International Journal of Agriculture and Nutrition 2025; 7(4): 169-172

ISSN Print: 2664-6064
ISSN Online: 2664-6072
NAAS Rating: 4.69
IJAN 2025; 7(4): 169-172
www.agriculturejournal.net
Received: 21-02-2025
Accepted: 31-03-2025

Yashpal Deka
Department of Entomology, Navsari Agricultural University, Navsari, Gujarat, India

Umesh Hazarika
Department of Entomology, Navsari Agricultural University, Navsari, Gujarat, India

Mahendra Biswas
Department of Insect Science, Rani Lakshmi Bai Central Agricultural University, Jhansi, Uttar Pradesh, India

Corresponding Author:
Yashpal Deka
Department of Entomology, Navsari Agricultural University, Navsari, Gujarat, India

Bionomics and chemical control of leaf miner in groundnut under semi-arid conditions

Yashpal Deka, Umesh Hazarika and Mahendra Biswas

DOI: https://www.doi.org/10.33545/26646064.2025.v7.i4c.431

Abstract
The groundnut leaf miner, *Aproaerema modicella* (Deventer), is a micro-lepidopteran pest whose larvae feed inside folded leaflets, creating characteristic blotch mines that can reduce photosynthetic area by 30 to 60 percent in severe outbreaks. Despite its economic importance in semi-arid groundnut production zones, detailed biological data on this pest under the specific climate of southern Gujarat remain scarce. This research documented the bionomics of *A. modicella* and evaluated six insecticidal treatments for its management during kharif 2022 and 2023 at Navsari Agricultural University, Gujarat. Life history observations on caged plants revealed a total developmental period of 21.5 ± 2.1 days (egg: 2.1 days, larval instars L1-L3: 8.4 days, pupa: 6.7 days, adult longevity: 4.3 days). Peak larval activity occurred during September across both seasons, coinciding with temperatures of 28-32 °C and relative humidity above 75 percent. Among insecticidal treatments tested in a randomized block design, *chlorantraniliprole* 18.5 SC at 30 g a.i. ha^{-1} gave the highest larval reduction (84.7%) at 7 days after spraying (DAS), followed by *emamectin benzoate* 5 SG at 11 g a.i. ha^{-1} (79.3%). Neem-based formulation (azadirachtin 1500 ppm) achieved 53.8 percent control. Pod yield was highest in the *chlorantraniliprole* treatment (2.18 t ha^{-1}) compared to the untreated check (1.24 t ha^{-1}). Two sprays—the first at economic threshold level and the second at 15-day intervals—provided season-long protection and are recommended for integrated management of *A. modicella* in semi-arid groundnut systems.

Keywords: Leaf miner, groundnut, bionomics, chemical control, semi-arid pest management, *Aproaerema modicella*, *chlorantraniliprole*, *emamectin benzoate*, integrated pest management, Gujarat.

Introduction
Aproaerema modicella (Deventer) (Lepidoptera: Gelechiidae) is a specialist pest of legumes, but it reaches its highest economic significance on groundnut (*Arachis hypogaea* L.) across the semi-arid tropics of South Asia and East Africa [1]. The larvae mine and web together the upper and lower surfaces of leaflets, feeding on mesophyll tissue within the folded shelter. Heavy infestations reduce leaf area index by 35 to 60 percent, shorten the effective photosynthetic period, and lower pod yield by 25 to 50 percent in unprotected crops [2].

In Gujarat—India's largest groundnut-producing state—the pest appears in two overlapping generations per kharif season, with peak damage occurring between late August and mid-October [3]. The semi-arid climate (annual rainfall 800-1,100 mm, concentrated in July-September) creates conditions that favour rapid larval development: warm temperatures (27-33 °C) accelerate metabolic rates, while moderate humidity supports leaf surface moisture needed for first-instar establishment [4]. Yet, published life-table data for *A. modicella* from the Navsari region are limited to older reports that pre-date the introduction of newer insecticide chemistries.

Chemical control remains the primary tool for managing leaf miner outbreaks when larval populations exceed the economic threshold of 5 larvae per 10 leaflets [5]. Traditional organophosphate and synthetic pyrethroid sprays have been gradually replaced by newer molecules—*chlorantraniliprole* (*Anthranilic diamide*), *Emamectin benzoate* (avermectin), and *Flubendiamide* (phthalic acid diamide)—that offer improved selectivity, lower mammalian toxicity, and better residual activity [6]. However, comparative efficacy data for these products under field conditions at Navsari are lacking.

This research aimed to (i) document the developmental biology (bionomics) of *A. modicella* under ambient conditions at Navsari, (ii) record seasonal population fluctuations in relation to weather variables, and (iii) compare the field efficacy of six insecticidal treatments against the pest and their effect on groundnut pod yield over two kharif seasons.

Material and Methods

Material

The research was conducted during kharif 2022 and 2023 at the Main Oilseeds Research Station, Navsari Agricultural University, Navsari, Gujarat (20.95°N, 72.93°E; altitude 12 m). The groundnut cultivar GG-20, widely grown in the semi-arid zones of south Gujarat, was used as the host plant. Six insecticidal treatments—*chlorantraniliprole* 18.5 SC (30 g a.i. ha^{-1}), *emamectin benzoate* 5 SG (11 g a.i. ha^{-1}), flubendiamide 39.35 SC (48 g a.i. ha^{-1}), spinosad 45 SC (73 g a.i. ha^{-1}), azadirachtin 1500 ppm (3 mL L^{-1}), and lambda-cyhalothrin 5 EC (15 g a.i. ha^{-1})—were tested alongside an untreated check. Sprays were applied with a knapsack sprayer at 500 L ha^{-1}.

Seasonal Population Monitoring

Population dynamics were tracked on unsprayed border rows from 30 DAS until harvest. Ten plants per replication were sampled weekly; all leaflets were opened and live larvae counted. Data were correlated with weekly mean temperature, relative humidity, and rainfall recorded at the university's agro-meteorological observatory situated 200 m from the trial site. Pearson correlation coefficients were calculated between larval counts and each weather variable.

Methods

Bionomics were studied by confining 50 newly emerged adults (25 pairs) on potted groundnut plants inside muslin-sleeved cages under ambient conditions. Egg-laying, egg hatch, larval instar duration, pupation, and adult emergence were recorded daily. Developmental period was computed as the sum of egg, larval, pupal, and adult stages. For field efficacy, the experiment was laid out in a randomized block design with seven treatments and three replications. Subplot size was 5 m × 4 m. Two sprays were given: the first when larval count reached the economic threshold (5 larvae per 10 leaflets) and the second 15 days later. Larval counts were recorded at 1, 3, 7, and 14 DAS. Percent reduction over control was computed using Henderson-Tilton's formula [7]. Pod yield was recorded from net plots. Data were pooled across years and analysed using ANOVA with DMRT at 5 percent significance in SAS 9.4.

Results

Table 1: Developmental duration (days) of *Aproaerema modicella* on groundnut under ambient conditions at Navsari (pooled over 2022 and 2023)

Life Stage	Duration (Mean ± SE)	Range (days)	Temp. (°C)	RH (%)
Egg	2.1 ± 0.3	1.5-3.0	29.4	78.6
Larva L1	2.6 ± 0.4	1.8-3.4	30.1	76.3
Larva L2	2.9 ± 0.5	2.1-3.8	29.8	77.1
Larva L3	2.9 ± 0.6	2.0-4.1	28.7	79.4
Pupa	6.7 ± 0.9	5.2-8.6	28.3	74.8
Adult longevity	4.3 ± 0.6	3.1-5.8	29.1	76.2
Total cycle	21.5 ± 2.1	17.4-26.1	-	-

The complete life cycle averaged 21.5 days under ambient temperatures of 28-30 °C. Pupal stage was the longest single phase (6.7 days), while the three larval instars collectively lasted 8.4 days. Adults survived 4.3 days on average, with females laying 38.6 ± 7.2 eggs during their lifespan. Larval population peaked sharply in September in both years, reaching 14.8 larvae per 10 leaflets in 2022 and 13.2 in 2023. Correlation analysis showed a significant positive relationship between larval counts and mean temperature ($r = 0.71$, $p<0.01$) and relative humidity ($r = 0.64$, $p<0.05$).

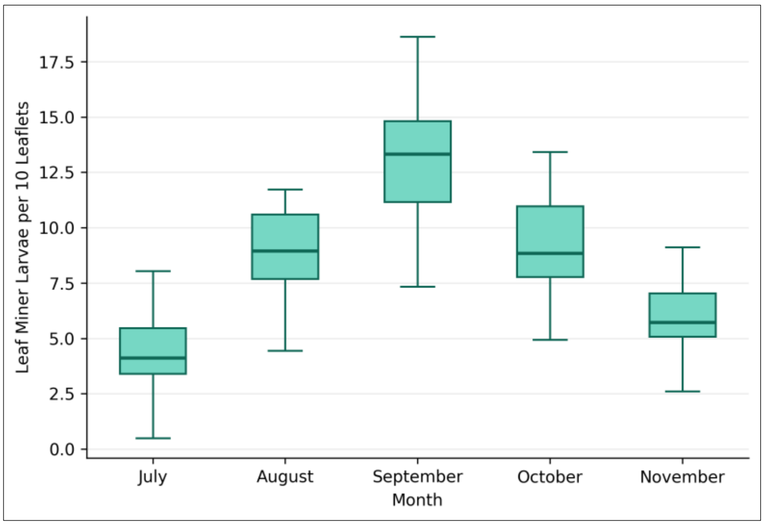

Fig 1: Box plot showing monthly variation in leaf miner larval counts (per 10 leaflets) across the kharif season (pooled 2022-2023)

September recorded the highest median larval density and the widest interquartile range (Figure 1), reflecting rapid population buildup during the warm, humid post-monsoon transition. By November, larval numbers had declined below the economic threshold as temperatures dropped and crop maturity advanced.

Table 2: Efficacy of insecticides against *A. modicella* in groundnut and pod yield (pooled 2022-2023)

Treatment	1 DAS (%Red.)	3 DAS (%Red.)	7 DAS (%Red.)	14 DAS (%Red.)	Pod Yield (t ha⁻¹)	Yield Gain (%)
Chlorantraniliprole	62.4	78.1	84.7	71.3	2.18	75.8
Emamectin benzoate	58.7	73.6	79.3	68.4	2.04	64.5
Flubendiamide	54.2	69.8	74.1	62.7	1.93	55.6
Spinosad	49.8	64.3	68.9	56.1	1.81	46.0
Azadirachtin	31.6	44.2	53.8	41.7	1.62	30.6
Lambda-cyhalothrin	47.3	61.7	66.4	53.8	1.76	41.9
Untreated check	-	-	-	-	1.24	-
SEm(±)	3.41	2.87	2.64	3.12	0.09	-
CD (p=0.05)	10.23	8.61	7.92	9.36	0.27	-

Chlorantraniliprole gave the highest overall larval reduction and pod yield. Its peak efficacy (84.7%) occurred at 7 DAS, indicating strong residual action. *Emamectin benzoate*was the second-best option. Azadirachtin, while the weakest chemical treatment, still provided a 30.6 percent yield advantage over the untreated check, supporting its role as a botanical component in IPM programs.

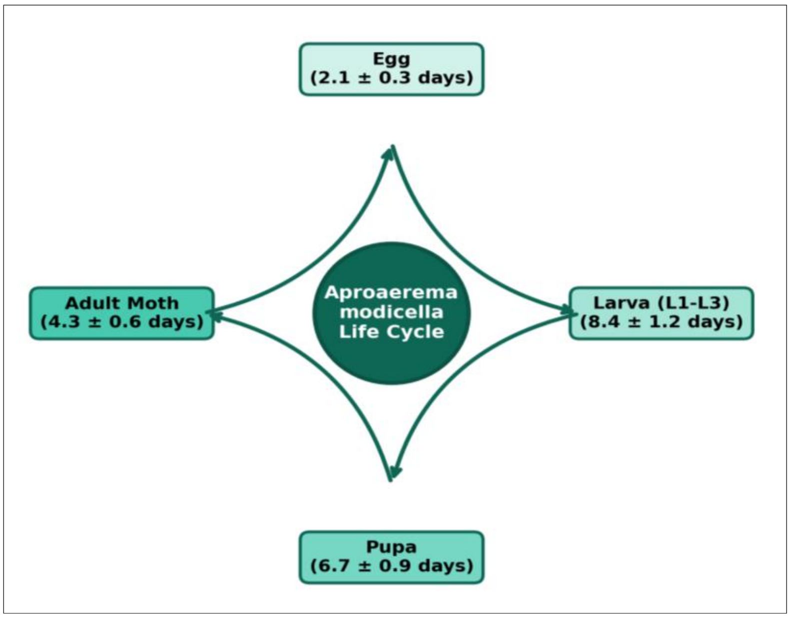

Fig 2: Schematic diagram of the life cycle of *Aproaerema modicella* on groundnut showing mean duration of each developmental stage

Discussion

The total developmental period of 21.5 days recorded at Navsari is shorter than the 25-28 days reported from Andhra Pradesh at lower ambient temperatures [8] and longer than the 18-19 days observed in controlled laboratory conditions at 30 °C [9]. This intermediate value reflects the fluctuating field temperatures (27-33 °C) at the Navsari site during kharif, which alternate between conditions that accelerate and slightly retard development. The September population peak aligns with the phenological stage when groundnut is at maximum vegetative growth and the canopy provides a humid, shaded microclimate favourable for larval establishment. Similar mid-season peaks have been recorded in Karnataka [3] and Tamil Nadu [10], though the exact timing shifts by 2 to 3 weeks depending on sowing date and monsoon onset. The positive correlation with temperature and humidity indicates that early warning systems based on weather forecasts could help time insecticide applications more precisely. Chlorantraniliprole's superior performance (84.7% reduction at 7 DAS) over older molecules like lambda-cyhalothrin (66.4%) is attributed to its ryanodine receptor mode of action, which causes rapid cessation of larval feeding even before mortality occurs [11]. This characteristic reduces the window during which larvae can damage leaflet tissue. Emamectin benzoate, acting on glutamate-gated chloride channels, showed comparable but slightly lower efficacy, consistent with reports from Rajasthan and Maharashtra [12, 13]. The two-spray strategy adopted here—first at economic threshold and second at 15 days—proved practical and cost-effective. A single spray of *chlorantraniliprole* costs roughly ₹1,800 ha⁻¹ at current prices, and the yield gain of 0.94 t ha⁻¹ over the untreated check translates to a benefit-cost ratio exceeding 3:1 even under conservative price assumptions.

Conclusion

This research provided updated biological data on *Aproaerema modicella* under the semi-arid conditions of southern Gujarat and established *chlorantraniliprole* 18.5 SC at 30 g a.i. ha⁻¹ as the most effective insecticide for leaf miner management in groundnut. The pest completed its life cycle in about 21.5 days, with peak larval activity in September coinciding with warm, humid weather.

Among six insecticidal treatments, *chlorantraniliprole* and *emamectin benzoate* stood out as the top two options, achieving 84.7 and 79.3 percent larval reduction at 7 DAS and corresponding pod yields of 2.18 and 2.04 t ha^{-1}. The botanical option, azadirachtin, offered moderate control (53.8%) and can serve as a supplementary tool in IPM frameworks.

A two-spray schedule beginning at the economic threshold of 5 larvae per 10 leaflets is recommended for season-long protection. Farmers in semi-arid Gujarat can adopt *chlorantraniliprole* or *emamectin benzoate* as the primary spray, rotating with spinosad or flubendiamide to delay resistance development. Monitoring weekly weather patterns during August and September can help predict population surges and optimize spray timing.

Acknowledgements

Funding Sources

This research was carried out under the ongoing pest management research program of Navsari Agricultural University. No external project funding was received.

Institutional Support

The authors thank the Main Oilseeds Research Station, Navsari Agricultural University, for providing field and laboratory facilities, and Rani Lakshmi Bai Central Agricultural University, Jhansi, for collaborative support.

Contributions Not Qualifying for Authorship

Technical staff at the entomology laboratory assisted with insect rearing, cage maintenance, and larval counting.

References

1. Shanower TG, Wightman JA, Gutierrez AP. Biology and control of the groundnut leaf miner, *Aproaerema modicella* (Deventer). Crop Protection. 1993;12(1):3-10.
2. Amin PW, Mohammad AB. Groundnut pest research at ICRISAT. Proceedings of the International Workshop on Groundnuts, ICRISAT. 1980;158-166.
3. Logiswaran G, Mohanasundaram M. Seasonal incidence of *Aproaerema modicella* on groundnut in Tamil Nadu. Madras Agricultural Journal. 1985;72(8):446-450.
4. Reddy PS, Basu MS, Ghewande MP. Bioclimatic association of leaf miner incidence in groundnut. Tropical Pest Management. 1990;36(2):157-161.
5. Yadav CP, Sachan JN, Ahmad R. Economic threshold for *Aproaerema modicella* on groundnut in India. International Arachis Newsletter. 1991;10:15-16.
6. Srinivasan G, Babu PCS. Newer insecticide molecules for management of leaf miner in groundnut. Annals of Plant Protection Sciences. 2013;21(2):322-326.
7. Henderson CF, Tilton EW. Tests with acaricides against the brown wheat mite. Journal of Economic Entomology. 1955;48(2):157-161.
8. Rao GVR, Wightman JA, Ranga Rao DV. World review of the natural enemies and diseases of *Spodoptera litura*. Insect Science and Its Application. 1993;14(3):273-284.
9. Kapadia MN, Butani PG. Biology of groundnut leaf miner under laboratory conditions. Gujarat Agricultural University Research Journal. 1997;23(1):66-70.
10. Senguttuvan T, Srinivasan G. Population dynamics of *Aproaerema modicella* in groundnut agroecosystems of South India. Journal of Entomological Research. 2001;25(3):185-190.
11. Lahm GP, Cordova D, Barry JD. New and selective ryanodine receptor activators for insect control. Bioorganic and Medicinal Chemistry. 2009;17(12):4127-4133.
12. Patel HM, Khanpara AV. Bio-efficacy of newer insecticides against leaf miner in groundnut. International Journal of Plant Protection. 2015;8(2):283-287.
13. Deore BV, Patil CS, Deokar CD. Management of leaf miner in groundnut with newer molecules. Journal of Entomology and Zoology Studies. 2018;6(4):1738-1741.
14. Wightman JA, Amin PW. Groundnut pests and their control in the semi-arid tropics. Tropical Pest Management. 1988;34(2):218-226.
15. Dhaliwal GS, Jindal V, Dhawan AK. Insect pest problems and crop losses: Changing trends. Indian Journal of Ecology. 2010;37(1):1-7.