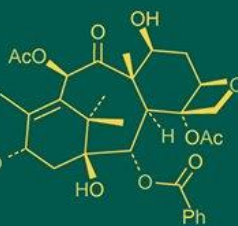
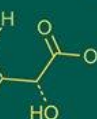
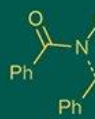


International Journal of Advanced Biochemistry Research



ISSN Print: 2617-4693
ISSN Online: 2617-4707
NAAS Rating (2026): 5.29
IJABR 2026; 10(9): 376-380
www.biochemjournal.com
Received: 21-07-2026
Accepted: 23-08-2026

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Annotation and seasonal incidence of insect pests on fennel (*Foeniculum vulgare* mill)

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DOI: <https://www.doi.org/10.33545/26174693.2026.v10.i9e.9988>

Abstract

Fennel (*Foeniculum vulgare* Mill.) is an important seed spice crop in which insect pest occurrence can vary with crop stage and prevailing weather conditions, so information on the insect pest complex and its seasonal activity under the agro-climatic conditions of *Vidarbha* is comparatively limited. A field survey was conducted at six locations comprising institutional farms and farmer fields during the crop season to document the arthropod fauna associated with fennel under local conditions. Seasonal incidence of insect pests and natural enemies was also monitored during the *rabi* season of 2025-26 at the Research Farm of the Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola. Weekly observations were recorded from crop establishment to maturity. The survey recorded a diverse arthropod community comprising 17 species/groups, including 12 insect pests, three predators, one pollinator and one decomposer. Aphid (*Hyadaphis spp.*) was the most persistent and widespread pest and was recorded across the surveyed locations. Other important pests included tree hopper, leaf hopper, plant hopper, red cotton bug, stink bug, seed bug, seed wasp, cabbage looper, tobacco caterpillar, twig looper and hairy caterpillar. Among the natural enemies, ladybird beetles, predatory spiders and hover flies were commonly associated with the crop, particularly in areas with higher aphid abundance. Pest activity became evident from the 46th-47th meteorological week and increased progressively during the later crop period. Aphid population increased from 1.2 aphids per 5 cm twig during the 47th meteorological week and reached a maximum of 39.1 aphids per 5 cm twig during the 9th meteorological week. Tree hopper and leaf hopper populations attained their maximum levels during the 7th and 4th meteorological weeks, respectively, while red cotton bug reached its highest population during the 8th and 9th weeks. Hairy caterpillar, twig looper and cabbage looper attained maximum populations during the 5th, 6th-7th and 6th meteorological weeks, respectively. Natural enemy populations increased along with pest abundance, with ladybird beetles, predatory spiders and hover flies reaching maximum populations of 4.3, 1.7 and 2.3 individuals per plant, respectively. The study indicated that aphid was the predominant pest of fennel and that pest activity increased considerably during the later crop period, accompanied by an increase in natural enemy abundance. The findings provide useful baseline information for pest surveillance and timely management of insect pests in fennel under *Vidarbha* conditions.

Keywords: Fennel, *Foeniculum vulgare*, insect pests, annotation, seasonal incidence, aphid, natural enemies, *Vidarbha*, standard meteorological week

1. Introduction

Fennel (*Foeniculum vulgare* Mill.) is an important seed spice crop belonging to the family Apiaceae and is valued for its aromatic fruits, culinary applications and medicinal properties. In India, fennel is cultivated extensively in different agro-climatic regions and contributes substantially to the seed-spice sector. The crop is mainly cultivated during the *rabi* season and is adapted to moderately cool and dry conditions. In Maharashtra, fennel is cultivated on a limited scale, while its cultivation has expanded in parts of the *Vidarbha* region. However, productivity and quality of fennel can be affected by several insect pests belonging to different taxonomic groups. The pest complex associated with fennel comprises predominantly sucking insects and defoliating caterpillars. Aphids, leaf hoppers and other sap-feeding insects can affect plant growth by removing plant sap, whereas caterpillars may cause damage by feeding on foliage. The occurrence and abundance of these insects vary with crop stage and prevailing environmental conditions.

Knowledge of the pest complex and its seasonal abundance is essential for identifying periods of pest build-up and planning appropriate management measures. Regular monitoring can also help avoid unnecessary calendar-based pesticide applications. Meena *et al.* (2020) [5] emphasized the importance of rational pest-management practices in fennel cultivation. Therefore, the present investigation was undertaken to document the insect-pest complex and determine the seasonal incidence of insect pests and associated natural enemies on fennel under the local conditions of Vidarbha.

2. Materials and Methods

2.1 Experimental site

The investigation was conducted during *rabi* 2025-26 at the Experimental Farm, Department of Agricultural Entomology, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra. Fennel variety AF-101 was sown by line sowing method at 60 cm × 45 cm spacing. For seasonal incidence observations, a separate fennel plot was maintained without insecticidal protection so that natural pest infestation could be followed throughout the crop period.

2.2 Annotation of insect pests

For annotation of insect pests on fennel a field survey was conducted at six locations within the jurisdiction of Dr. PDKV, Akola. The survey locations included the Department of Entomology field, Chilli and Vegetable Research Unit field, Agricultural Technology Information Centre field and farmer fields at *Barsi takli*, *Vivara* and *Akot (Distt. Akola)*. The observations were recorded at regular interval at these places from vegetative stage through crop maturity to know the infestation of insect pests on fennel. The insect specimens from each places were collected and identified using insect catalogues, identification keys and pictorial resources. The recorded arthropods were grouped according to their ecological status as pests, predators, pollinators or decomposers.

2.3 Seasonal incidence

For seasonal incidence studies separate fennel plot was maintained under natural infestation at the Entomology Research field of Dr. PDKV, Akola. Observations were initiated at crop establishment and continued until harvest. Ten randomly selected and tagged plants were used for weekly observations. Pest and natural enemy populations were recorded at weekly intervals following the methodology adopted by Ranjeetha *et al.* (2020) [7]. Aphid population was recorded on the apical 5-cm twig and expressed as number per 5 cm twig. Tree hopper, leaf hopper and red cotton bug populations were recorded per plant, while hairy caterpillar, twig looper and cabbage looper populations were recorded as larvae per plant, while seed wasp population was recorded as number per umbel. Ladybird beetles, predatory spiders and hover flies were recorded as number per plant.

Meteorological observations corresponding to the observation weeks were obtained for maximum and minimum temperature, bright sunshine hours, wind speed, morning and evening relative humidity, evaporation and rainfall. The seasonal trend was interpreted in relation to the observed pest and natural enemy populations.

The relationship between the seasonal population of insect pests and natural enemies and prevailing weather parameters was determined using Pearson's correlation coefficient (*r*). Weekly population observations corresponding to the meteorological weeks were paired with the respective weekly weather observations. The weather variables considered were maximum temperature, minimum temperature, morning relative humidity, evening relative humidity, sunshine hours and evaporation. Correlation coefficients were calculated separately for each insect pest and natural enemy to determine the direction and strength of association with the individual weather parameters.

3. Results and Discussion

Annotation of insect pests and beneficial insects associated with fennel

The survey conducted at six locations revealed a diverse arthropod assemblage associated with the fennel ecosystem (Table 1). The recorded fauna comprised 17 species, including 12 pest species, 3 predator species, 1 pollinator species and 1 decomposer species.

Among the pest complex, aphid (*Hyadaphis spp.*) was the most consistently occurring insect and was recorded at almost all surveyed locations. Other sucking pests included, leaf hopper (*Empoasca sp.*), tree hopper, plant hopper, stink bug (*Nezara viridula*) and seed bug (*Nysius spp.*) and defoliating insects included cabbage looper (*Trichoplusia ni*), tobacco caterpillar (*Spodoptera litura*), hairy caterpillar, twig looper (*Ectropis excursaria*). In addition, red cotton bug (*Dysdercus cingulatus*) and seed wasp (*Systole albipennis*) were recorded during the survey. The occurrence of pest groups varied among locations, indicating variation in the arthropod assemblage within the local fennel ecosystem.

The predominance of aphid in the present investigation agrees with previous observations on fennel and other seed spices. Meena *et al.* (2020) [5] recorded a diverse pest complex on fennel under an organic production system in Rajasthan and reported aphids as one of the most persistent and important pest groups. They recorded *Hyadaphis coriandri*, along with other sucking pests, seed-associated insects and defoliators. Shewale and Borad (2020) [8] also reported several insect pests on fennel.

The beneficial arthropod fauna observed in the fennel ecosystem comprised ladybird beetles and their grubs, hover fly larvae and predatory spiders. Honeybees were also observed and were considered as pollinators rather than predatory natural enemies.

Seasonal incidence of insect pests

The observations on seasonal incidence (Table 2) revealed that insect pest incidence was commenced during the 46th standard meteorological week. At the beginning of the observation period, insect populations were generally very low or absent. Only cabbage looper was recorded at 0.1 larva per plant during the initial observation. Pest activity commenced during the 46th MW and increased progressively with crop development. Sucking pests were predominant during the observation period.

Aphid was the most prominent insect pest observed during the seasonal incidence observation period. Its population increased progressively from 1.2 aphids per 5 cm twig during the 47th SMW and attained a peak of 39.1 aphids per 5 cm twig during the 9th SMW. The marked increase during

the later part of the crop season clearly indicated the predominance of aphid in the fennel pest complex under the prevailing conditions.

Tree hopper appeared at a relatively low population during the initial period, recording 0.2 per plant during the 47th SMW. Its population increased progressively and reached a maximum of 5.8 per plant during the 8th SMW, after which it declined slightly to 5.1 per plant during the 9th SMW.

Leaf hopper population was initially low, with 0.2 per plant during the 48th SMW. It subsequently increased and reached a maximum of 5.1 per plant during the 3rd SMW. Thereafter, the population gradually decreased and reached 2.9 per plant by the 9th SMW.

Hairy caterpillar population increased from 0.1 per plant during the 47th SMW and attained its maximum population of 4.4 per plant during the 5th SMW. Following the peak, its population declined and reached 2.3 per plant by the 9th SMW.

Cabbage looper was recorded at comparatively low density. Its population increased from 0.1 per plant during the initial period to a maximum of 1.5 per plant during the 5th SMW and subsequently declined to 0.9 per plant by the 9th SMW.

Twig looper remained at a comparatively low population throughout the observation period. Its population increased gradually and reached 1.0 per plant during the 6th and 7th SMWs, followed by a decline to 0.7 per plant by the 9th SMW.

Red cotton bug appeared relatively later during crop development. Its population increased and reached 2.4 per plant during the 8th and 9th SMWs.

Seed wasp was not recorded during the initial period. It appeared from approximately the 4th SMW and gradually increased to 1.9 per umbel by the 9th SMW. The gradual increase towards the later crop period indicates a distinct seasonal pattern compared with the early-appearing defoliators.

Seasonal incidence of natural enemies: The natural-enemy population increased progressively with crop development and increasing insect abundance. Ladybird beetles increased

from 0.2 per plant during the 47th SMW and reached a maximum of 4.3 per plant by the 9th SMW. Predatory spiders first appeared during the 49th SMW, attained a maximum of 1.7 per plant during the 6th and 7th SMWs, and recorded 1.6 per plant towards the end of the observation period. Hover fly larvae also appeared during the 49th SMW and increased gradually to 2.3 per plant by the 9th SMW.

Similar increases in coccinellid and other predator populations during periods of higher aphid abundance have been reported in coriander and fennel (Purti and Anuradha, 2017; Kanjiya *et al.*, 2018; Dadhich and Pandey, 2022) [1, 2, 6].

Overall seasonal pattern

The data clearly identify aphid as the predominant pest, followed by tree hopper and leaf hopper in terms of maximum population recorded. Among defoliators, Hairy caterpillar recorded the highest population. The complete seasonal dataset confirms that pest abundance changed substantially during crop development and that individual pest species followed different seasonal patterns.

Association with weather parameters

The correlation coefficient between the insect pests, natural enemies and different weather parameters were worked out (Table 3). The correlation analysis revealed that maximum temperature, minimum temperature, Wind speed and evaporation were positively and significantly associated with the populations of all the insect pests and natural enemies, whereas bright sunshine hours and relative humidity did not show significant associations with any of the organisms.

The present findings are in agreement with the earlier results of Swami *et al.* (2018), Dadhich and Pandey (2022), Kumari *et al.* (2023), Kumar V *et al.* (2023) [1, 3, 4, 9], who demonstrated varying associations between weather parameters and insect pest populations under different agro-ecological conditions.

Table 1: Insect pest complex recorded on fennel under local conditions

Sr. No.	Common name	Scientific name	Order	Status
1	Aphid	<i>Hyadaphis spp</i>	Hemiptera	Pest
2	Treehopper	<i>Oxyrhachis tarandus</i>	Hemiptera	Pest
3	Leafhopper	<i>Empoasca kerri</i>	Hemiptera	Pest
4	Planthopper	<i>Eurybrachys tomentosa</i>	Hemiptera	Pest
5	Red cotton bug	<i>Dysdercus cingulatus</i>	Hemiptera	Pest
6	Stink bug	<i>Nezara viridula</i>	Hemiptera	Pest
7	Hairy caterpillar	<i>Spilosoma obliqua</i>	Lepidoptera	Pest
8	Tobacco caterpillar	<i>Spodoptera litura</i>	Lepidoptera	Pest
9	Cabbage looper	<i>Trichoplusia ni</i>	Lepidoptera	Pest
10	Twig looper	<i>Ectropis excursaria</i>	Lepidoptera	Pest
11	Seed wasp	<i>Systole albipennis</i>	Hymenoptera	Pest
12	Seed bug	<i>Nysius spp</i>	Hemiptera	Pest
13	ladybird beetle	<i>Cheilomenes spp</i>	Coleoptera	Predator
14	Hover fly	-	Diptera	Predator/ Pollinator
15	Spider	-	Araneae	Predator
16	Honeybee	<i>Apis spp.</i>	Hymenoptera	Pollinator
17	Chironomid midge	-	Diptera	Decomposer

Table 2: Weekly incidence of insect pests and natural enemies on fennel during *rabi* 2025-26

	Incidence of insect pests								Incidence of natural enemies		
	Aphids (No./5 cm)	Tree hoppers	Leaf hoppers	Hairy caterpillars (No./ plant)	Twig loopers (No./ plant)	Cabbage loopers (No./	Red cotton	Seed wasp	Lady bird	Predatory spiders (No./	Hover flies

Metrological Week No.	twig	(No./ plant)	(No./ plant)			plant)	bug (No./ plant)	(No./ Umbel)	beetles (No./ plant)	plant)	(No./ plant)
46 th (12Nov-18Nov)	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
47 th (19Nov-25Nov)	1.2	0.2	0.0	0.1	0.0	0.3	0.0	0.0	0.2	0.0	0.0
48 th (26Nov-02Dec)	2.8	0.4	0.2	0.3	0.0	0.4	0.0	0.0	0.7	0.0	0.0
49 th (03Dec-09Dec)	4.5	0.7	0.8	0.6	0.1	0.6	0.0	0.0	1.2	0.0	0.4
50 th (10Dec-16Dec)	9.8	1.2	1.4	1.1	0.1	0.8	0.0	0.0	1.5	0.1	0.8
51 th (17Dec-23Dec)	15.5	2.5	1.9	1.8	0.3	1.0	0.2	0.0	1.6	0.3	1.2
52 th (24Dec-31Dec)	21.4	3.8	2.2	2.1	0.5	1.1	0.4	0.0	2.2	0.4	1.7
1 st (01Jan-07Jan)	26.8	4.2	3.4	2.4	0.6	1.2	0.5	0.0	2.6	0.6	1.6
2 nd (08Jan-14Jan)	27.3	4.5	4.0	2.9	0.7	1.3	0.7	0.0	2.9	1.0	1.7
3 rd (15Jan-21Jan)	27.6	5.4	4.6	3.6	0.8	1.3	0.8	0.0	3.2	1.2	1.6
4 th (22Jan-28Jan)	28.2	5.5	5.1	4.1	0.8	1.4	1.3	0.4	3.5	1.3	1.7
5 th (29Jan-04Feb)	29.7	5.6	4.8	4.4	0.9	1.4	1.5	0.6	3.7	1.6	1.7
6 th (05Feb-11Feb)	33.6	5.7	4.2	3.8	1.0	1.5	2.1	1.0	3.8	1.7	1.8
7 th (12Feb-18Feb)	35.5	5.8	3.6	3.2	1.0	1.3	2.3	1.2	4.0	1.7	1.9
8 th (19Feb-25Feb)	38.8	5.3	3.2	2.7	0.9	1.1	2.4	1.5	4.1	1.5	2.1
9 th (26Feb-04Mar)	39.1	5.1	2.9	2.3	0.7	0.9	2.4	1.9	4.3	1.6	2.3

Table 3: Correlation coefficients between insect pests & natural enemies on fennel and weather parameters

Weather Parameter	Aphids	Tree hoppers	Leaf hoppers	Hairy Caterpillar	Twig loopers	Cabbage loopers	Red cotton bug	Seed wasp	Lady bird beetles	Predatory Spiders	Hover flies
Temperature (Max.)	0.749**	0.676**	0.498*	0.553*	0.741**	0.486*	0.903**	0.842**	0.754**	0.810**	0.633**
Temperature (Min.)	0.805**	0.767**	0.633**	0.648**	0.792**	0.514*	0.905**	0.816**	0.816**	0.869**	0.681**
Bright Sunshine Hours	-0.294	-0.368	-0.472	-0.456	-0.317	-0.322	-0.246	-0.148	-0.354	-0.339	-0.241
Wind Speed	0.457	0.379	0.337	0.323	0.386	0.210	0.556*	0.577*	0.499*	0.471	0.410
Relative Humidity (Morning)	0.734**	-0.613*	-0.467	-0.457	-0.627**	-0.375	-0.858**	0.886**	-0.742**	-0.777**	0.659**
Relative Humidity (Evening)	-0.315	-0.183	-0.037	-0.072	-0.209	-0.079	-0.465	0.584*	-0.316	-0.329	-0.339
Evaporation rate	0.852**	0.744**	0.573*	0.584*	0.767**	0.538*	0.921**	0.882**	0.842**	0.846**	0.792**
Rainfall (mm)	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

*Correlation is significant at 5% ($0.497 \leq |r| < 0.623$) **Correlation is significant at 1% ($|r| \geq 0.623$)

4. Conclusion

The present investigation demonstrated that fennel supported a diverse arthropod community comprising insect pests, predators, pollinators and decomposers under the agro-climatic conditions of *Vidarbha*. Twelve pest taxa were recorded during the survey, with Aphid (*Hyadaphis coriandri*) emerging as the predominant pest and Other pests included tree hopper, leaf hopper, planthopper, red cotton bug, stink bug, seed bug, seed wasp and several foliage-feeding caterpillars.

The seasonal study showed that pest activity increased progressively as the crop advanced towards flowering, seed formation and maturity. Aphid was the dominant pest, appearing during the 47th meteorological week and reaching

its highest population of 39.1 aphids per 5 cm twig during the 9th meteorological week. Other pests showed species-specific periods of peak activity. Regular monitoring of aphids and other sucking pests, together with conservation of naturally occurring predators, should receive particular attention during the period of increasing pest abundance. The seasonal activity of the pests was not uniform. Leaf hopper and twig looper attained their peaks relatively early, whereas aphid, tree hopper, red cotton bug and seed wasp showed greater abundance during the later part of the crop season. Cabbage looper and hairy caterpillar remained comparatively low in abundance. The later crop period, particularly January and February, was therefore identified as an important period for regular pest surveillance.

Ladybird beetles, predatory spiders and hover flies were the major natural enemies recorded in association with the fennel pest complex. Their populations increased with increasing pest abundance, suggesting an important ecological association between pests and their natural enemies.

Weather analysis indicated that maximum temperature, minimum temperature and evaporation were showed significant positive associations with pest and natural-enemy populations, while morning and evening relative humidity showed predominantly significant negative relationships. The findings indicate that weather-based monitoring, particularly during the late rabi period, can help in identifying periods of increased pest risk. The information generated from the present investigation provides a useful baseline for future studies on pest forecasting, economic-threshold development and conservation-based integrated pest management of fennel under *Vidarbha* conditions.

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