Plant Archives Vol. 26, No. 2, 2026 pp. 2291-2297 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.no.2.314

POPULATION DYNAMICS OF SEED BORER, *TRYMALITIS MARGARIAS* MEYRICK ON SAPOTA (*Manilkara zapota* L.)

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(Date of Receiving-29-05-2026; Date of Revision-30-07-2026; Date of Acceptance-20-08-2026)

ABSTRACT

Sapota (*Manilkara zapota* L.) is an economically important tropical fruit crop, but its productivity is severely affected by the sapota seed borer, *Trymalitis margarias* Meyrick (Lepidoptera: Tortricidae), which causes extensive fruit and seed damage. The present study was conducted during 2024–2026 at the University of Agricultural Sciences, Dharwad, Karnataka, to investigate the seasonal population dynamics, nature of fruit damage and influence of weather parameters on pest incidence. Observations on larval population, fruit infestation and seed infestation were recorded at 15-day intervals and their relationship with meteorological factors was studied using correlation and regression analyses. The pest remained active throughout the study period, with peak incidence during the winter months (December–February). The higher larval population (55.00 larvae per 100 fruits) was recorded in the month of December 2025, with maximum fruit infestation (59.00%) and seed infestation (21.69%) in December 2025. Morphometric studies revealed characteristic exit holes, feeding tunnels and seed galleries caused by larval feeding. Correlation analysis showed that minimum temperature, morning relative humidity and rainfall had significant negative effects on pest incidence, whereas maximum temperature and evening relative humidity showed non-significant effects. The study provides valuable information for forecasting pest incidence and developing timely, location-specific integrated pest management strategies for sustainable sapota production.

***Key words*:** Sapota seed borer, Sapota, Population dynamics, Weather variables, Seasonal incidence, Fruit infestation, Seed infestation

Introduction

Sapota (*Manilkara zapota* L.), commonly known as chikoo or the “chicle tree” (Simpson and Ogorzaly, 1995), is an important tropical evergreen fruit crop belonging to the family Sapotaceae. Native to southern Mexico and Central America, it is widely cultivated in tropical and subtropical regions because of its adaptability to diverse agro-climatic conditions, regular bearing habit, high productivity and excellent keeping quality. The fruit is highly appreciated for its sweet taste, pleasant flavour and rich nutritional composition. It is an excellent source of carbohydrates, dietary fibre, antioxidants, carotenoids, ascorbic acid, vitamins A and C, and essential minerals such as calcium, phosphorus and iron (Poongavanam *et al*., 2023). Owing to its nutritional and commercial value, sapota has emerged as one of the most important fruit crops cultivated in many tropical countries.

India is one of the leading producers of sapota,

cultivating the crop over an area of about 75 thousand hectares with an annual production of approximately 898 thousand metric tonnes (Agricultural Statistics, 2025). The crop is extensively grown in Karnataka, Gujarat, Maharashtra, Tamil Nadu and Andhra Pradesh, with Karnataka occupying a prominent position in both area and production. The adoption of improved cultivation practices, including grafted planting material, drip irrigation, fertigation and integrated nutrient management, has significantly enhanced productivity and fruit quality. Increasing consumer demand for fresh fruits and processed products has further expanded sapota cultivation, thereby contributing substantially to the horticultural economy and improving farmers' income.

Despite its economic importance, sapota cultivation is severely constrained by several insect pests that reduce fruit yield and quality. Earlier, Butani (1979) reported 25 insect pests associated with sapota in India, while Patel (2002) documented 16 species of insect pests and mites. Subsequently, Bisane *et al.* (2018) recorded approximately 33 pest species from the major sapota-growing states of Karnataka, Maharashtra and Gujarat. Among these, leaf webbers, bud borers, fruit borers, fruit flies, bark-eating caterpillars, mealybugs, scale insects and seed borers are of major economic importance. Among the fruit-infesting pests, the sapota seed borer, *Trymalitis margarias* Meyrick (Lepidoptera: Tortricidae), is considered one of the most destructive pests because it directly damages the marketable portion of the crop.

The sapota seed borer has been reported to cause fruit losses of up to 35 per cent in Karnataka (Kalpana, 2003). The larvae bore into developing fruits soon after hatching and feed on the seed kernel while remaining concealed inside the fruit throughout their larval development. As a result, infested fruits exhibit seed damage, tissue deterioration, deformation, premature fruit drop and poor market quality, leading to considerable economic losses. In severe infestations, fruits become unsuitable for consumption and marketing. Because larval feeding occurs internally, infestations remain unnoticed during the early stages, making timely detection and effective management extremely difficult.

The pest exhibits a predominantly nocturnal habit. Females lay eggs singly or with group of 2 to 5 on developing fruits and tender leaves. After hatching, the larvae penetrate the fruit and remain concealed while feeding on the seed kernel until maturity. Fully grown larvae emerge by creating a characteristic exit hole in the fruit and subsequently pupate within silken cocoons on leaves or other sheltered plant parts. These exit holes often facilitate the entry of secondary pathogens and microorganisms, thereby accelerating fruit deterioration. Adult moths emerge during the night, mate during the scotophase and continue the life cycle. The concealed larval feeding habit, nocturnal adult behaviour and cryptic nature of infestation enable the pest to escape early detection and significantly reduce the effectiveness of conventional management practices.

Management of the sapota seed borer is challenging because the larvae remain concealed within the fruit, rendering conventional insecticidal applications largely ineffective. Repeated pesticide applications not only increase production costs but also result in pesticide residues, environmental contamination and adverse effects on natural enemies. Therefore, understanding the seasonal occurrence and population dynamics of the pest is essential for developing timely and effective management strategies. Knowledge of pest incidence in relation to crop phenology and prevailing weather conditions provides valuable information for forecasting outbreaks and implementing appropriate control measures at the most vulnerable stage of the pest.

Population dynamics of insect pests are greatly influenced by abiotic factors such as temperature, relative humidity and rainfall, as well as by host plant phenology. These environmental factors regulate insect survival, development, reproduction and population build-up throughout the cropping season. Therefore, studying the seasonal incidence of *Trymalitis margarias* in relation to meteorological parameters is essential for identifying peak periods of infestation and understanding the ecological factors governing its population fluctuations. Such information will contribute to the development of reliable pest forecasting models and strengthen integrated pest management (IPM) strategies for sustainable management of sapota seed borer in sapota orchards.

Materials and Methods

Studies on the population dynamics of sapota seed borer, *Trymalitis margarias* Meyrick (Lepidoptera: Tortricidae), were conducted in a sapota orchard at the Horticulture Block, College of Agriculture Dharwad, University of Agricultural Sciences, Dharwad, during 2024–2026. The sapota variety 'Kalipatti' was selected for the study. Seasonal incidence was recorded at 15-day intervals from October 2024 to April 2026. Five randomly selected trees were used for recording observations. Twenty immature fruits were randomly collected from each tree (five fruits from each direction of the canopy). The collected fruits were examined in the laboratory to record larval population, fruit infestation and seed infestation. Fifteen damaged fruits were selected

during peak infestation and its morphological features were studied.

Observations recorded

1. Number of larvae per fruit
2. Total number seeds per fruit
3. Number of damaged seeds per fruit
4. Fruit infestation (%)
5. Seed infestation (%)

Morphological observations of damaged fruits

1. Number of exit hole
2. Diameter of exit hole
3. Position of exit hole
4. Length of the tunnel
5. Width of the tunnel
6. Length of seed gallery
7. Number of damaged seeds per fruit

Assessment of fruit and seed infestation

Fruits were examined for external symptoms of infestation and dissected to record larval presence and internal damage. Fruit infestation and seed infestation were calculated using the following formulae:

$$\text{Fruit infestation (\%)} = \frac{\text{Number of damaged fruits}}{\text{Total number of fruits examined}} \times 100$$

$$\text{Seed infestation (\%)} = \frac{\text{Number of damaged seeds}}{\text{Total number of seeds examined}} \times 100$$

Influence of weather parameters

Meteorological data on maximum temperature (°C), minimum temperature (°C), morning relative humidity (%), evening relative humidity (%) and rainfall (mm) were obtained from the Meteorological Observatory, Main Agricultural Research Station (MARS), University of Agricultural Sciences, Dharwad. The relationship between sapota seed borer incidence and weather parameters was analysed using correlation and regression analyses to determine the influence of climatic factors on seasonal population fluctuations.

Results and Discussion

The data on the population of sapota seed borer, *Trymalitis margarias* Meyrick, recorded from October 2024 to April 2026 are presented in Table 1. The pest population exhibited distinct seasonal variation throughout the study period. During 2024 (Oct- Dec), fruit infestation increased gradually from 24.00 per cent in early October 2024 to a maximum of 54.00 per cent during the first fortnight of December 2024. Similarly, seed infestation increased from 7.81 per cent to 19.81 per cent during the same period. The number of larvae also increased from 12 larvae per 100 fruits in October 2024 to a peak of 41 larvae per 100 fruits in early December 2024. Thereafter, the pest incidence declined progressively from January onwards, reaching its lowest level during May and June 2025, when fruit infestation ranged from 3.00 to 8.00 per cent, seed infestation from 1.09 to 3.51 per cent, and larval population from 1 to 7 larvae per 100 fruits.

During 2025–26, the pest population again started increasing from October 2025. The highest fruit infestation (59.00%), seed infestation (21.69%), and larval population (55 larvae per 100 fruits) were recorded during December 2025. Subsequently, the infestation and larval population declined gradually from January onwards, reaching minimum levels of 3.00 per cent fruit infestation, 1.54 per cent seed infestation, and 3 larvae per 100 fruits during the second fortnight of April 2026.The results indicated that the incidence of *T. margarias* was relatively high during the winter months (December to February) and comparatively low during the summer and monsoon periods, suggesting that cooler weather conditions favoured the population build-up of the pest.

Fig. 1 depicts the seasonal fluctuations in the larval population of *Trymalitis margarias* on sapota during October 2024 to April 2026. The pest was active throughout the study period, with noticeable variations in

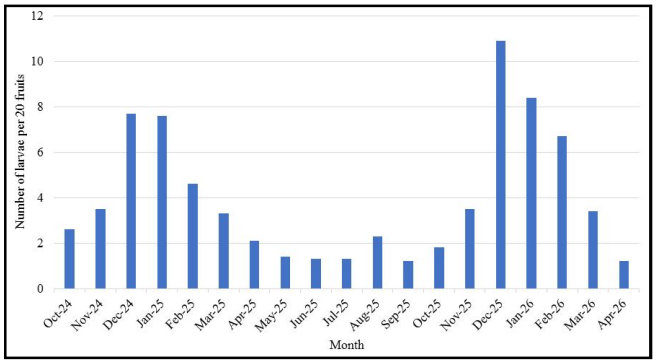


Fig. 1: *Trymalitis margarias* larval population seasonal fluctuation (October 2024–April 2026).



Plate 1: Damage symptoms of sapota seed borer, *Trymalitis margarias*.

Table 1: *Trymalitis margarias* population and damage on sapota (October 2024–April 2026).

Date of observation	Damaged fruits / 100 fruits	Total no. of seeds / 100 fruits	Damaged seeds / 100 fruits	Number of larvae / 100 fruits	Fruit infestation (%)	Seed infestation (%)
01-10-2024	24.00	320.00	25.00	12.00	24.00	07.81
16-10-2024	29.00	351.00	31.00	14.00	29.00	08.83
01-11-2024	32.00	356.00	33.00	17.00	32.00	09.27
16-11-2024	37.00	316.00	40.00	18.00	37.00	12.66
01-12-2024	54.00	313.00	62.00	41.00	54.00	19.81
16-12-2024	48.00	302.00	50.00	36.00	48.00	16.56
01-01-2025	49.00	311.00	54.00	39.00	49.00	17.36
16-01-2025	47.00	293.00	49.00	37.00	47.00	16.72
01-02-2025	40.00	294.00	43.00	24.00	40.00	14.63
15-02-2025	38.00	303.00	42.00	22.00	38.00	13.86
01-03-2025	29.00	301.00	30.00	17.00	29.00	09.97
16-03-2025	26.00	276.00	27.00	16.00	26.00	09.78
01-04-2025	13.00	304.00	14.00	11.00	13.00	04.61
16-04-2025	12.00	335.00	13.00	10.00	12.00	03.88
01-05-2025	08.00	285.00	10.00	07.00	08.00	03.51
16-05-2025	05.00	302.00	07.00	04.00	05.00	02.32
01-06-2025	03.00	275.00	03.00	02.00	03.00	01.09
16-06-2025	04.00	315.00	06.00	01.00	04.00	01.90
01-07-2025	06.00	286.00	07.00	03.00	06.00	02.45
16-07-2025	07.00	289.00	08.00	04.00	07.00	02.77
01-08-2025	14.00	312.00	15.00	11.00	14.00	04.81
16-08-2025	18.00	315.00	19.00	12.00	18.00	06.03
01-09-2025	04.00	240.00	06.00	02.00	04.00	02.50
16-09-2025	06.00	242.00	07.00	06.00	06.00	02.89
01-10-2025	13.00	285.00	14.00	08.00	13.00	04.91
16-10-2025	17.00	288.00	21.00	10.00	17.00	07.29
01-11-2025	20.00	299.00	33.00	17.00	20.00	11.04
16-11-2025	29.00	278.00	31.00	18.00	29.00	11.15
01-12-2025	59.00	304.00	65.00	55.00	59.00	21.38
16-12-2025	55.00	272.00	59.00	48.00	55.00	21.69
01-01-2026	47.00	315.00	49.00	41.00	47.00	15.56
16-01-2026	49.00	319.00	54.00	43.00	49.00	16.93
01-02-2026	45.00	313.00	49.00	41.00	45.00	15.65
15-02-2026	41.00	328.00	42.00	26.00	41.00	12.80
01-03-2026	29.00	297.00	33.00	18.00	29.00	11.11
16-03-2026	21.00	284.00	24.00	16.00	21.00	08.45
01-04-2026	10.00	278.00	11.00	09.00	10.00	03.96
16-04-2026	03.00	260.00	04.00	03.00	03.00	01.54

larval population. During 2024–25, the population increased gradually from 2.6 larvae per 20 fruits in October 2024 to a peak of 7.7 larvae per 20 fruits in December 2024, remained almost similar in January 2025 (7.6 larvae per 20 fruits) and then declined steadily from February onwards, reaching the lowest level of 1.2–1.4 larvae per 20 fruits during May to July 2025. The population began to increase again from August 2025 and rose sharply from October onwards, reaching the highest peak of 10.9 larvae per 20 fruits in December 2025. Thereafter, the larval population gradually declined to 8.4, 6.7, 3.4 and 1.2 larvae per 20 fruits during January, February, March and April 2026, respectively. Overall, the larval population was consistently higher during the winter months (December–February) and lower during the summer months (May–July), indicating a clear seasonal pattern in the incidence of *T. margarias* on sapota.

Table 2: Morphometric analysis of sapota fruits damaged by *Trymalitis margarias.*

Sl. No.	Number of exit hole	Diameter of exit hole (mm)	Length of tunnel (cm)	Width of tunnel (mm)	Length of seed gallery (mm)	Number of damaged seeds	Position of Hole
1	1.00	1.00	1.50	1.00	10.50	1.00	Upper half
2	1.00	1.50	1.75	1.00	08.30	2.00	Lower half
3	1.00	2.00	1.60	2.00	09.50	2.00	Lower half
4	2.00	1.20	2.00	1.50	20.24	3.00	Lower half
5	1.00	1.00	1.45	1.00	15.60	1.00	Middle
6	1.00	1.50	1.32	2.00	11.80	1.00	upper half
7	2.00	1.75	0.95	2.00	10.00	2.00	Lower half
8	2.00	2.25	0.50	1.00	09.75	2.00	Upper half
9	1.00	2.00	1.75	2.00	08.50	1.00	Upper half
10	1.00	3.00	2.25	1.00	10.56	1.00	Upper half
11	1.00	3.25	3.50	1.00	21.06	1.00	Middle
12	1.00	2.75	3.00	1.00	23.45	2.00	Middle
13	1.00	2.60	2.50	1.50	12.78	1.00	Lower half
14	2.00	2.50	1.80	1.00	16.42	2.00	Lower half
15	2.00	1.75	2.10	2.00	19.38	2.00	Lower half
Total	20.00	30.05	27.97	21.00	207.84	25.00	
Mean	1.33	2.00	1.86	1.40	13.86	1.60	
SD	0.49	0.71	0.76	0.47	5.09	0.72	

The present study revealed that the population of *Trymalitis margarias* exhibited distinct seasonal fluctuations, with maximum incidence during December to February and minimum incidence during May to September. Higher pest incidence during the winter months may be attributed to favourable weather conditions, particularly moderate temperature and relatively high humidity, coupled with the availability of developing fruits, which favoured adult activity, oviposition and larval development. The decline in pest population during summer and monsoon months could be due to high temperature, rainfall and reduced availability of suitable fruits, which were unfavourable for pest multiplication. These findings indicate that seasonal weather conditions play an important role in regulating the population dynamics of the sapota seed borer.

The present findings are in agreement with Munj *et al.,* (2014) and Bisane (2016), who reported higher infestation of *Trymalitis margarias* during November and December, followed by a gradual decline in the subsequent months. Similar seasonal trends were observed in the present investigation, where the pest population reached its peak during the winter months and declined thereafter. The higher incidence during the winter season may be attributed to favourable temperature, relative humidity and the availability of developing fruits, which favoured adult activity, oviposition and larval development.

Morphometric characteristics of sapota fruits damaged by sapota seed borer, *Trymalitis margarias* Meyrick

The morphometric characteristics of sapota fruits damaged by *Trymalitis margarias* Meyrick are presented in Table 2. The number of exit holes per fruit varied from 1 to 2, with a mean of 1.33 exit holes per fruit. The diameter of the exit hole ranged from 1.00 to 3.25 mm, with an average of 2.00 mm. The length of the larval tunnel varied between 0.50 and 3.50 cm, with a mean of 1.86 cm, while the tunnel width ranged from 1.00 to 2.00 mm, averaging 1.40 mm. The length of the seed gallery ranged from 8.30 to 23.45 mm, with a mean of 13.86 mm. The number of damaged seeds per fruit varied from 1 to 2, with an average of 1.60 damaged seeds per fruit. Exit holes were observed predominantly on the lower half of the fruit, followed by the upper half and middle portion.

The present study demonstrated that larval feeding by *T. margarias* produced distinct internal and external damage symptoms, including characteristic exit holes, feeding tunnels and seed galleries. The variation in the number and size of exit holes and tunnels may be attributed to differences in larval feeding behaviour and the extent of infestation. The predominance of exit holes on the lower half of the fruit suggests a preferred route for larval emergence, while the presence of one to two damaged seeds indicates that a single larva is capable of causing considerable injury to the seed and surrounding tissues. Such internal feeding adversely affects fruit quality and marketability, making the damaged fruits unsuitable for commercial sale.

Table 3: Correlation and regression values for *Trymalitis margarita* population in relation to weather parameters (October 2024-April 2026).

Particulars (Y)	Correlation coefficient (r) Meteorological parameters					Co-efficient of determi-nation (R^2)	Regression equation
	Max. Temp. X_1(°C)	Min. Temp. X_2(°C)	Morning RHX_3 (%)	Evening RHX_4 (%)	Rainfall X_5 (mm)		
Fruit infestation (%)	-0.090^{NS}	-0.478**	-0.571**	-0.350*	-0.658**	0.6022	Y=235.978-2.971X_1-0.317 X_2-1.226X_3-0.203X_4-1.164 X_5+11.878
Seed infestation (%)	-0.103^{NS}	-0.499**	-0.559**	-0.352*	-0.669**	0.6123	Y=83.632-1.133X_1-0.137 X_2-0.371X_3-0.112X_4-0.395 X_5+4.089
No. of Larvae per 100 fruits	-0.186^{NS}	-0.510**	-0.437**	-0.267^{NS}	-0.624**	0.5433	Y=187.737-3.135X_1-0.418 X_2-0.491X_3-0.434X_4-0.909 X_5+10.612

* Correlation is significant at the 0.05 level; ** Correlation is significant at the 0.01 level; NS: Non-significant; RH: Relative humidity

Influence of weather parameters on the population dynamics of sapota seed borer, *Trymalitis margarias* Meyrick

The correlation and regression analysis between the population of *Trymalitis margarias* and weather parameters is presented in Table 3. Fruit infestation exhibited a significant negative correlation with minimum temperature (r = -0.478), morning relative humidity (r = -0.571), evening relative humidity (r = -350) and rainfall (r = -0.658), whereas its association with maximum temperature was negative and non-significant. Similarly, seed infestation showed a significant negative correlation with minimum temperature (r = -0.499), morning relative humidity (r = -0.559), evening relative humidity (r = -0.352) and rainfall (r = -0.667), while the correlations with maximum temperature was non-significant. Larval population also exhibited a significant negative correlation with minimum temperature (r = -0.510), morning relative humidity (r = -0.437) and rainfall (r = -0.624), whereas maximum temperature and evening relative humidity showed non-significant negative correlations.

The present investigation indicated that minimum temperature, morning relative humidity and rainfall significantly influenced the population dynamics of *T. margarias*. The significant negative association suggests that an increase in these weather parameters reduced larval population and infestation levels. In contrast, maximum temperature and evening relative humidity had no significant effect on pest incidence during the study period. The high coefficient of determination (R^2 = 0.5433 to 0.6123) indicated that weather parameters collectively played a major role in influencing the seasonal abundance of the sapota seed borer.

The present findings are in agreement with Bisane (2016), who reported that weather parameters significantly influenced the seasonal incidence of *T. margarias*. The study also indicated that minimum temperature, evening relative humidity and rainfall were negatively associated with pest infestation. Correlation analysis revealed that sapota seed borer infestation had a significant negative correlation with maximum temperature (r = -0.653), minimum temperature (r = -0.635), and rainfall (r = -0.145), whereas relative humidity showed a significant positive correlation (r = 0.565), suggesting that cooler and more humid conditions favoured pest incidence (Kalpana, 2003).

Summary and conclusion

The present investigation on the population dynamics, morphometric characteristics and influence of weather parameters on the sapota seed borer, *Trymalitis margarias* Meyrick, was conducted in a sapota orchard at the University of Agricultural Sciences, Dharwad, during 2024–2026. The pest remained active throughout the study period, exhibiting distinct seasonal fluctuations. The larval population, fruit infestation and seed infestation gradually increased from October and reached their peak during the winter months (December–February), followed by a steady decline during the summer and monsoon months. Morphometric studies revealed that larval feeding caused characteristic exit holes, feeding tunnels and seed galleries, with an average of 1.33 exit holes and 1.60 damaged seeds per fruit, resulting in severe internal damage and reduced fruit quality. Correlation and regression analyses indicated that minimum temperature, morning relative humidity and rainfall significantly influenced pest incidence, while maximum temperature and evening relative humidity had no significant effect. Weather parameters collectively explained a substantial

proportion of the seasonal variation in pest population (R^2 = 0.5433 to 0.6123), highlighting the important role of climatic factors in regulating the abundance of *T. margarias*.

The information generated through the present study will be useful designing location-specific integrated pest management (IPM) strategies. Timely monitoring and implementation of appropriate management practices during periods of peak pest activity can reduce fruit and seed damage, improve fruit quality and marketable yield, minimize unnecessary insecticide applications, conserve natural enemies and promote environmentally sustainable sapota production. Furthermore, the baseline information generated in this investigation may serve as a valuable reference for future studies on the bio-ecology, monitoring and eco-friendly management of *T. margarias* in different sapota-growing regions.

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