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Incidence of leaf roller, *Statherotis leucaspis* and tea tortrix, *Homona coffearia* (Tortricidae: Lepidoptera) on litchi (*Litchi chinensis*) flowers in India

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ABSTRACT

The litchi leaf roller, *Statherotis leucaspis*, was reported to attack litchi foliage and the tea tortrix, *Homona coffearia,* on the bud and foliage of many fruit and plantation crops except litchi in India. The incidence of *S. leucaspis* and litchi as a new host plant for *H. coffearia* flowers was observed in two major litchi-growing states (Bihar and Jharkhand) of India during 2021 and 2022. A description of the species, their population dynamics and correlations with weather parameters is presented. Larvae of *S. leucaspis* and *H. coffearia* feed in inflorescences through webbing and feeding inside silken webs and tunnelling into immature fruits. The number of webs per inflorescence ranged from 1.58 to 2.05 at flowering to fruit setting phenophase of litchi during 2021 and 2022, respectively. During 2022, the percentage of panicle damage in experimental farms varied from 1.9 to 34.2% and 2.8 to 37.7% in farmers' fields of Muzaffarpur, Bihar by *S. leucaspis*. The correlation analyses showed a significant positive correlation (p<0.05) with rainfall for the incidence of *H. coffearia*, and with temperature for the incidence of *S. leucaspis.* The studies suggest an urgent need to develop effective and pollinator-friendly management strategies against these additional flower feeder insect pests in litchi.

Keywords: Flower webber, Homona coffearia, litchi, Statherotis leucaspis, tortricids

INTRODUCTION

Litchi or Lychee (*Litchi chinensis* Sonn), family Sapindaceae, is an evergreen sub-tropical fruit crop. Litchi appears to be indigenous to Southern China and Southeast Asia. Litchi cultivation has spread to other countries such as the West Indies, Australia, Taiwan, South Africa, Florida, Indonesia, and Brazil, accounting for 91 per cent of global production (Singh et al., 2012). Litchi was introduced to India in the 18th century, specifically in the Northeast region of Tripura, India. Over time, it gradually moved to the eastern and northern parts of the country (Rai et al., 2002). India is the second largest litchi grower worldwide, following China. India every year produces 746,000 metric tonnes of litchi fruit from a total of 98,180 hectares (GOI, 2024). The average productivity of litchi in the country was 7.6 tonnes per hectare, which is substantially lower than the potential productivity of the crop. Due to its specific climatic requirements, litchi cultivation is limited to certain states. Approximately 66% of the country's total litchi production is concentrated in Bihar, West Bengal, and Jharkhand.

Pests, diseases, pollinator's asynchrony, and physiological disorders are the major obstacles to consistently achieving high-quality fruits and high yields (Singh et al., 2012; Choudhary et al., 2013). The damage inflicted by insect pests is a result of the simultaneous presence of many species. Additionally, the persistence of high pest populations extends the duration during which litchi orchards remain vulnerable to these threats (Choudhary et al., 2013; Parveen et al., 2015). In India, there are approximately 42 species of insects and mites that have been documented to infest and damage trees and fruits of litchi at various phases of development (Rai et al., 2002; Singh et al., 2012). The majority of insect species reported to feed on litchi belong to the orders Lepidoptera and Coleoptera, followed by the Homoptera and Hemiptera (Srivastava & Choudhary, 2022; Kumar et al., 2014).

Litchi fruit borer, *Conopomorpha sinensis* Bradley & *Conopomorpha litchiella* Bradley (Lepidoptera: Gracillariidae), and litchi leaf roller, *Dudua aprobola* Meyrick (Lepidoptera: Tortricidae) have acquired the status of major pests and recently litchi looper, *Perixera illepidaria* Guenée (Lepidoptera: Geometridae), litchi bugs, *Tessaratoma javanica* Thunberg, *Tessaratoma papillosa* Dury, and *Tessaratoma quadrata* Distant (Hemiptera: Tessaratomidae), and bagworms are among the important emerging pests of litchi (Kumar et al., 2011; Choudhary et al., 2013; Kumar et al., 2013 & 2014). The most vulnerable stage of litchi against insect-pest attack is the flowering stage, where many pests are associated with causing economic damage (Choudhary et al., 2021). Litchi leaf roller species, *D. aprobola* & *Statherotis* (=*Argyroploce*) *leucaspis* Meyr. are common and reported in India attacking litchi foliage. The tea tortrix, *Homona coffearia* (Nietner, 1861) is reported to attack on bud and foliage of *Mangifera indica* (Anacardiaceae), *Dimocarpus longan*, *Nephelium lappaceum* (Sapindaceae), *Camellia sinensis* (Theaceae), and *Duranta erecta* (Verbenaceae) etc. but not on litchi in India (Pathania et al., 2020). Data about insect pests monitoring and their population dynamics were recorded at the ICAR-RCER Farming System Research Centre for Hill and Plateau Region, Ranchi, India, and the National Research Centre on Litchi (NRCL), Muzaffarpur, India to know the status and behaviour of the pests in litchi. In the present study, we have reported the infestation of tea tortrix, *H. coffearia*, and the incidence *S. leucaspis* from foliage to flower feeders in litchi in India. The extent of occurrence and damage intensity, along with damage symptoms of flower webbers are also described.

MATERIALS AND METHODS

Experimental details

The present investigation was conducted in litchi orchards of the ICAR Research Complex for Eastern Region, Farming System Research Centre for Hill and Plateau Region (ICAR-RCER FSRCHPR), Plandu, Ranchi, India and the National Research Centre on Litchi (NRCL), Muzaffarpur, India and the adjoining areas during 2021 and 2022. Geographically, orchards are located at 23° 452 N latitude, 85° 302 E longitude, elevation 620 m amsl and 26° 04' N latitude, 85° 27' E longitude, elevation 210 m amsl in Jharkhand, Ranchi and Bihar, Muzaffarpur state of India, respectively. The area has a typically sub-tropical climate with an average annual rainfall of 1100-1300 mm. Litchi orchards of about one hectare having cvs. 'Shahi' and 'China' planted at 10×10 m spacing row to row and plant to plant were selected for observations. The age of the trees was 20–30 years old. The selected experimental plots were free from pesticide applications.

Observation of pest and phenology

The population of insect pests was counted at weekly intervals during the period of investigation. Leaf cum flower webs were counted as the number of leaf webs or flower webs per shoot at Ranchi during 2021 and 2022. Ten trees were selected randomly and from each plant, four twigs in four directions (North, South, East, and West) were randomly chosen to record insect pest incidence and phenological observations. Different phenological stages of litchi were observed by using a standardized BBCH (*Biologische Bundesantalt*, *Bundessortenamt*, and *Chemische Industrie*) scale (Wei et al., 2013). Immature stages from webs were collected and reared in the laboratory for adult stages emergence by providing fresh flower panicles. Collected specimens were pinned systematically and identified by a taxonomist, and the voucher specimen was submitted to the Division of Entomology, Indian Agricultural Research Institute, New Delhi, India. The process of collection and identification was carried out throughout the data collection period. The insect pest species were identified based on the morphological characteristics and developmental biology of the pest.

Quantitative data on flower webber incidence at NRCL experimental farm and farmer's field were based on the counts of the number of webs and panicles damaged by flower Webber during 2022. The data were collected from 3 randomly selected trees in 10 different blocks/ orchards from selected locations. From each randomly selected tree, 30 panicles from each direction and a total of 120 panicles from each tree were observed. The total number of webs and damaged panicles was counted and converted into the per cent damaged panicles.

Statistical analysis

The analyses of mean value data and correlations were calculated by using SPSS V. 21 to find out the effect of different weather parameters on the incidence and

development of flower webs in the litchi. The experimental was laid out in a randomized block design with three replications. Data of webbers from NRCL experimental farm and farmer's fields were transformed using the square root for the number of webs, and arc sine transformed for per cent panicle damage before analysis. The significant means of different blocks and orchards were separated using the least significant differences (LSD) between means at a 5% significance level (*Pd"*0.05). Statistical analyses within a group over time periods were performed by repeated-measures analysis of variance (RM-ANOVA) with Bonferroni correction of unpaired t-test. Comparisons between time periods were made by applying Wilks' Lambda test. The threshold for statistical significance was $P<0.05$.

RESULTS AND DISCUSSION

Infestation of webbers on litchi flowers was observed in litchi orchards of Jharkhand and Bihar states of India. The species identified as *Statherotis* (=*Argyroploce*) *leucaspis* Meyr. (Tortricidae: Lepidoptera) in both the states and *Homona coffearia* (Nietner, 1861) (Tortricidae: Lepidoptera) only from Jharkhand state by a taxonomist at ICAR-Indian Agricultural Research Institute, New Delhi. *H. coffearia* is the first report as a pest of the litchi fruit tree in India (Fig. 1A & 1I). Earlier reports suggest that *S. leucaspis* incidence was restricted to the leaf of litchi, which rolled new leaves on feed on them (Singh & Kumar, 1997; Nair & Sahoo, 2006). The *H. coffearia* was reported to attack the bud and foliage of many fruit and plantation crops (Pathania et al., 2020).

The present study reports the spread of incidence of *S. leucaspis* from foliage to flowers of litchi (Fig. 1B & J), and litchi as a new host plant in India for tea tortrix, *H. coffearia*. The infestation was observed up to the fruit development stage of litchi. Before flowering, larvae of *S. leucaspis* were observed feeding inside young leaves, while, rolling inward the edges of leaves through silken threads. Young larvae of *H. coffearia* were found to feed on young growing top leaves while making webs altogether of young leaves. Larvae of both species were observed to cause damage from leaves to inflorescence, and young growing fruits of litchi (Fig. 1A-1J). Flowers in the inflorescence were webbed together by larvae using silken threads. Florets of flowers and small-sized fruits were cut and

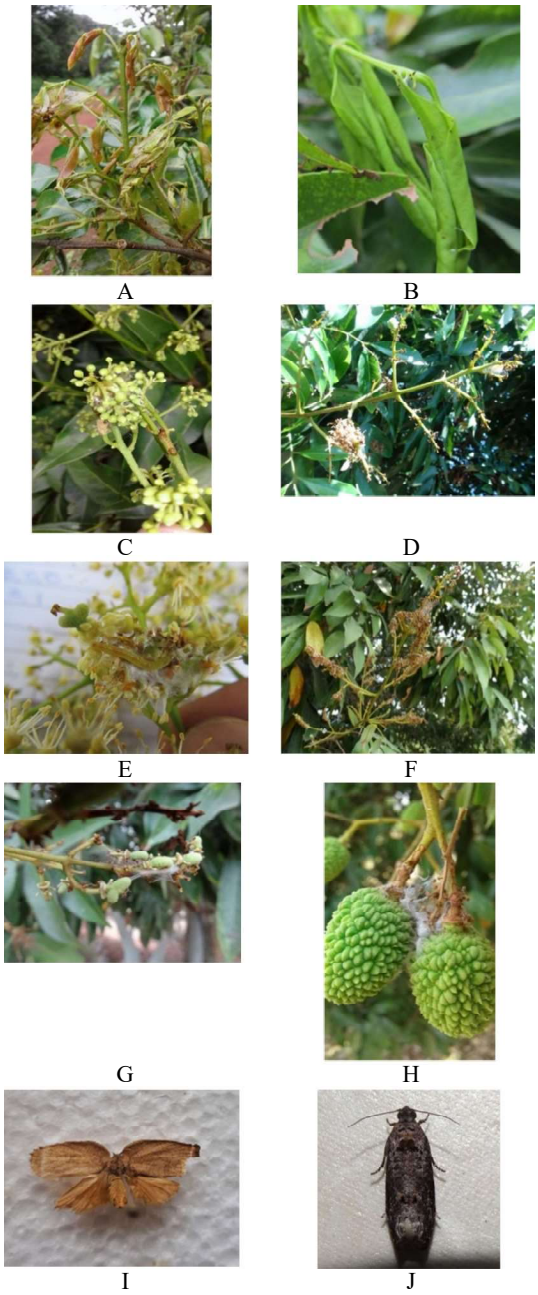

Fig. 1 : Webs and damage symptoms caused by the infestation of *Homona coffearia* and *Statherotis leucaspis* at different phenophases from flowering to fruiting stage in litchi. Leaf webbing by *H. coffearia* (A) & *S. leucaspis* (B); early-stage flower webbing *H. coffearia* (C) & *S. leucaspis* (D); webs of *S. leucaspis* on different phenophases of litchi (E-H) and adults of *H. coffearia* (I) & *S. leucaspis* (J)

carried in one place to make web balls. Larvae remain inside webs and were observed to feed the florets and tunnel into immature fruits. Feeding of webbers on litchi inflorescence ultimately resulted in bare pedicel and peduncles and drying up of inflorescences.

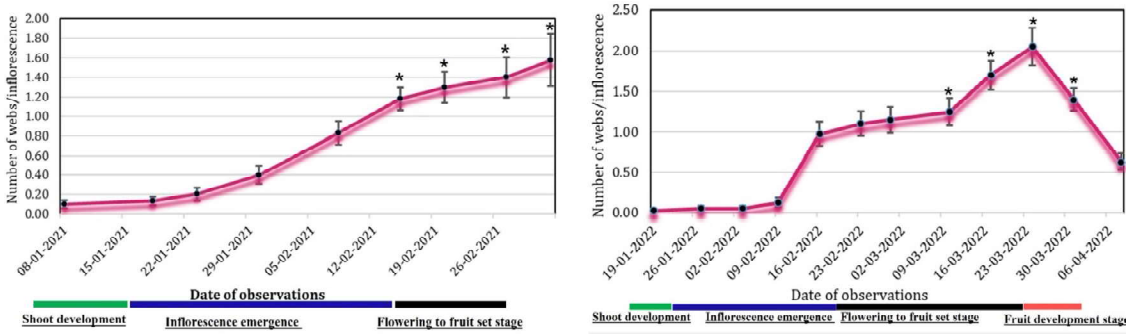

Fig. 2 : Leaf webber, *Statherotis leucaspis*, population dynamics observed in different phenophases of litchi from flowering to fruiting stage in Ranchi, Jharkhand during the years 2021 & 2022
*p<0.05 versus baseline. Data represent mean ± standard deviation (SD)

Incidence, minor to major pest status, and changing feeding behaviour with stages of crops of insect pests mainly depends on biotic and abiotic factors. Several other factors, such as the use of insecticides, crop and cultivar changes, ecology of the geographical regions, etc. are also responsible factors for changes in insect richness and diversity (Zahoor et al., 2003).

The incidence of leaf webber, *S. leucaspis,* was observed from flower emergence phenophase and continued up to the fruiting stage at Experimental Farms of Ranchi Centre during 2021 and 2022. The maximum number of webs per inflorescence was observed at 1.58 webs on 4th March 2021 (data were incomplete due to the coronavirus lockdown) and 2.05 webs on 24th March 2022 at flowering to fruit setting phenophase of litchi, respectively (Fig. 2).

The observations on per cent damage caused by *S. leucaspis* recorded at the experimental farm of NRCL revealed that panicle damage varied from 1.9 to 34.2% among different blocks during observation periods. Similarly, number of webs ranged from 0.8 to 21.4 webs/120 panicles (Table 1). The intensity of the number of webs and damaged panicles was observed more or less the same in farmers' orchards of Muzaffarpur district of Bihar, India (Table 2). The mean number of webs and per cent panicle damage was observed to be significantly different among the orchards of farmers' fields and

Table 1 : Leaf webber, *Statherotis leucaspis*, infestation, and per cent panicle damage on litchi during the flowering period (2022) at the research farm of ICAR-NRCL, Muzaffarpur, Bihar, India

Date of observation	02-03-2022		15-03-2022		30-03-2022	
Experimental blocks	No. of webs/120 panicles*	Per cent damaged panicles**	No. of webs/120 panicles*	Per cent damaged panicles**	No. of webs/120 panicles*	Per cent damaged panicles**
Block I	0.8 (1.14)	3.6 (11.99)	6.1 (2.57)	10 (20.18)	17.2 (4.21)	28.6 (35.85)
Block II	1.7 (1.48)	2.2 (8.93)	6.9 (2.72)	7.5 (17.20)	21.4 (4.68)	33.6 (39.40)
Block III	0.8 (1.14)	1.9 (8.13)	4.7 (2.28)	6.4 (16.02)	18.3 (4.34)	29.2 (36.22)
Block IV	4.4 (2.21)	8.6 (18.73)	7.5 (2.83)	12.8 (22.93)	16.1 (4.07)	28.6 (35.83)
Block V	2.2 (1.64)	3.6 (11.89)	6.9 (2.72)	10.6 (20.71)	18.1 (4.31)	26.1 (34.02)
Block VI	2.2 (1.64)	4.7 (13.52)	10.0 (3.24)	11.7 (21.93)	20.3 (4.56)	29.4 (36.45)
Block VII	3.6 (2.02)	5.3 (14.43)	8.6 (3.02)	9.4 (19.64)	19.4 (4.46)	34.2 (39.79)
Block VII	2.2 (1.64)	2.5 (9.72)	6.4 (2.63)	8.1 (18.07)	18.6 (4.37)	31.4 (37.84)
Block IX	2.5 (1.73)	5.8 (15.31)	6.4 (2.63)	11.7 (21.86)	13.3 (3.71)	25.6 (33.61)
Block X	2.8 (1.82)	5.0 (14.09)	7.5 (2.83)	9.4 (19.61)	18.1 (4.31)	25.8 (33.80)
SE(m) ±	0.21	1.57	0.11	1.34	0.18	1.01
LSD (*pd"0.05*)	0.63	4.68	0.336	4.02	0.54	3.03

*Data in parentheses are square root ("+0.5) transformed values; **Data in parentheses are Arcsine transformed values

Table 2 : Leaf webber, *Statherotis leucaspis*, infestation, and per cent panicle damage on litchi during the flowering period (2022) at farmers field of Muzaffarpur district, Bihar, India

Date of observation	13-03-2022		29-03-2022		14-04-2022	
Farmers field orchards	No. of webs/120 panicles*	Per cent damaged panicles**	No. of webs/120 panicles*	Per cent damaged panicles**	No. of webs/120 panicles*	Per cent damaged panicles**
Orchard I	1.9 (1.55)	3.6 (11.99)	8.1 (2.93)	11.7 (21.93)	20.3 (4.56)	33.3 (39.20)
Orchard II	2.5 (1.73)	3.1 (10.86)	8.3 (2.97)	10.3 (20.49)	24.2 (4.97)	36.7 (41.53)
Orchard III	1.7 (1.48)	2.8 (10.34)	7.5 (2.83)	9.4 (19.66)	20.0 (4.53)	31.4 (37.83)
Orchard IV	5.0 (2.35)	8.6 (18.73)	8.6 (3.02)	14.4 (24.50)	17.5 (4.24)	28.9 (36.05)
Orchard V	3.1 (1.90)	3.6 (11.89)	8.1 (2.93)	13.6 (23.80)	19.2 (4.44)	26.1 (34.03)
Orchard VI	2.8 (1.82)	4.7 (13.52)	9.2 (3.11)	13.6 (23.79)	21.7 (4.71)	31.1 (37.65)
Orchard VII	3.6 (2.02)	5.6 (14.89)	6.7 (2.68)	12.2 (22.51)	20.8 (4.62)	36.1 (41.15)
Orchard VII	2.5 (1.73)	3.1 (10.86)	4.7 (2.28)	10.3 (20.50)	20.0 (4.53)	33.1 (39.02)
Orchard IX	2.8 (1.82)	5.8 (15.31)	9.7 (3.19)	12.8 (22.93)	15.0 (3.94)	28.6 (35.85)
Orchard X	3.1 (1.90)	5.3 (14.50)	8.9 (3.07)	10.3 (20.45)	19.2 (4.44)	26.9 (34.64)
SE(m) ±	0.16	1.22	0.14	1.09	0.17	0.88
LSD (*pd"0.05*)	0.48	3.67	0.41	3.25	0.52	2.64

*Data in parentheses are square root ("+0.5) transformed values; **Data in parentheses are Arcsine transformed values

Table 3 : The mean population and infestation of leaf webber, *Statherotis leucaspis*, mean±standard deviation (SD), during the flowering (2022) across the orchards of Muzaffarpur district, Bihar, India

Observation	Research farm of ICAR NRCL, Muzaffarpur		Farmers field of Muzaffarpur district	
	No. of webs/120 panicles	Per cent damaged panicles	No. of webs/120 panicles	Per cent damaged panicles
Ist	2.32 ± 1.06	4.32 ± 1.65	3.90 ± 1.88	4.53 ± 1.08
IInd	7.10 ±1.37*	9.54 ± 2.67*	9.98 ± 2.65*	11.95 ± 3.27*
IIIrd	18.08 ± 2.13*	29.05 ± 5.10*	24.10 ± 4.95*	31.35 ± 6.16*
F (*df=1, 9*)	142.48	135.02	203.66	156.86
(*pd"0.05*)	<0.001	<0.001	<0.001	<0.001

*p<0.05 significant versus baseline

research farms of NRCL tested by one-way ANOVA (*p*d"0.05) (Table 1 & 2). There was a significant build-up of the population of *S. leucaspis* on litchi flowers compared with baseline data in both experimental and farmers' field litchi orchards of Bihar (*pd"0.05*) (Table 3). The population build-up of *S. leucaspis* in Ranchi orchards also indicated a significant time effect in both the years (2021 & 2022) data observations (*pd"0.05*) (Fig. 2).

A higher number of webs were recorded in the farmer's litchi orchards of Bihar state compared to research farms of NRCL and Ranchi Centre. The build-up of a higher number of webs in litchi orchards of farmers may be due to unmanaged old litchi plantations in the vicinity of observed orchards where data were recorded (Kumar et al., 2014). However, understanding the factors responsible for the population build-up of insect pests is very complex and difficult to predict based on one or two responsible factors (Moanaro & Choudhary, 2016). The incidence of flower webber, *Homona coffearia* was observed from inflorescence emergence phenophase and reached its peak at the fruit set stage at Ranchi Centre experimental orchards in 2022 (Fig. 3). The maximum number of webs formed by *H. coffearia* per inflorescence was observed at 0.60 webs on 16th March 2022 on the fruit set stage with no significant progression over baseline (Fig. 3).

Table 4 : Influence of weather parameters on leaf webber, *Statherotis leucaspis* and *Homona coffearia* population dynamics in Jharkhand and Bihar states of India

Pest	Max. temperature (°C)	Min. temperature (°C)	Relative humidity (%)	Wind velocity (km/h)	Rainfall (mm)
Statherotis leucaspis (Jharkhand)	0.67*	0.54	-0.69*	0.04	-0.13
Homona coffearia (Jharkhand)	-0.35	-0.15	-0.11	-0.13	0.56*
Statherotis leucaspis (Bihar)	0.87*	0.96*	-0.88*	0.98*	-0.73

*Significant at $p<0.05$

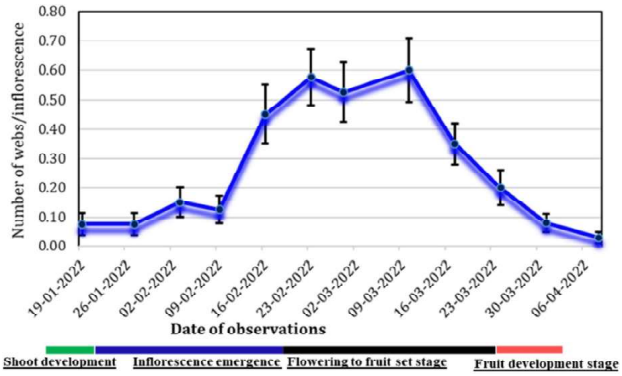

Fig. 3 : Leaf webber, *Homona coffearia*, population dynamics observed in different phenophases of litchi from flowering to fruiting stage in Ranchi, Jharkhand, during 2022. Non-significant change over baseline data was observed (p=0.22). Data represent mean ± standard deviation (SD)

The relationship between the population of leaf webbers and weather factors showed that some of the weather parameters were important factors that influenced the webber's population (Table 4) significantly. The correlation analysis indicated rainfall had a significant positive effect on the per cent incidence of *H. coffearia* ($p<0.05$). Temperatures had positive correlations with *S. leucaspis* incidence at both places and positive with wind velocity at research farms of NRCL, Bihar. Rainfall was observed to have a significant negative correlation with *S. leucaspis* incidence at research farms of NRCL, Bihar, but not correlated at Experimental Farms of Ranchi Centre (Table 4).

Earlier studies showed that temperature and rainfall had a significant impact on the incidence of lepidopteran and other pests (Kumar et al., 2014; Choudhary et al., 2022). The study conducted by Mishra & Pandey (1965) also showed positive correlations with average temperature, average relative humidity and rainfall with the larval population of *S. leucaspis* in the litchi orchards as foliage feeder. The new and greater number of insect pest incidences in the flowering stage of litchi is of great concern. The direct losses caused by reported flower webber species will influence litchi production in India. Due to the high cross-pollination nature and dependency on insects for pollination in litchi, it will be very difficult to control the selected effective chemical insecticides (Choudhary et al., 2013). Insecticidal spray on flower webbers will be less effective due to its concealment in feeding and habitat, which protects it from insecticide applications.

CONCLUSION

The present study reported the incidence of *S. leucaspis* and *H. coffearia* on litchi flowers in major litchi-growing regions of India. A significant increase in the *S. leucaspis* population was observed in litchi flowers in Bihar and Jharkhand litchi orchards. Two environmental factors, rainfall and temperatures, affect the population dynamics of *H. coffearia* and *S. leucaspis.* Considering the expansion of incidence (*S. leucaspis*) and litchi as a new host plant (*H. coffearia*) in major litchi growing areas, it is very urgent to study further ecology, biology, spatial and temporal distribution of both species. The studies will be helpful in planning effective management strategies for these two insect pests.

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