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Current scenario of insect pests on jackfruit in Tamil Nadu

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Abstract

Studies on the seasonal incidence of pests and natural enemies in different Jackfruit cultivars revealed the presence of various pests and predators in the Jackfruit ecosystem. The major pests identified included the fruit and shoot borer (SFB), stem borer, mealybug, whitefly, spittle bug, bud weevil and fruit fly. At the same time, predatory coccinellid beetles were the key natural enemies. The fruit and shoot borer (8.92%), stem borer (0.21%), mealybugs (1.48%), bud weevil (19.28%) and whiteflies (17.78%) were less in Muttam varikkai followed by Palur 1- SFB (27.57%), stem borer (1.35%), mealybug (1.14%), whiteflies (18.21%) and bud weevil (17.92%). The Jackfruit cultivar, Muthandikuppam, was found to be more susceptible to insect pests, which recorded SFB (37.85%), mealybugs (2.42%), whitefly (35.50%) and bud weevil (26.42%). The chrysopa and coccinellids population was high in AH2 Muthandikuppam (4.00 and 17.68/tree) followed by AH15 Muthandikuppam (3.21 and 17.17/tree). Comparatively, the spiders were found high in Pechiparai 1 (11.78/tree), but in AH2 Muthandikuppam it was 7.35 per tree. The SFB, stem borer, mealybugs, whiteflies and bud weevil were more during hot weather and were positively correlated with maximum and minimum temperature. In contrast, they are negatively correlated with other weather parameters, *viz.,* rainfall, wind speed and relative humidity. The SFB incidence was recorded as high during maximum temperature (0.479) with high wind speed (0.502) and minimum temperature (0.577). The population of coccinellids beetles increased with maximum temperature (0.71), minimum temperature (0.706), high wind speed (0.312) and relative humidity (0.514).

Keywords

jackfruit: insect pests; natural enemies; seasonal incidence

Introduction

Jackfruit (*Artocarpus heterophyllus* Lam.), commonly known as the 'wonder' fruit is widely cultivated in Southeast Asia. It is also known as poor man's food and consumed as a vegetable or fruit. India is the lead producer of jackfruit, with 900 germplasm and an average production of 1436 thousand tonnes followed by Bangladesh during 2012-2013. Jackfruit is a rich source of potassium, vitamins A and C, thiamine, riboflavin and minerals like sodium, calcium, iron, zinc, etc., with a low calorific value. A 100g portion of edible raw jackfruit provides about 95 calories and is a good source of antioxidants and vitamin C, providing about 13.7 mg. 18.9 g carbohydrate, 1.9g protein, 0.1 g fat, 77% moisture, 1.1g fiber, 0.8 g total mineral matter, 20 mg calcium, 30 mg phosphorus, 500 mg iron, 540 IU Vitamin A, 30 mg thiamine and 84 calories (1, 2).

Jackfruit is attacked by 38 species of insect pests, causing significant yield loss during vegetative and reproductive stages (3). Among these, the fruit and shoot

borer *Diaphania* sp. Walker and stem borer, *Batocera rufomaculata* De Geer are the major insect pests. Minor insect species recorded in India are bud weevil *Ochyromera artocarpi* Marshall, bark eating caterpillars, *Indarbela tetraonis* Moore, leaf eating caterpillar, *Perina nuda* Fabricius and *Diaphania bivitralis* Guenee, spittle bug, *Cosmoscarta relata* Distant, mealy bug *Nipaecoccus viridis* Newstead, aphid, *Toxoptera aurantii* Fonscolombe, thrips *Pseudodendrothrips dwivarna* Ramakrishna and Margabandhu, scale insect, (*Icerya aegyptica* Douglas, *Ceroplastes rubens* Maskell and *Coccus acuticimus* Green) and red ants *Oecophylla smaragdina* Fabricius (4, 5).

Weather parameters play a vital role in the growth, development and dispersal of insects thereby influencing their seasonal abundance. Temperature prevailing in the ecosystem is a powerful parameter affecting insect population dynamics and the survival of sucking pests and defoliators. The cold weather reduces the population density and to cause insects to enter diapause during the winter season. The seasonal variations play a vital role in the multiplication, growth, development and distribution of hoppers and thrips (6).

The knowledge of the population dynamics of any insect pest provides awareness of the association between weather and insects. The multiplicative seasonal autoregressive integrated moving average and artificial neural network model help to predict pest population, planning of timely prevention and development of effective management strategies to minimize the use of hazardous pesticides.

Thus, it directs farmers of a particular area or region in framing a management program and imparts proper control measures to prevent loss due to insect attacks. This research aimed to survey and document pests and natural enemies in different jack fruit cultivars and correlate their incidence with weather parameters.

Materials and Methods

Survey on insect pests and their natural enemies in different Jackfruit cultivars

The survey was conducted in different jackfruit cultivars for the occurrence of insect pests and natural enemies at Central Farm, Horticultural College and Research Institute, Theni district Tamil Nadu, during 2022-2023. The cultivars observed were AH15 Muthandikuppam, AH Pattukottai, Palur 2, Muttam Varikkai, Pechiparai 1, AHS Virudhachalam Selection, Palur 1 and AH2 Muthandikuppam. Ten trees were randomly selected from each cultivar and damage and pest /natural enemies counts were observed on 10 randomly selected branches, leaves and fruits per cultivar at weekly intervals. The experimental plot was kept free of insecticidal spray throughout observation. The varietal screening studies data obtained was analysed statistically using a Randomized Block Design with square root transformation for pest and natural enemies count (number) and arcsine transformation for pest damage (Percent).

Correlation on incidence of insect pests and their natural enemies with weather parameters

The weather parameters taken for the study were maximum temperature, minimum temperature, rainfall, wind velocity, wind direction and relative humidity (Table 1). Observations were conducted on experimental jackfruit trees kept free from insecticides, with all other agronomic practices followed per recommendations. Trees (20 Nos.) were randomly selected from the orchard and the monitoring of pests and natural enemies will be carried out during the experimental period. Observations on weather data were recorded at weekly intervals from the Automatic Weather Station (AWS) located in the Theni district.

Method of analysis

Percentage data gathered were subjected to arc sine (angular) transformation and the statistical analysis has been carried out using a standard protocol (7) using R program 4.3.3. The correlation coefficient and regression analysis were calculated using Pearson's coefficient rule in R program 4.3.3. Simple linear and correlation matrix were also computed.

Results and Discussion

Insect pests and their natural enemies on jackfruit cultivars

The incidence of insect pests and their natural enemies in different jackfruit cultivars revealed that the shoot and fruit borer, stem borer, fruit fly, mealybug, bud weevil, spiders, chrysoperla and predatory coccinellid beetles were found to be the major pests and predators in the jackfruit ecosystem (Table 2 and Fig. 1).

Table 1. Weather parameters recorded at Central Farm, Horticultural College and Research Institute, Periyakulam during 2022- 2023

Month	Temperature °C		Rainfall (mm)	Rainy day	RH (%)	Atmospheric Pressure	Wind speed
	Maximum	Minimum					
Oct 2022	32.88	23.86	325.20	9	73.9	977.07	2.32
Nov 2022	30.60	22.00	102.40	5	79.2	978.42	2.49
Dec 2022	30.45	20.27	55.40	6	76.1	977.91	2.32
Jan 2023	31.00	18.30	1.2	0	68.6	964.74	2.64
Feb 2023	32.90	19.14	9.0	2	60.9	979.44	3.24
Mar2023	34.52	22.64	93.60	5	65.7	979.05	3.28
April 2023	36.21	25.77	71.60	4	64.5	978.56	2.76
May 2023	35.68	25.51	65.00	9	70.0	977.72	2.77
June 2023	36.15	26.42	9.0	2	64.3	976.20	4.19
July 2023	34.50	25.04	25.8	2	67.7	975.40	4.12
Aug 2023	36.36	25.42	64.4	2	63.6	976.68	4.32
Sep 2023	33.54	24.70	120.0	4	75.6	976.35	3.09

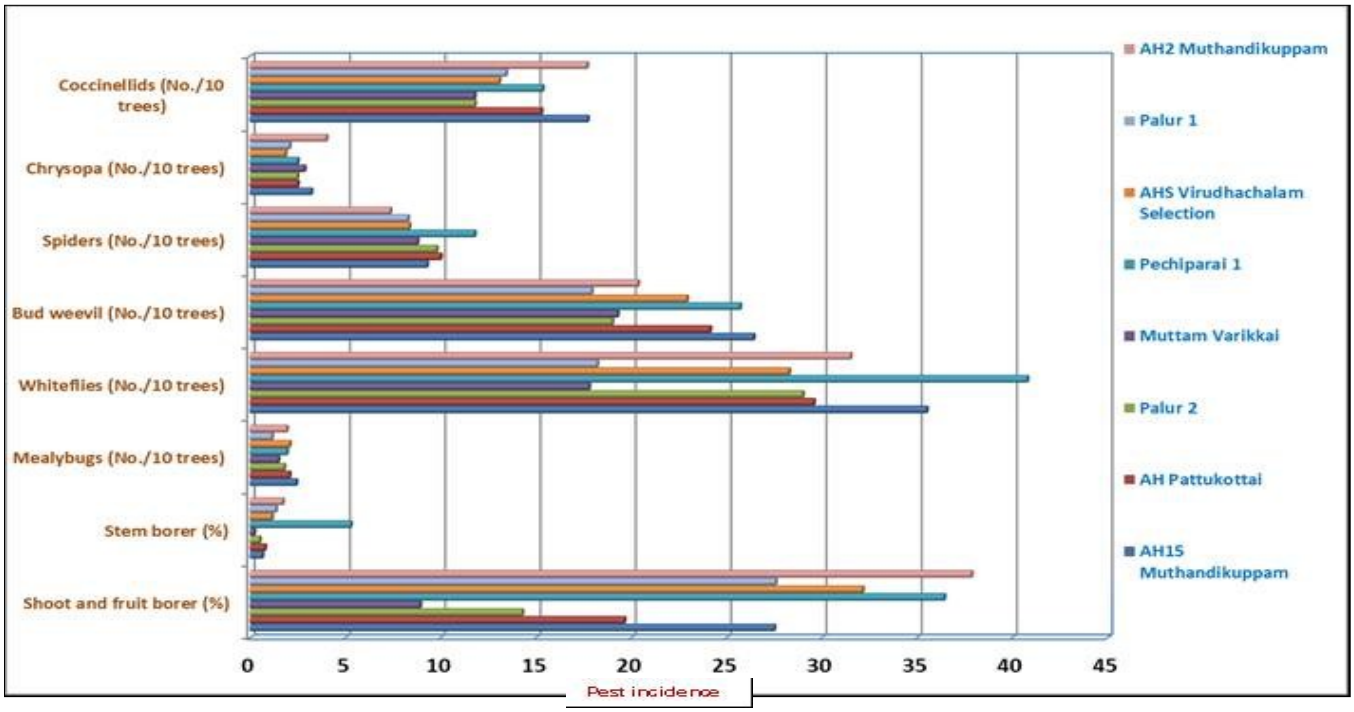

Fig. 1. Insect pests and natural enemies on jackfruit cultivars.

Among the different cultivars, Muttam Varikkai was found to be less susceptible to stem borer (0.21%), shoot and fruit borer (8.92%) and whiteflies (17.92/10 trees) followed by Palur 2 (shoot and fruit borer, 14.28% and whiteflies, 29.00 /10 trees and stem borer, 0.50%). Conversely, in AH2 Muthandikuppam and Pechiparai 1 recorded maximum damage from the shoot and fruit borer (37.85 and 36.42%, respectively). Pechiparai 1 stem borer (5.28%) also exhibits the maximum damage compared to other cultivars. The jackfruit cultivar, AH15 Muthandikuppam and Palur 1 were found to be less susceptible to bud weevil (16.42 and 17.92/10 trees) and were found to be maximum in Pechiparai 1 (25.71/10 trees) (Table 3 and Plate1).

The spider population was highest in Pechiparai 1 (11.78/10 trees) and AH Pattukottai (10.00/10 trees), whereas chrysoperla and coccinellids populations were maximum in AH2 Muthandikuppam (4.00 and 17.68/ 10 trees) (Table 3 and Plate 2). Although major pests were observed during the experimental period, the level and stage of the crop damage vary in Tamil Nadu. For example, stem borer incidence was reported as a maximum issue across cultivars and varieties surveyed (8), but the incidence of bark caterpillar was not observed, even though it is a dominant pest in states like Madhya Pradesh, Uttar Pradesh, Rajasthan, Punjab and Haryana (9).

The shoot and fruit borer were found to be significantly abundant species in Karnataka, Kerala and Tamil Nadu (10) and an outbreak of the pest was recorded in Kerala during 2022 by (8) in Tekam Yellow and Vietnam Super Early. Researchers also reported 40 % infestation in different districts of Kerala (11). The bud weevils were found to damage the buds and make them pre-fall before fruit set, whereas bud weevils were also reported to be feeding on leaves of jackfruit from India (12). Mealy bug is a polyphagous pest known to attack 35 plant species and is predominant in horticultural crops (8).

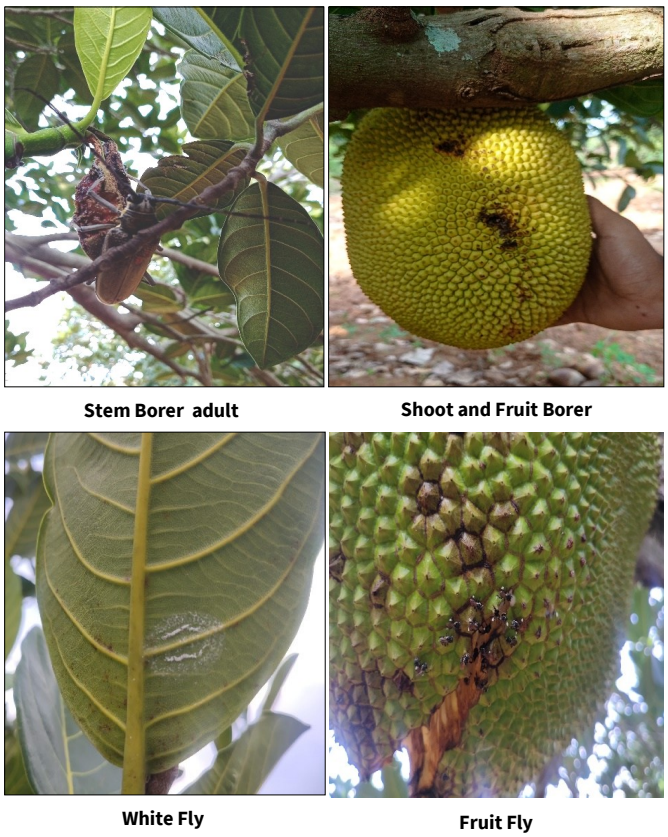

Plate 1. Incidence of Pest in jackfruit cultivars.

Table 2. Insect pests and natural enemies on jackfruit cultivars at Theni district, Tamil Nadu in 2023

S. No.	Insect Pests on jackfruit cultivars		
	Common Name	**Scientific Name**	**Family and Order**
1	Stem borer	*Batocera rufomaculata*	Cerambycidae, Coleoptera
2	Shoot and fruit borer	*Diaphania = Glyphodes caesalis*	Pyralidae, Lepidoptera
3	Fruit fly	*Bactrocera dorsalis*	Tephritidae, Diptera
4	Bud weevil	*Ochyromera atrocarpi*	Curculionidae, Coleoptera
5	Mealybug	*Drosicha mangiferae*	Margarodidae, Hemiptera

Spider Coccinellid

Plate 2. Incidence of Natural Enemies in jackfruit cultivars.

Seasonal incidence of insect pests and their natural enemies in jackfruit

The seasonal incidence of insect pests and their natural enemies correlated with weather parameters (Table 4) in jackfruit revealed that the shoot and fruit borer and stem borer were maximum during hot, humid conditions and were positively correlated with minimum and maximum temperature (0.479 and 0.126 and 0.577 and 0.217, respectively). These pests were negatively correlated with rainfall, wind speed and relative humidity. Similarly, mealybug, whitefly and bud weevil incidence were highest during maximum temperature and relative humidity, showing strong positive correlation (0.979, 0.952, 0.967, 0.87, 0.859 and 0.88, respectively) and negatively correlated with rainfall and wind speed (Table 4). The coccinellids beetle and spiders were more active during hot temperatures (0.71, 0.706 and 0.455, 0.444, respectively), but chrysoperla were negatively correlated (-0.252 and -0.366). The present study revealed the incidence of shoot and fruit more during April- June, but it was (13) reported during August to November. A significant positive correlation of *D. caesalis* with relative humidity, minimum temperature and rainfall was found that the population increased with an increase in temperature along with humidity (14) whereas maximum occurrences of lepidopteran pest populations during the monsoon season (15). The adult insect of stem borer was observed to be active during hot weather, but (16) recorded its maximum activity from October to January. The adult beetles come out after the onset of monsoon (June-July) and lay eggs (17). Sucking pests were more abundant during August to November (18).

Variations in the incidence of pests and related natural enemies depend on the morphological characteristics of leaves, stems and fruits (19). The biochemicals, phenols and flavonoids conferred resistance in rice by acting as barriers to insect feeding (20). The increased susceptibility to brinjal shoot and fruit borer is due to a lesser quantity of protein, thus making the plants less prone to insect attack (21). Thus, phytochemicals play a major role in the attraction and repellence of pests (17).

Conclusion

The shoot and fruit borer, stem borer, whiteflies, mealybugs and predatory coccinellid beetles and chrysopa were major pests and natural enemies in the jackfruit ecosystem in Tamil Nadu. The occurrence of predatory beetles and Chrysopha was found to reduce the population of sucking pests in jackfruit.

The shoot and fruit borer and stem borer were positively correlated with temperature, whereas they were negatively correlated with rainfall, wind speed and relative humidity.

Table 3. Incidence of insect pests and their natural enemies on jackfruit cultivars at during 2022-2023

Varieties/Cultivars	Shoot and fruitborer (%) **	Stem borer (%) **	Mealybugs (No./10 trees) *	Whiteflies (No./10 trees) *	Bud weevil (No./10 trees) *	Spiders (No./10 trees) *	Chrysopa (No./10 trees) *	Coccinellids (No./10 trees) *
AH15 Muthandikuppam	27.50^{d}	0.64^{c}	2.42^{f}	35.50^{g}	26.42^{f}	9.28^{c}	3.21^{b}	17.71^{a}
AH Pattukottai	19.64^{c}	0.78^{c}	2.07^{e}	29.57^{d}	24.14^{e}	10.00^{b}	2.50^{d}	15.28^{b}
Palur 2	14.28^{b}	0.50^{b}	1.78^{c}	29.00^{c}	19.00^{b}	9.78^{b}	2.48^{d}	11.79^{d}
Muttam Varikkai	8.92^{a}	0.21^{a}	1.48^{b}	17.78^{a}	19.28^{b}	8.78^{d}	2.85^{c}	11.78^{d}
Pechiparai 1	36.42^{f}	5.28^{f}	1.92^{c}	40.78^{h}	25.71^{f}	11.78^{a}	2.50^{d}	15.35^{b}
AHS Virudhachalam Selection	32.14^{e}	1.14^{d}	2.07^{e}	28.28^{e}	22.92^{d}	8.35^{e}	1.85^{f}	13.07^{c}
Palur 1	27.57^{d}	1.35^{d}	1.14^{a}	18.21^{b}	17.92^{a}	8.28^{e}	2.07^{e}	13.42^{c}
AH2 Muthandikuppam	37.85^{f}	1.71^{e}	1.92^{d}	31.50^{f}	20.35^{c}	7.35^{f}	4.00^{a}	17.68^{a}
SE (d)	0.043	0.088	0.013	0.029	0.034	0.028	0.015	0.028
CD (P=0.05)	0.896	0.174	0.025	0.057	0.073	0.052	0.032	0.060

Figures in parentheses are square root transformed values * and arcsine transformed values **

Means followed by a common letter in a column are not significantly different

Values are the mean of twenty replications

Table 4. Correlation on the incidence of insect pests and natural enemies on jackfruit cultivars with weather parameters during 2022-2023

Weather Parameter	Correlation Coefficient (No./ % incidence)							
	Shoot and fruit borer	Stem borer	Mealybugs	Whiteflies	Bud weevil	Spiders	Chyrsopa	Coccinellids
Max. Temp	0.479	0.126	0.979*	0.952*	0.967*	0.455	-0.252	0.710*
Mini. Temp	0.577*	0.217	0.264	0.115	0.125	0.444	-0.366	0.706*
RF (mm)	-0.351	0.001	-0.490	-0.402	-0.471	-0.645*	0.450	-0.379
RH (%)	-0.103	0.127	0.870*	0.859*	0.880*	-0.584*	0.367	-0.514
Wind speed (km/hr)	-0.502	-0.249	-0.603*	-0.449	-0.502	0.039	0.498	-0.312

*Highly significant ($p < 0.05$) at 0.05 level (one-tailed)

A correlation coefficient is significant at a 0.05% level (one-tailed)

Mealybug, whiteflies and bud weevil incidence were recorded high during maximum temperature and relative humidity and were positively correlated and negatively correlated with rainfall and wind speed. The baseline data help to choose varieties in pest-prone zones and guide the farmers and extension officials for pest forecast-based pest management strategies.

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Authors' contributions

SSK, SKR, MR and VS carried out the field survey, identification of pests and natural enemies and data entry. SSK, KP and KK completed the statistical analysis. SSK and KRR envisioned the manuscript and coordinated. All authors read and approved the final manuscript

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

Ethical issues: None

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