 2021) [10]. Correspondingly, the percentage of infested fruits in Orchard 1 increased steadily from 30% in SMW 22–26 to a maximum of 68% in SMW 31–38, before declining to 32% in SMW 39–48. Orchard 2 exhibited a similar pattern, with infestation rates rising from 24% to 50% and then decreasing to 22% in the later weeks. The total number of infested fruits followed this same trend, with the highest infestation observed during SMW 31–38 (Murugan, M., & Thirumurugan, A., 2001) [15]. These observations suggest that increased rainfall and humidity, in particular, are closely linked to the severity of fruit infestation by *D. isocrates*, underscoring the importance of monitoring climatic conditions for effective pest management

Table 1: Climatic parameters and *D. isocrates* infestation in two pomegranate orchards (SMW 22–48)

SMW	Avg. Temp (°C) (Max-Min)	Rainfall (mm)	Humidity (%)	Infestation (%) (Orchard 1)	Infestation (%) (Orchard 2)	Total Fruits observed
22–26	36.1 - 24.7	125.7	74.5	15	12	100
27–30	29.7 - 22.6	150.0	89	28	18	100
31–38	30.6 - 22.2	230	82.5	34	25	100
39–48	30.6 - 20.1	89.8	78	16	11	100

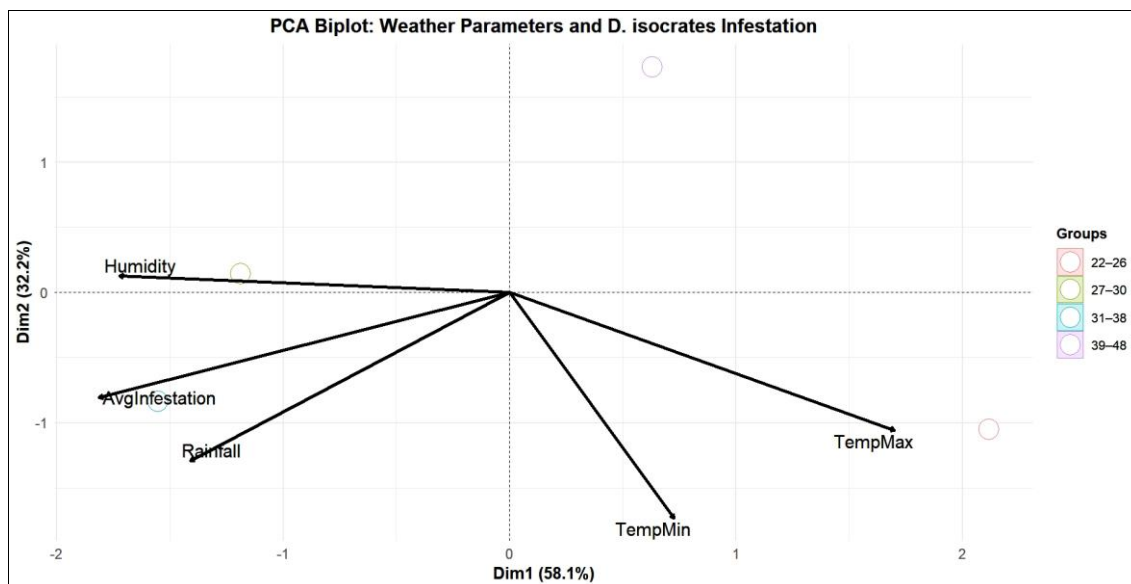


Fig 1: PCA biplot showing the relationship between climatic parameters and *D. isocrates* infestation across different Standard Meteorological Weeks (SMWs)

Principal Component Analysis (PCA) was performed to explore the relationship between climatic variables and the infestation of *D. isocrates* across different Standard Meteorological Weeks (SMWs). The first two principal components, PC1 and PC2, together explained 91.4% of the total variance in the dataset, effectively capturing the major patterns influencing infestation dynamics.

PC1, accounting for 62.6% of the variance, was mainly influenced by temperatures, indicating their major role in explaining variation along this axis. PC2, which explained 28.8% of the variance, was primarily associated with humidity and rainfall.

Infestation levels in both orchards showed a strong positive association with humidity and rainfall, particularly during SMWs 27–30 and 31–38, which clustered closely with the infestation vectors in the PCA biplot. This suggests that humid and wet conditions increased infestation by *D. isocrates*.

However, SMW 22–26 was distinctly separated along PC1 and aligned with higher temperature values but lower infestation, indicating a negative correlation between temperature and occurrence of pest. These results suggest that the climatic conditions supporting *D. isocrates* infestation are characterized by high humidity and rainfall, while increased temperatures may affect the infestation.

Altogether, rainfall the most significant climatic factor linked with infestation, followed by humidity, while temperature showed a negative but weak relationship. These results highlight the importance of humid conditions and seasonal rainfall patterns in influencing the dynamics of *D. isocrates* infestation on pomegranate.

To find out the relationship between environmental factors and pest infestation in two orchards, a linear regression analysis was performed. Separate linear regression models were fitted for each orchard, with infestation percentage as the dependent variable and average temperature (computed as the mean of maximum and minimum temperatures), rainfall, and humidity as independent variables.

For Orchard 1, the model shows a coefficient of determination (R^2) of 1.00, indicating that 100% of the variability in infestation percentage was explained by the predictors. The regression equation is

$$\text{Infestation (\%)} = -76.73 - 0.46 \times \text{Avg. Temp (}^\circ\text{C)} + 0.11x \\ \text{Rainfall (mm)} + 0.84 \times \text{Humidity \%}$$

For Orchard 2, the model showed an R^2 of 1.00, explaining 100% of the variability, with the equation:

$$\text{Infestation (\%)} = -61.20 - 0.37 \times \text{Avg. Temp (}^\circ\text{C)} + 0.08x \\ \text{Rainfall (mm)} + 0.67 \times \text{Humidity \%}$$

In both models, humidity and rainfall exhibited positive associations with infestation rates, suggesting that higher moisture levels contribute to increased pest activity (Abbes. *et al.*, 2020) [1]. While temperature showed a negative association, indicating that higher temperatures may suppress infestation. Due to the small sample size ($n=4$), statistical significance of the predictors could not be assessed, as the models utilized all available degrees of freedom. These findings suggest that rainfall and humidity are main cause of pest infestation in both orchards.

The combined PCA and linear regression analyses highlight that *D. isocrates* infestation in pomegranate orchards is positively influenced by climatic factors like rainfall and humidity. Pest incidence was highest during humid and wet conditions, while higher temperatures were observed to reduce pest occurrence. Rainfall was found to be the major contributor across both orchards, supported by high R^2 values (0.92 and 0.89).

Conclusion

These findings explain the potential use of climatic data for pest incidence and highlight the importance of study of climate-based monitoring for early warnings for effective pest management.

Acknowledgements

The author is thankful to Principal of MVP'S K.R.T. Arts, B.H. Commerce and A.M. Science (KTHM) College, and MVP'S Arts, Science and Commerce College, Ozar (Mig), Nashik, for necessary permission and guidance.

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