RESEARCH ARTICLE Legume Research- An International Journal, Volume 49 Issue 5: 876-882 (May 2026)

Spatial Dynamics of Fenugreek Pests and Their Natural Predators: Influence of Environmental Factors on Aphid Infestation and Sustainable Management

S. Sumaiya Parveen[1], C. Samyuktha[2]

10.18805/LR-5623

ABSTRACT

Background: Fenugreek is an important winter-season legume crop in South India; however, very limited information is available on the spatial dynamics of its key sucking pests and associated natural enemies. Understanding the influences of local microclimate on pest abundance is very essential for developing site-specific and sustainable management strategies.

Methods: An open field experiment was carried out to study the spatial dynamics of major pests of fenugreek and their natural enemy fauna under two different geographical locations of Tamil Nadu (Thondamuthur, Coimbatore and Kangeyam, Tiruppur) during the *Rabi* season, 2022-23. Monthly observations were recorded on major sucking pests (aphids, thrips and whitefly) and natural enemies (spiders and coccinellids) from early vegetative growth to seed maturity. Meteorological data (temperature, relative humidity, rainfall, sunshine hours and wind speed) were used to determine their correlations with pest populations.

Result: The incidence of pest infestations started at the early vegetative stage and continued until the seed maturity. The aphids were predominant throughout the crop growth phase, although their intensity varied and a higher abundance was noticed during February with 19.88 to 25.85 aphids per 10 cm apical shoot under the experimental field of Thondamuthur (Coimbatore) and Kangeyam (Tiruppur), respectively; while the thrips population appeared to its peak during February in Thondamuthur (7.35 per three leaves) and Kangeyam (8.45 per three leaves). Meanwhile, the peak infestation of whitefly was recorded as 6.65 and 8.45 per three leaves in the experimental plots of Thondamuthur and Kangeyam, respectively. The prevailing maximum temperature was found to have an adverse effect on the population growth of fenugreek pests (r = -0.84, -0.46, -0.59 and -0.68, -0.12, -0.08 against aphids, thrips and whitefly, respectively). The bright sunshine and wind speed have shown a positive association in both of the experimental areas. The natural enemy population controls the pest abundance significantly at both the experimental areas. Spatial distribution indicates a comparatively higher aphid density under the experimental plots of Thondamuthur (Coimbatore), compared to the plots from Kangeyam (Tiruppur), in comparison to that of the whitefly and thrips populations.

Key words: Aphid infestation, Environmental factors, Fenugreek pests, Natural enemies, Spatial variation, Sustainable pest management.

INTRODUCTION

Fenugreek (*Trigonella foenum graecum* L.) is widely recognized as methi, under the family Leguminosae and is native to Southeastern Europe and Western Asia (Ahmad *et al*., 2016). It is among the most significant cold-season leguminous crops grown in the northern parts of India. Punjab, Gujarat, Rajasthan, Maharashtra and Madhya Pradesh are some of the prominent states in India in the production of this crop (Kumar *et al*., 2016). The green plant in its tender or succulent stage is used as a vegetable, while the dough stage is used as fodder for cattle and the seeds are primarily used as a spice and for medicinal purposes (Basu *et al*., 2014). The high market price attracts the attention of farmers and hence becomes a permanent feature of their cropping strategy, especially in areas with problematic soils. It proves better than other legumes, like gram, because of its moderate tolerance toward salinity (Habib *et al*., 1971). Among various insect pest fauna under the fenugreek ecosystem, the aphids *Aphis craccivora* (Koch) and *Acyrthosiphon pisum* (Harris) cause significant losses during the early crop stage (Mishra and Pandey, 2023).

The aphids feed on the sap of plants, lowering their vitality and potential yield in varying proportions. A severe infestation of pests may cause the crop plant to wither and die, leading to total crop loss (Kumar *et al*., 2016). Moreover, whiteflies, jassids, thrips and mites are among the numerous sucking pest complexes that harm the fenugreek crop (Bindhani *et al*., 2021), where adults and

[1]Division of Entomology, School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Karunya Nagar, Coimbatore-641 114, Tamil Nadu, India.
[2]School of Agricultural Sciences, Amrita Vishwa Vidyapeetham, Coimbatore- 642 109, Tamil Nadu, India.

Corresponding Author: S. Sumaiya Parveen, Division of Entomology, School of Agricultural Sciences, Karunya Institute of Technology and Sciences, Karunya Nagar, Coimbatore-641 114, Tamil Nadu, India. Email: ssumaiyasaleem@gmail.com
ORCID: 0000-0001-8434-6508

How to cite this article: Parveen, S.S. and Samyuktha, C. (2026). Spatial Dynamics of Fenugreek Pests and Their Natural Predators: Influence of Environmental Factors on Aphid Infestation and Sustainable Management. *Legume Research*. **49(5):** 876-882. doi: 10.18805/LR-5623.

Submitted: 15-12-2025 **Accepted:** 24-01-2026 **Online:** 02-02-2026

nymphs directly consume the sap off the leaves, particularly on the undersides of the leaflets, to ward off whiteflies (Nisha *et al*., 2021) and cause harm by using a jassid to inject its poisonous saliva into plant tissues (Chandrasekaran *et al*., 2021). The knowledge of seasonal incidence is also necessary for adopting sustainable management practices against fenugreek insect pests. The key abiotic factors, including temperature, relative humidity and rainfall, have a significant influence on insect pest population fluctuations (Mishra and Pandey, 2023). It is well-known that the attack of prevalent insect pests is correlated with the stage of plant growth and the climate at a given period (Malhotra and Vashishtha, 2017). Therefore, under varying crop geometry, changes in the sowing period might have a major impact on the infestation of a particular pest. This practice was previously demonstrated by Meena (1998) and Yadav (2004) on fenugreek, Kanwat (1988) on fennel (*Foeniculum vulgare* Mill.) and Meena *et al*. (2002) on coriander (*Coriandrum sativum* Das), but the climatic conditions have changed significantly in the last decade, which needs to be considered while planting the crop. Under such conditions, the study was undertaken to find out the spatial variation of important fenugreek pests and prevailing natural enemy fauna under the experimental plots of Thondamuthur (Coimbatore) and Kangeyam (Tiruppur).

MATERIALS AND METHODS

The experiment was conducted in a farmer's field at both the experimental field of Thondamuthur, Coimbatore, Tamil Nadu (10.9899°N and 76.8409°E) and Kangeyam, Tiruppur, Tamil Nadu (11.0053°N and 77.5609°E) during the 2022-23 cropping seasons. The fenugreek seeds (Variety: RMt1, known to be moderately tolerant of root rot and powdery mildew infestation) were sown in the last week of October. Standard agronomic practices as well as water manage-ment procedures were followed to ensure a satisfactory crop establishment. No plant protection measures were incorporated in any cropping sets.

The observations were based on the modified procedures performed by Tiwari *et al*. (2005) and Kant *et al*. (2017). Twenty fenugreek plants were chosen at random from each of the experimental plots. Initially, no. of aphids plant^{-1} was counted and later on, numbers per 10 cm terminal shoot were taken as a unit sample at 3 shoots plant^{-1} × 20 plants strip^{-1}. Thrips and whitefly populations were counted as numbers per 3 leaves @ 9 leaves plant^{-1} × 20 plants strip^{-1}. Data on natural enemy fauna were collected on a weekly basis beginning with 10 DAS. These were obtained as number plant^{-1} from a random choice of 10 plants strip^{-1} × 4 strips. Mature and immature stages of natural enemy fauna were counted altogether. Mean values of all the observations were evaluated to compare the relative performance of two cropping sets. The incidence of the fenugreek pests and natural enemy fauna, along with prevailing mean meteorological data, was also worked out, as mean values are presented in tabular form. A correlation coefficient matrix was established among the arthropod fauna and meteorological variables and further forewarning regression models of pest population were developed under both of the experimental setups.

RESULTS AND DISCUSSION

The prevalent meteorological parameters are provided in Table 1, which shows the lower maximum temperatures of 25.03°C and 21.90°C during the month of December under the experimental plots of Thondamuthur (Coimbatore) and Kangeyam (Tiruppur), respectively, while the reported mean higher maximum temperatures during the month of November are 30.04°C at Thondamuthur and 27.10°C at Kangeyam. The minimum temperature varied between 9.74°C to 19.82°C in Thondamuthur and 11.23 to 14.44°C at Kangeyam. The relative humidity percentage varied between 91.77-42.29% and 92.00-32.00% at the experimental field of Thondamuthur and Kangeyam, respectively. Slight rainfall was recorded during the months of November, December and January, with the maximum average rainfall recorded in the month of December with 0.40 mm; meanwhile, very low to negligible rainfall was noticed during the experimental period at Kangeyam. A moderate wind breeze was noticed in both of the experimental stations, ranging from 4.6 to 5.8 kmph.

The incidence of fenugreek pest population such as aphids, thrips and whitefly are being noticed from the experimental fields of Thondamuthur and Kangeyam (Table 2), although location-specific variation of their distribution is being noticed. Among the pest diversity, the aphids were present in significant numbers in both of the locations, with the minimum average population being noticed in the month of November with 5.25 aphids per 10 cm shoot, followed by the month of December (13.15 aphids per 10 cm shoot length), while the maximum population was noticed in the month of January (25.85 per 10 cm shoot) under the experimental area of Thondamuthur (Coimbatore). A similar population trend of aphid population is being noticed from the experimental plot of Kangeyam (Tiruppur), having a lower mean value and the population is found to be significantly different among the observation months. A comparatively lower thrips and whitefly population in comparison to the aphid population was noticed in both of the experimental areas and found to have significant differences with each other in the abundance. The lowest thrips population, was 1.20 and 1.38 per 3 leaves, were recorded from the experimental areas of Thondamuthur and Kangeyam in the month of November, while the peak incidence was noticed in the month of February, coinciding with higher temperature and maturity of the plant. A quite similar trend of whitefly is being noticed in both of the experimental areas, with the peak during the month of January in Thondamuthur and during February in Kangeyam. A significant difference in population abundance was also observed in relation to the whitefly.

Table 1: Meteorological data on Kangeyam (Tiruppur) and Thondamuthur (Coimbatore).

Period	Thondamuthur (Coimbatore)							Kangeyam (Tiruppur)						
	T_{max} (°C)	T_{min} (°C)	RH_{max} (%)	RH_{min} (%)	RF (mm)	BSS (hours)	WS (kmph)	T_{max} (°C)	T_{min} (°C)	RH_{max} (%)	RH_{min} (%)	RF (mm)	BSS (hours)	WS (kmph)
Nov, 22	30.04	19.82	91.75	50.97	0.28	7.06	4.6	26.11	14.44	64.00	32.00	0.00	7.24	5.00
Dec, 22	26.46	14.02	91.77	48.06	0.40	5.73	5.2	23.33	12.22	71.00	42.00	0.02	8.21	5.57
Jan, 23	25.03	9.74	90.77	42.29	0.00	7.19	5.8	21.90	11.23	92.00	51.00	0.02	8.27	5.14
Feb, 23	28.20	13.14	89.64	39.68	0.36	7.70	6.1	27.10	12.95	82.00	34.00	0.00	7.63	4.70

Table 2: Incidence of pests and natural enemies Kangeyam (Tiruppur) and Thondamuthur (Coimbatore).

Particulars	Thondamuthur (Coimbatore)				Kangeyam (Tiruppur)			
	Nov, 22	Dec, 22	Jan, 23	Feb, 23	Nov, 22	Dec, 22	Jan, 23	Feb, 23
Aphid per 10 cm shoot	5.25^{a}	13.15^{bc}	25.85^{d}	16.25^{c}	4.04^{a}	10.12^{b}	19.88^{d}	12.50^{c}
Thrips per three leaves	1.20^{a}	3.18^{b}	6.65^{c}	7.35^{cd}	1.38^{a}	3.66^{b}	7.65^{cd}	8.45^{d}
Whitefly per three leaves	0.67^{a}	2.35^{bc}	5.17^{d}	2.08^{b}	1.34^{a}	4.70^{b}	6.21^{c}	6.88^{c}
Spider plant^{-1}	1.80^{a}	3.60^{b}	5.30^{d}	4.60^{c}	2.16^{a}	4.32^{b}	6.36^{d}	5.00^{bc}
Coccinellids plant^{-1}	2.60^{b}	1.80^{a}	4.20^{c}	5.00^{d}	2.34^{b}	1.60^{a}	3.70^{c}	5.20^{d}

[*Mean of 3 replications; Means followed by different letters in the same row are significantly different (Pd”0.05, Tukey HSD) against each experimental location. All the calculations were made after proper transformation].

The population of natural enemies plays an important role in the maintenance of ecological balance under varying agro-ecosystems, while lowering their population responsible for higher fecundity and pest outbreaks. In our experiment it was observed that the significantly higher spider population in the month of January (5.30 and 6.36 plant^{-1} with respect to Thondamuthur and Kangeyam) and their population get maintained till the crop maturity (Table 2). Meanwhile, the coccinellid population gets reduced in number in the month of December at Thondamuthur, while following a continuous increasing trend (ranging from 2.34 to 5.20 plant^{-1}) in the experimental plot of Kangeyam.

In the correlation coefficient matrix (Table 3), we have observed that the aphid populations have followed a significantly negative correlation with minimum temperature (r = -0.97) while only positive correlation with bright sunshine hours. The aphid populations have formed a positive correlation with natural enemy (spider and coccinellids) population. Thrips populations have formed a positive correlation with bright sunshine hours and wind speed while temperature, relative humidity and rainfall have formed a negative correlation. Among the natural enemy population, the spider population have found to form a significant positive correlation (r = 0.91) with thrips abundance. A similar trend with whitefly population being recorded, where bright sunshine hours and wind speed have recorded with lower coefficient values (r = 0.07 and 0.05). Here the total rainfall and relative humidity have formed a negative association. The whitefly population have also found to have a negative interaction with maximum and minimum temperature, the coefficient value being recorded as, r = -0.59 and -0.87, respectively. Among the natural enemy population, the spider population have formed a significant negative association with prevailing minimum temperature (r = -0.90).

The correlation coefficient matrix was drawn in the experimental area of Kangeyam (Tiruppur) (Table 4). Here aphid populations have formed a significant positive correlation with maximum relative humidity percentage (r = 0.96), while maximum temperature and wind speed have formed a negative correlation, with the coefficient values being r = -0.68, -0.76 and -0.25, respectively. The incidence of aphid population has been highly influenced by the presence of spider and coccinellid populations (r = 0.81 and 0.29, respectively). Among the abiotic parameters, the thrips population has been positively influenced by most of the prevailing agro-meteorological determinants, except the temperature (r = -0.12 and -0.32) and bright sunshine hours (r = -0.28). Meanwhile, the biotic parameters have played a crucial role along with their abundance, with the coefficient values being recorded as 0.95 (significant) against the spider population and 0.86 against coccinellids. The whitefly population has been influenced positively by the biotic parameter (0.91 spider population) and has only had a positive reaction to relative humidity, rainfall, wind speed and coccinellids, the respective coefficient values being r = 0.78, 0.42, 0.28, 0.42 and 0.67.

The forewarning regression models indicate that all seven abiotic factors, along with two biotic factors, are responsible for 93.60 to 94.70% of the variation in aphid population in the experimental plots of Kangeyam and Thondamuthur. The coefficient of determination value for the thrips population ranged between 81.50% and 92.60% in the experimental fields of Kangeyam and Thondamuthur, respectively, while the variation for the whitefly population ranged from 76.00% to 88.70% (Table 5).

During the present investigation, aphid, thrips and whitefly populations were found as an important sucking pest complex under the fenugreek crop ecosystem in both of the experimental areas, whereas ash weevils, painted bugs, *Spodoptera* sp. and green stink bugs were noticed in the crop ecosystem, but their presence doesn't cause significant damage to the fenugreek plant. Both nymphs and adults of the pest population (aphids, thrips and whitefly) feed on the leaves, tender shoot portion and flowers and develop yellowish to brownish necrotic spots. Sucking pest complexes like aphids, thrips and whitefly have also emerged early in the crop cycle, around four weeks post-sowing and persisted in feeding until pod maturity. Aphids (*Aphis craccivora* Koch, *Acyrthosiphon*

Table 3: Correlation coefficient (r) of weather factors vis-a-vis fenugreek pests and natural enemies in Thondamuthur (Coimbatore).

Particulars	Aphid	Thrips	Whitefly	Spider	Coccinellids	T_{max}	T_{min}	RH_{max}	RH_{min}	RF	BSS	WS
Aphid	1	0.80	0.87	0.83	0.47	-0.84	-0.97*	-0.63	-0.80	-0.56	0.32	-0.21
Thrips	-	1	0.65	0.91*	0.83	-0.46	-0.84	-0.67	-0.84	-0.23	0.55	0.25
Whitefly	-	-	1	0.85	0.37	-0.59	-0.87	-0.19	-0.44	-0.19	0.07	0.05
Spider	-	-	-	1	0.66	-0.47	-0.90*	-0.38	-0.63	-0.06	0.23	0.35
Coccinellids	-	-	-	-	1	-0.02	-0.45	-0.51	-0.61	0.01	0.81	0.41
T_{max}	-	-	-	-	-	1	0.79	0.67	0.73	0.84	-0.08	0.62
T_{min}	-	-	-	-	-	-	1	0.57	0.77	0.43	-0.19	0.05
RH_{max}	-	-	-	-	-	-	-	1	0.95*	0.79	-0.68	0.42
RH_{min}	-	-	-	-	-	-	-	-	1	0.69	-0.62	0.26
RF	-	-	-	-	-	-	-	-	-	1	-0.35	0.87
BSS	-	-	-	-	-	-	-	-	-	-	1	-0.07
WS	-	-	-	-	-	-	-	-	-	-	-	1

pisum Harris) and whitefly (*Bemisia tabaci* Genn.) populations were reported as important pests of fenugreek (Kalra *et al*., 2002; Manjula *et al*., 2015), proliferating during the vegetative stages, with substantial populations observed during flowering and fruiting stages, resulting in considerable yield losses (Selvaraj *et al*., 2010; Kakani and Anwer, 2012; Abro *et al*., 2016). Natural enemy fauna in the fenugreek ecosystem comprises mostly generalist predators like spiders and coccinellids. Besides a very few chrysopid and praying mantid populations were also noticed in a few pockets by Kalra *et al*. (2002); Selvaraj *et al*. (2010); Abro *et al*. (2016) and Kant *et al*. (2017). In the spatial distribution study, we found that the pest populations exhibited only a negative correlation with the prevailing temperature at both locations. Here the pest population multiplies its number with the prevailing temperature and their presence is mainly noticed due to available food along with migration in the case of the aphid population. Mishra *et al*. (2023) investigated that aphid populations were more abundant during the winter months, usually from November to February, corresponding with the prevailing winter, which helps aphid populations develop and reproduce. Besides, the aphid populations can be affected by particular alterations in climatic conditions and microclimates and infestations may arise outside of the typical winter season. Another important fenugreek pest, such as thrips and whitefly populations, also increased for more or less the same reasons in the present context. A contradictory result was found regarding the relationship between relative humidity percentage and pest abundance in a spatial distribution study. Here a comparatively higher relative humidity percentage was noticed at Thondamuthur (Coimbatore) compared to the experimental station of Kangeyam (Tiruppur) and it indicates the increase in relative humidity percentage under a lower temperature regime adversely affects the growth of the pest population. Although a heavy rainfall was absent under both of the experimental plots, from the correlation analysis, we have observed that the pest population is dispersed with periodic rainfall. Moreover, the bright sunshine hours, along with the prevailing wind speed, have favored the population development in both of the experimental plots.

Mishra and Pandey (2023) have also reported that the peak infestation of aphids (*Aphis craccivora*) occurred at the end of January at Mandor, India, within the fenugreek ecosystem and the correlation coefficient showed that maximum relative humidity had a positive significant correlation (r = 0.534) with aphid populations. Spider populations played an important role, together with the other dominant natural enemy fauna, for suppressing the pest population (Michalko *et al*., 2019) and our experiments are in line with under spatial deviation. Small pest species,

Table 4: Correlation coefficient (r) of weather factors vis-à-vis fenugreek pests and natural enemies in Kangeyam (Tiruppur).

Particulars	Aphid	Thrips	Whitefly	Spider	Coccinellids	T_{max}	T_{min}	RH_{max}	RH_{min}	RF	BSS	WS
Aphid	1	0.75	0.70	0.81	0.29	-0.68	-0.76	0.96**	0.87	0.67	0.30	-0.25
Thrips	-	1	0.95*	0.86	0.80	-0.12	-0.32	0.87	0.39	0.15	-0.28	0.33
Whitefly	-	-	1	0.91*	0.67	-0.08	-0.27	0.78	0.42	0.28	-0.14	0.42
Spider	-	-	-	1	0.52	-0.18	-0.28	0.86	0.66	0.52	-0.02	0.33
Coccinellids	-	-	-	-	1	0.37	0.16	0.51	-0.15	-0.44	-0.79	0.59
T_{max}	-	-	-	-	-	1	0.96**	-0.50	-0.78	-0.75	-0.78	0.85
T_{min}	-	-	-	-	-	-	1	-0.61	-0.73	-0.66	-0.66	0.74
RH_{max}	-	-	-	-	-	-	-	1	0.75	0.48	0.05	-0.07
RH_{min}	-	-	-	-	-	-	-	-	1	0.91*	0.62	-0.42
RF	-	-	-	-	-	-	-	-	-	1	0.834	-0.428
BSS	-	-	-	-	-	-	-	-	-	-	1	-0.706
WS	-	-	-	-	-	-	-	-	-	-	-	1

Table 5: Regression analysis of important pests along with their prevailing biotic and abiotic determinants under fenugreek crop ecosystem at the experimental plots of Thondamuthur (Coimbatore) and Kangeyam (Tiruppur).

Pest population	Forewarning regression model	R^2
Thondamuthur (Coimbatore)		
Aphid	$43.19 + 0.22 X_1 - 1.97X_2 + 0.001 X_3 + 0.008 X_4 - 0.265 X_5 + 0.127 X_6 - 0.08 X_7 + 0.03 X_8 + 0.09 X_9$	0.947
Thrips	$29.82 - 0.13 X_1 - 0.18 X_2 + 0.32 X_3 - 0.59 X_4 - 0.08 X_5 - 0.07 X_6 + 0.42 X_7 + 0.24 X_8 - 0.12 X_9$	0.926
Whitefly	$24.10 - 0.40 X_1 - 0.14 X_2 - 0.16 X_3 - 0.36 X_4 + 0.29 X_5 + 0.12 X_6 + 0.28 X_7 + 0.23 X_8$	0.887
Kangeyam (Tiruppur)		
Aphid	$- 31.70 - 0.26 X_1 - 0.26 X_2 + 0.34 X_3 + 0.55 X_4 + 0.26 X_5 + 0.25 X_6 + 0.25 X_7 - 0.98 X_8 - 0.28 X_9$	0.936
Thrips	$- 2.21 + 0.03 X_1 - 0.07 X_2 + 0.44 X_3 - 0.27 X_4 - 0.33 X_5 - 0.22 X_6 - 0.23 X_7 + 1.64 X_8 + 0.43 X_9$	0.815
Whitefly	$- 0.949 + 0.084 X_1 - 0.02 X_2 + 0.009 X_3 - 0.32 X_4 - 0.22 X_5 - 0.11 X_6 - 0.11 X_7 + 1.27 X_8 + 0.27 X_9$	0.760

[$X_1 = T_{max}$; $X_2 = T_{min}$; $X_3 = RH_{max}$; $X_4 = RH_{min}$; X_5 = Rainfall; X_6 = Bright sunshine hours; X_7 = Wind speed; X_8 = Spider; X_9 = Coccinellids].

such as aphids, thrips and whitefly (both nymphal and adult populations) may die by being caught under the webs of large spiders, even when they are mostly ignored by the smaller ones (Nentwig, 1987). The predatory spider population might even kill a greater number of pests than if the pests were high-quality preferred prey, because spiders would remain unsatiated. Coccinellids such as *Epilachna vigintioctopunctata*, *Cheilomenes sexmaculata*, *Nephus lentiformis*, *Psylloborab isoctonotata* Mulsant were prevalent in the fenugreek field and controlled the pest populations significantly under both of the cropping locations (Cock, 1985; Kumashiro *et al*., 1983; Ignacimuthu, 2002; Kundoo and Khan, 2017).

The mustard aphid (*Lipaphis erysimi*) is notably more prevalent in areas where mustard crops are cultivated during the cooler months, often from November to February. These months align with the winter season in numerous nations. Lower temperatures during this period facilitate the development and reproduction of aphid populations.

CONCLUSION

The populations of *A. craccivora* and *A. pisum* were found abundantly in both the experimental plots and identified as the major pests under the fenugreek ecosystem; while the populations of whiteflies and thrips were minimal and had lower mean values. Hence, the early sowing of the fenugreek crop may be adopted to protect the crop from aphid attack and to achieve a higher seed percentage. A significantly positive correlation was observed between maximum relative humidity and aphid population; whereas, the minimum temperature was negatively associated with the prevailing aphid population at experimental plots of Thondamuthur (Coimbatore). The preventable reduction in seed yield of fenugreek caused by aphid infestations was maximum in control plots, followed by that of those treated with the higher numbers and the feeding propensity of different instars and adults of spiders and coccinellids revealed them as an effective predator and therefore the crop can be used as a component under push-pull technology for sustainable pest management.

ACKNOWLEDGEMENT

Not applicable.

Disclaimers

The views and conclusions expressed in this article are solely those of the authors and do not necessarily represent the views of their affiliated institutions. The authors are responsible for the accuracy and completeness of the information provided, but do not accept any liability for any direct or indirect losses resulting from the use of this content.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

REFERENCES

Abro, G.H., Syed, T.S., Khanzada, M.S., Khanzada, S.R., Salman, M., Anwar, S., Sarwar, M., Dayo, S.H., Perzada, A.A., Suwang, S. and Abro, A.H. (2016). Arthropods associated with some medicinal plants under field conditions in Sindh province of Pakistan. *Journal of Entomology and Zoological Studies*. **4(1):** 516-520.

Ahmad, A., Alghamdi, S.S., Mahmood, K. and Afzal, M. (2016). Fenugreek a multipurpose crop: Potentialities and improvements. *Saudi Journal of Biological Sciences*. **23(2):** 300-310. https:// doi.org/10.1016/j.sjbs.2015.09.015.

Basu, A., Basu, S.K., Kumar, A., Sharma, M., Chalghoumi, R., Hedi, A., Solorio-Sánchez, F., Balogun, M.O., Hafez, E.E. and Cetzal-Ix, W. (2014). Fenugreek (*Trigonella foenum-graecum* L.), a potential new crop for Latin America. *American Journal of Social Issues and Humanities*. **4(3):** 148-162.

Bindhani, G., Das, A. and Chakraborti, S. (2021). Study on the pest-complex of fenugreek in West Bengal. *Journal of Entomology and Zoology Studies*. **9(1):** 349-352.

Chandrasekaran, M., Soundararajan, R.P. and Pirithiraj, U. (2021). Bio-ecology and management of Jassid, *Amrasca devastans* (Dist.) in Bhendi. *Biotica Research Today*. **3(7):** 584-587.

Cock, M.J.W. (1985). A review of biological control of pests in the Commonwealth Caribbean and Bermuda up to 1982. Technical Communication of the Commonwealth Institute of Biological Control 9, Commonwealth Agricultural Bureaux, Farnham Royal, UK. p. 149.

Habib, A.F., Swamy-Rao, T. and Mensinkai, S.W. (1971). Salt tolerance in methi at germination stage. *Current Science*. **40(3):** 67. http://www.jstor.org/stable/24074577.

Ignacimuthu, S. (2002). Biological control of insect pests. *Journal of Scientific and Industrial Research*. **61(7):** 543-546.

Kakani, R.K. and Anwer, M.M. (2012). Fenugreek. In: Handbook of Herbs and Spices (Second Edition, Volume 1) [Peter, K.V. (Ed.)]. Woodhead Publishing Ltd., UK. pp. 289-290.

Kalra, V.K., Sharma, S.S. and Batra, G.R. (2002). Insect pests associated with fenugreek in Haryana. *Indian Journal of Entomology*. **64(2):** 237-238.

Kant, K., Meena, N.K., Meena, S.R., Mishra, B.K., Lal, G., Vishal, M.K. and Singh, D.P. (2017). Population dynamics of insect pests, natural enemies and pollinators of Fenugreek (*Trigonella foenum-graecum* L.). *International Journal of Seed Spices*. **7(1):** 56-59.

Kanwat, P.M. (1988). Studies on insect-pests of fennel (*Foeniculum vulgare* L.) and their control. PhD Thesis. Submitted to Rajasthan Agricultural University, Bikaner, India. p. 42.

Kumar, R., Deshwal, H.L., Mehra, K. and Singh, V. (2016). Qualitative and quantitative survey of the pest faunal complex of fenugreek in Bikaner district of Rajasthan. *Journal of Experimental Zoology, India*. **19(Suppl. 1):** 1521-1523.

Kumashiro, B.R., Lai, P.Y., Funasaki, G.Y. and Teramoto, K.K. (1983). Efficacy of *Nephaspis amnicola* and *Encarsia haitiensis* in controlling *Aleurodicus dispersus* in Hawaii. *Proceedings of the Hawaiian Entomological Society*. **24:** 261-269.

Kundoo, A.A. and Khan, A.A. (2017). Coccinellids as biological control agents of soft bodied insects: A review. *Journal of Entomology and Zoology Studies*. **5(5):** 1362-1373.

Malhotra, S.K. and Vashishtha, B.B. (2017). Production, Development, Quality and Export of Seed Spices. ICAR-National Research Centre on Seed Spices, NRCSS, Ajmer, Rajasthan (India). p. 373.

Manjula, K.N., Kotikal, Y.K., Patil, H.B. and Biradar, I.B. (2015). Studies on insect fauna, their natural enemies and pollinators in fenugreek. *Karnataka Journal of Agricultural Sciences*. **28(2):** 279-281.

Meena, B.L. (1998). Management of insect pests of fenugreek (*Trigonella foenum graecum* L.). M.Sc. (Ag.) Thesis. Rajasthan Agriculture University, Bikaner, Campus-Jobner, India. pp. 24-36.

Meena, P.C., Sharma, J.K. and Nook, A. (2002). Varietal reaction of coriander (*Coriandrum sativum* L.) and impact of date of sowing on incidence of aphid (*Hyadaphis coriandari* Das). *Indian Journal of Entomology*. **64(1):** 58-62.

Michalko, R., Pekár, S. and Entling, M.H. (2019). An updated perspective on spiders as generalist predators in biological control. *Oecologia*. **189(1):** 21-36. https://doi.org/10.1007/s00442-018-4313-1.

Mishra, S. and Pandey, S. (2023). Population dynamics of insect pests in fenugreek (*Trigonella foenum-graecum* L.). *Annals of Plant Protection Sciences*. **31(1):** 61-64. https://doi.org/10.5958/0974-0163.2023.00011.3.

Mishra, S., Mishra, A.K., Tiwari, B., Mishra, S.K. and Danish, M. (2023). Integrated pest management for Mustard Aphid, *Lipaphis erysimi* (Kaltenbach). *Biotica Research Today*. **5(10):** 741-742.

Nentwig, W. (1987). The Prey of Spiders. In: *Ecophysiology of Spiders* [Nentwig, W. (Ed.)]. Springer, Berlin Heidelberg, Germany. pp. 249-263. https://doi.org/10.1007/978-3-642-71552-5_18.

Nisha, P.K., Ranjith, M. and Bose, S.C.A. (2021). Rugose Spiralling Whitefly *Aleurodicus rugioperculatus* (Hemiptera: Aleyrodidae). *Biotica Research Today*. **3(12):** 1174-1176.

Selvaraj, K., Kaushik, H.D., Gulati, R. and Sharma, S.S. (2010). Bioefficacy of *Beauveria bassiana* (Balsamo) Vuillemin against *Hyadaphis coriandri* (Das) on coriander and *Aphis craccivora* Koch on fenugreek. *Journal of Biological Control*. **24(2):** 142-146. https://doi.org/10.18311/jbc/2010/3598.

Tiwari, M., Singh, C.P. and Goel, R. (2005). Effect of intercropping on the population, dynamics of insect pests and yield of mustard. *Shashpa*. **12(2):** 106-110.

Yadav, S.R. (2004). Biology and management of aphid, *Acyrthosiphon pisum* (Harris) on fenugreek, *Trigonella foenum graecum* Linn. M.Sc. (Ag.) Thesis. Submitted to Rajasthan Agriculture University, Bikaner Campus, Rajasthan.