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## Occurrence of groundnut Leafminer (GLM), *Aproaerema modicella* Deventer (Lepidoptera: Gelechiidae) and its parasitoid fauna in various groundnut growing areas of Tamil Nadu

**Murugasridevi K, S Jeyarani and S Mohankumar**

### Abstract

An extensive survey was conducted during the period of 2016 to 2018 (July to October – Rainy season) on the occurrence of Groundnut Leafminer (GLM), *Aproaerema modicella* Deventer and its parasitoid fauna in different groundnut growing areas of Tamil Nadu. During 2016 -2017, the highest GLM damage was recorded in Kannarapettai Village of Cuddalore district (88.78%) followed by Omanthoor Village of Viluppuram district (85.20%). Similarly, in 2017-2018, the highest GLM damage was recorded in Kannarapettai Village of Cuddalore district (84.30%) followed by K.G. Kandigai village of Thiruvallur district (75.40%). Observations on the parasitization revealed maximum parasitization of GLM larvae in 2016-2017. At Kannarapettai Village of Cuddalore district (36.67%) followed by Omanthoor Village of Viluppuram district (33.33%). In 2017-2018, the highest parasitization percentage of 30.00 per cent was observed at Kannarapettai Village of Cuddalore district followed by K.G. Kandigai Village of Thiruvallur district (26.67%). Among the parasitoids recorded, *Chelonus blackburni* Cameron and *Bracon* sp. was found to be prevalent in all the groundnut growing areas during 2016 to 2018 with the parasitization percentage of 6.67 to 16.67 per cent and 3.33 to 6.67 per cent, respectively. The highest parasitization of 16.67 per cent by *C. blackburni* was recorded in Kannarapettai Village of Cuddalore district during 2016-2017. In general, parasitoid activity was found to increase with the increase in GLM population.

**Keywords:** Survey, groundnut leafminer, parasitoids, *Chelonus blackburni* Cameron, *Bracon* sp

### Introduction

The Groundnut Leafminer (GLM), *Aproaerema modicella* Deventer (Lepidoptera: Gelechiidae) is a serious pest of groundnut and soybean in South and South-East Asia [1]. The larvae make blister like mines on the dorsal side of the leaf near mid-rib. Later on, the entire leaf becomes brown, rolled and dried up. In severe infestation, the crop turns burnt up in appearance [2]. The leafminer damage reduces the photosynthetically active leaf area and thereby causes yield losses of 24 to 92 percent [3]. Owing to the concealed nature of the pest, biological control based on entomophages may be an environmentally and economically sound tool for the management of *A. modicella* than the synthetic insecticides. In this context, knowledge on the indigenous natural enemies that are adapted to the pest is crucial for developing sustainable pest control strategies. Many species of natural enemies of GLM viz., *Stenomeresius japonicus* (Ashmead), *Sympiesis* sp. and *Tetrastichus* sp., *Chelonus* sp., *Bracon* sp., *Brachymeria* sp., *Temelucha* sp. and *Goniozus* sp. were reported in Asia [4, 5]. Success of any biological control programme depends on the exploration of indigenous natural enemies. Keeping this in view, extensive surveys were carried out in various groundnut growing areas of Tamil Nadu on the occurrence of GLM, *A. modicella* and its parasitoid fauna.

### Materials and Methods

Extensive Surveys were conducted during 2016 to 2018 (July to October-Rainy season) at Viluppuram, Cuddalore, Thiruvannamalai and Thiruvallur districts of Tamil Nadu to document the damage potential of *A. modicella* on Groundnut and its associated parasitoids.

### Damage potential assessment

Damage potential was assessed in twenty five randomly selected plants from each location on symptom basis.

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For this purpose, top twenty opened leaflets from the central axis of each plant were examined for healthy and affected leaflets and percentage damage was calculated [6].

### Assessment of parasitization

To assess the parasitization percentage, twenty five plants were selected at random from each location and GLM infested leaves with live and parasitized larvae were brought to the laboratory and observed for the emergence of

parasitoids [6]. A sample size of 30 larvae per location was maintained. From the sample size, Per cent parasitization and parasitoid (different) species emergence percentage was worked out by the following formula.

$$\text{Percent parasitization} = \frac{\text{Number of larvae parasitized}}{\text{Total number of larvae collected}} \times 100$$

$$\text{Percent parasitoid (different) species emergence} = \frac{(\text{Number of larvae from which particular species of parasitoid emerged})}{\text{Total number of larvae collected}} \times 100$$

The parasitoids emerged were preserved in 70 per cent ethanol and identified with the help of available literature and by the experts viz., A.P. Ranjith, University of Calicut, Kerala and Dr. Santhosh Nair from Malabar Christian College, Calicut, Kerala.

### Results and Discussion

The survey during the period of 2016 to 2017 revealed highest damage by GLM in Kannarapettai Village of Cuddalore district (88.78%) followed by Omanthoor Village of Viluppuram district (85.20%). During 2017-2018, the highest damage by GLM was recorded in Kannarapettai Village of Cuddalore district (84.30%) followed by K.G. Kandigai village of Thiruvallur district (75.40%).

Observations on the parasitization revealed that the parasitism was increased with the increased availability of host larvae. Similar results were reported earlier by Muthiah and Kareem (2000) [6] who documented the mean leaflet damage of  $90.1 \pm 5.0$  per cent and mean parasitism of  $28.1 \pm 5.0$  per cent at Dharmapuri district. Likewise Shekarappa *et al.* (1990) [4] reported that the population of natural enemies synchronised with the maximum incidence of GLM. This is also in accordance with [7] who reported that rainfed groundnut suffered maximum damage by leafminer during July and August in South India. Of the eight parasitoid species recorded in Gujarat, six were present in the rainy season (July-October) and four were active at the end of the post-rainy season (March-May). Two species, *Goniozus* sp. and *S. japonicus* were active in both seasons [8]. The higher activity of leaf miner during rainy season may be attributed to the availability of many leguminous hosts and dry weather, while lower during post-rainy season due to less availability of other legumes.

The survey during 2016 - 2017 revealed highest parasitization at Kannarapettai village of Cuddalore district (36.67%) followed by Omanthoor Village of Viluppuram (33.33%) (Table 1- 4).

Similarly, during 2017 - 2018 revealed highest parasitization of GLM at Kannarapettai village of Cuddalore district (30%) followed by K.G. Kandigai village of Thiruvallur district (26.67%) (Table 5-8).

Survey on the parasitoid fauna of GLM revealed that the larvae of *A. modicella* were parasitized by 13 species of the order hymenoptera, of which four species of braconids viz., *C. blackburni*, *Avga chaospes* Nixon, *Apanteles* sp. and *Bracon* sp., three eulophids viz., *S. japonicus*, *Aprostocetes* sp. and

*Sympiesis dolichogaster* Ashmead., one each in Ichneumonid, (*Temelucha* sp.), Eurytomid, (*Eurytoma* sp.), Pteromalid, (*Pteromalus* sp.), Eupelmid, (*Eupelmus* sp.), Bethyloid, (*Goniozus* sp.) and Chalcid (*Brachymeria femorata* Panzer) were recorded. The parasitoids recorded were mostly larval parasitoids except *C. blackburni*, which is an Egg-larval parasitoid. Among the parasitoids recorded, *C. blackburni* and *Bracon* sp. was found to be prevalent in all the groundnut growing areas during the survey period (2016 to 2018) with the parasitization percentage of 6.67 to 16.67 per cent and 3.33 to 6.67 per cent, respectively. The highest per cent parasitisation of 16.67 per cent by *C. blackburni* was recorded in Kannarapettai Village of Cuddalore district during 2016-2017.

The present findings are in accordance with the reports of [9] who reported 15 parasitoids on *A. modicella* during summer 2009 at ARS, Bagalkot. It was also reported that the parasitoids encountered were of the order hymenoptera representing seven families viz., Bethyliidae, Braconidae, Chalcididae, Eulophidae, Eupelmidae, Eurytomidae and Ichneumonidae. Among that, five species were parasitic on larval stages, while one species was egg-larval parasitoid and another one was larval pupal parasitoid. Of the parasitoid found recorded highest per cent parasitism was recorded by *Chelonus* sp., *Bracon* sp. *S. dolichogaster*. *Eurytoma* sp. recorded the lowest parasitization (5%). In addition, Muthiah and Kareem (2000) [6] recorded maximum activity of egg larval parasitoid, *Chelonus* sp. (26.00%), larval-pupal parasitoid, *Brachymeria wittei* Schmitz (20.00%) and larval parasitoid, *G. indicus* (16.67%).

Similarly, [4] recorded 16 species of hymenopterous parasitoids during Kharif, 1989. Among them, three parasitoids viz., *S. japonicus* (Ashmead), *Sympiesis* sp. and *Tetrastichus* sp. were found to be maximum during the month of August, while the occurrence of *Chelonus* sp. was more during the month of September.

In other reports, it was reported that the parasitization rates varied from 25 to 90 per cent of the available GLM larvae [8, 10]. Although, largest number of parasitoids were reported from India, little is known of their distribution or seasonal abundance [11]. Indicated that the leaf miner guild has the greatest number of parasitoid species and very high parasitism levels. The mentioned observations on leaf miners, in general, may indicate that the diversity of parasitoids on GLM in India could increase in future and it may effectively check the population, if combined with augmentation.

**Table 1:** Occurrence of groundnut leaf miner and its parasitoid fauna in Viluppuram district during 2016-17

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Kolakkudi	TMV 7	12.14786 N	79.102577 E	138 ft	Pegging stage	26.80	-	-	-	-
Olakkur	TMV Gn 13	12.321307 N	79.766656 E	131 ft	Pegging stage	44.30	16.67	1	<i>Eurytoma</i> sp.	3.33
								1	<i>Brachymeria femorata</i> Panzer	3.33
								2	<i>Bracon</i> sp.	6.67
Endiyur	TMV Gn 13	12.313881 N	79.57938 E	125 ft	Pod formation stage	12.80	-	-	-	-
Kovudi	TMV Gn 13	12.314816 N	79.757435 E	121 ft	Pegging stage	28.80	-	-	-	-
Omanthoor	TMV Gn 13	12.29546 N	79.729753 E	95 ft	Pegging stage	85.20	33.33	3	<i>Stenomesus japonicus</i> Ashmead	10.00
								4	<i>Chelonus blackburni</i> Cameron	13.33
Kodipakkam	TMV Gn 13	12.313863 N	79.757712 E	127 ft	Flowering Stage	15.03	-	-	-	-
Kurumaapettai	TMV 7	12.29546 N	79.729753 E	171 ft	Flowering Stage	12.60	-	-	-	-
Molasur	TMV Gn 13	12.279427 N	79.703377 E	118 ft	Pod formation stage	56.70	30.00	2	<i>S. japonicus</i>	6.67
								1	<i>Goniozus</i> sp.	3.33
								4	<i>C. blackburni</i>	13.33
Maanur	TMV 7	12.26339 N	79.670717 E	190 ft	Flowering Stage	25.00	-	-	-	-
Konerikuppam	TMV Gn 13	12.19823 N	79.683293 E	138 ft	Pod formation stage	36.74	6.67	1	<i>Bracon</i> sp.	3.33

**Table 2:** Occurrence of groundnut leaf miner and its parasitoid fauna in Thiruvannamalai district during 2016-2017

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Pazhayanoor	TMV Gn 13	12.080046 N	79.037997 E	457 ft	Pod formation stage	45.70	13.33	2	<i>Eupelmus</i> sp.	6.67
Edakkal	TMV Gn 13	12.068584 N	79.016098 E	470 ft	Pod formation stage	80.16	30.00	3	<i>Temeluchas</i> p.	10.00
								1	<i>Avgachaopses</i> Nixon	3.33
								3	<i>C. blackburni</i>	10.00
Perayampattu	TMV 7	12.083423 N	79.015364 E	471 ft	Pegging stage	5.60	-	-	-	-
Kandiyamkuppam	TMV 7	12.05431 N	79.034037 E	467 ft	Flowering Stage	15.20	-	-	-	-
Athiyandal	TMV Gn 13	12.0558806 N	79.07305 E	463 ft	Pegging stage	32.40	10.00	2	<i>Eurytoma</i> sp.	6.67
Thachampattu	VRI 2	12.097357 N	79.086095 E	472 ft	Flowering Stage	36.68	13.33	1	<i>Bracon</i> sp.	3.33
Sirunaathur	TMV 7	12.24908 N	79.19929 E	535 ft	Flowering Stage	34.60	6.67	1	<i>Goniozus</i> sp.	3.33
Keezhpennathur	TMV Gn 13	12.24768 N	79.22168 E	492 ft	Pegging stage	20.00	-	-	-	-

**Table 3:** Occurrence of groundnut leaf miner and its parasitoid fauna in Cuddalore district during 2016-2017

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Ramapuram	VRI Gn 5	12.080046 N	79.037997 E	457 ft	Pod formation stage	35.70	6.67	1	<i>S. japonicus</i>	3.33
Odhiyadikuppam	VRI Gn 5	12.068584 N	79.016098 E	470 ft	Pod formation stage	37.30	10.00	1	<i>S. japonicus</i>	3.33
Kannarapettai	VRI Gn 5	12.083423 N	79.015364 E	471 ft	Pegging stage	88.78	36.67	5	<i>C. blackburni</i>	16.67
								1	<i>Goniozus</i> sp.	3.33
								1	<i>Temelucha</i> sp.	3.33

**Table 4:** Occurrence of groundnut leaf miner and its parasitoid fauna in Thiruvallur district during 2016-2017

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Tiruttani	VRI 3	13.179262 N	79.602355 E	364 ft	Pod formation stage	42.78	13.33	1	<i>S. japonicus</i>	3.33
K.G. Kandigai	TMV 7	13.175198 N	79.518584 E	340 ft	Pod formation stage	79.48	30.00	3	<i>S. dolichogaster</i>	10.00
								2	<i>Temelucha</i> sp.	6.67
								2	<i>C. blackburni</i>	6.67
								1	<i>B. femorata</i>	3.33
Lakshmapuram	TMV Gn 13	13.174904 N	79.518560 E	344 ft	Pegging stage	35.63	10.00	1	<i>B. femorata</i>	3.33
Kanagammachathram	TMV 7	13.20681 N	79.75123 E	184ft	Pegging stage	27.74	6.67	1	<i>A. chaopses</i>	3.33
T.C. Kandigai	VRI 3	13.070593 N	79.606932 E	272 ft	Flowering Stage	43.66	13.33	2	<i>S. dolichogaster</i>	6.67
								1	<i>Goniozus</i> sp.	3.33
Aathipattu	VRI 3	13.117382 N	79.572343 E	279 ft	Pegging stage	40.64	13.33	2	<i>Bracon</i> sp.	6.67
Beerakuppam	VRI 3	13.174874 N	79.518780 E	273 ft	Flowering Stage	32.24	10.00	1	<i>Eurytoma</i> sp.	3.33
Karthikayapuram	TMV 7	13.170950 N	79.558460 E	349 ft	Flowering Stage	56.78	16.67	2	<i>Apanteles</i> sp.	6.67

**Table 5:** Occurrence of groundnut leaf miner and its parasitoid fauna in Viluppuram district during 2017-2018

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Kolakkudi	TMV 7	12.14786 N	79.102577 E	138 ft	Pegging stage	37.03	10.00	1	<i>S. japonicus</i>	3.33
Olakkur	TMV Gn 13	12.321307 N	79.766656 E	131 ft	Pegging stage	70.16	23.33	1	<i>Bracon</i> sp.	3.33
								2	<i>S. japonicus</i>	6.67
								2	<i>B. femorata</i>	6.67
Endiyur	TMV Gn 13	12.313881 N	79.57938 E	125 ft	Pod formation stage	42.06	10.00	2	<i>Sympiesis dolichogaster</i> Ashmead	6.67
Kovudi	TMV Gn 13	12.314816 N	79.757435 E	121 ft	Pegging stage	35.68	6.67	1	<i>S. japonicus</i>	3.33
Omanthoor	TMV Gn 13	12.29546 N	79.729753 E	95 ft	Pegging stage	68.80	20.00	1	<i>Goniozus</i> sp.	3.33
								3	<i>C. blackburni</i>	10.00
Kodipakkam	TMV Gn 13	12.313863 N	79.757712 E	127 ft	Flowering Stage	25.50	-	-	-	-
Kurumaapettai	TMV 7	12.29546 N	79.729753 E	171 ft	Flowering Stage	20.00	-	-	-	-
Molasur	TMV Gn 13	12.279427 N	79.703377 E	118 ft	Pod formation stage	66.78	20.00	2	<i>Bracon</i> sp.	6.67
								2	<i>S. japonicus</i>	6.67
								1	<i>B. femorata</i>	3.33
Maanur	TMV 7	12.26339 N	79.670717 E	190 ft	Flowering Stage	15.03	-	-	-	-
Konerikuppam	TMV Gn 13	12.19823 N	79.683293 E	138 ft	Pod formation stage	35.20	6.67	1	<i>Eurytoma</i> sp.	3.33

**Table 6:** Occurrence of groundnut leaf miner and its parasitoid fauna in Thiruvannamalai district during 2017-2018

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Pazhayanoor	TMV Gn 13	12.080046 N	79.037997 E	457 ft	Pod formation stage	30.20	6.67	1	<i>B. femorata</i>	3.33
Edakkal	TMV Gn 13	12.068584 N	79.016098 E	470 ft	Pod formation stage	69.16	23.33	2	<i>S. japonicus</i>	6.67
								2	<i>Bracon</i> sp.	6.67
								1	<i>Pteromalus</i> sp.	3.33
Perayampattu	TMV 7	12.083423 N	79.015364 E	471 ft	Pegging stage	20.00	-	-	-	-
Kandiyamkuppam	TMV 7	12.05431 N	79.034037 E	467 ft	Flowering Stage	11.40	-	-	-	-
Athiyandal	TMV Gn 13	12.0558806 N	79.07305 E	463 ft	Pegging stage	37.20	10.00	2	<i>Bracon</i> sp.	6.67
Thachampattu	VRI 2	12.097357 N	79.086095 E	472 ft	Flowering Stage	64.20	20.00	2	<i>Temelucha</i> sp.	6.67
								2	<i>C. blackburni</i>	6.67
Sirunaathur	TMV 7	12.24908 N	79.19929 E	535 ft	Flowering Stage	8.35	-	-	-	-
Keezhpennathur	TMV Gn 13	12.24768 N	79.22168 E	492 ft	Pegging stage	44.80	13.33	1	<i>Bracon</i> sp.	3.33

**Table 7:** Occurrence of groundnut leaf miner and its parasitoid fauna in Cuddalore district during 2017-2018

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Ramapuram	VRI Gn 5	12.080046 N	79.037997 E	457 ft	Pod formation stage	30.06	10.00	2	<i>Bracon</i> sp.	6.67
Odhiyadiakuppam	VRI Gn 5	12.068584 N	79.016098 E	470 ft	Pod formation stage	46.74	13.33	2	<i>S. japonicus</i>	6.67
Kannarapettai	VRI Gn 5	12.083423 N	79.015364 E	471 ft	Pegging stage	84.30	30.00	2	<i>S. japonicus</i>	6.67
								3	<i>C. blackburni</i>	10.00
								2	<i>S. dolichogaster</i>	6.67

**Table 8:** Occurrence of groundnut leaf miner and its parasitoid fauna in Thiruvallur district during 2017-2018

Location	Variety	Latitude	Longitude	Altitude	Crop stage	Leaflet damage (%)	% Parasitization (n=30)	No. of parasitized larvae from which parasitoids emerged	Parasitoids species diversity	% Parasitoid emergence
Tiruttani	VRI 3	13.179262 N	79.602355 E	364 ft	Pod formation stage	25.70	6.67	1	<i>Temelucha</i> sp.	3.33
K. G. Kandigai	TMV 7	13.175198 N	79.518584 E	340 ft	Pod formation stage	75.40	26.67	1	<i>Bracon</i> sp.	3.33
								4	<i>C. blackburni</i>	13.33
								3	<i>Temelucha</i> sp.	10.00
Lakshmapuram	TMV Gn 13	13.174904 N	79.518560 E	344 ft	Pegging stage	35.64	10.00	1	<i>S. japonicus</i>	3.33
Kanagammachathram	TMV 7	13.20681 N	79.75123 E	184ft	Pegging stage	39.60	13.33	2	<i>S. dolichogaster</i>	6.67
T. C. Kandigai	VRI 3	13.070593 N	79.606932 E	272 ft	Flowering Stage	54.08	20.00	1	<i>Aprostocetes</i> sp.	3.33
								3	<i>Bracon</i> sp.	10.00
Aathipattu	VRI 3	13.117382 N	79.572343 E	279 ft	Pegging stage	35.56	6.67	2	<i>C. blackburni</i>	6.67
Beerakuppam	VRI 3	13.174874 N	79.518780 E	273 ft	Flowering Stage	41.34	10.00	1	<i>S. japonicus</i>	3.33
Karthikayapuram	TMV 7	13.170950 N	79.558460 E	349 ft	Flowering Stage	45.20	10.00	1	<i>Bracon</i> sp.	3.33

## Conclusion

Control methods of Groundnut leafminer rely mainly on chemical insecticides. However, in recent years numerous studies have suggested the necessity for the integrated approaches involving other control methods to lower the use of chemical insecticides and minimize their negative effects on the environment and human health. In specific, methods based on the conservation and enhancement of natural enemies have often been proposed. Nevertheless, despite a high number of publications listing parasitoids of *A. modicella* in India, too little is known on their identity, biology and ecology to select candidates for introduction into the field. Thus a biological control programme against *A. modicella* should start with indepth study on the parasitoid complex of the GLM with emphasis on precise identification of the species, their specificity, lifecycle, climatic, ecological requirements and its impact on GLM populations.

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## References

1. Wightman JA, Pick KM, Ranga Rao GR, Shanower TG, Gold CS. Pest of Groundnut in the Semi-Arid Tropics. In: Insect pests of food legumes. Ed. By S. R. Sing, John Willey and sons, New York, 1990, 243-322.
2. Faekin SD. Pest control in Groundnut. Pans. Manual No.2. Centre for overseas Pest Research, Foreign and Common wealth Office, Overseas Development Association, London, 1973.
3. Amin PW. Insect Pests of Groundnut in India and Their Management. In: Plant protection in field crops: lead papers of the National Seminar on Plant Protection in Field Crop, 29-31 January 1986, CPPTI, Hyderabad, 1987.
4. Shekarappa, Somasekhar, Patil BV. Parasitoid complex of the groundnut leaf miner, *Approaerema modicella* Deventer (Gelechiidae: Lepidoptera). Journal of Biological Control. 1990; 4(1):55-56.
5. Basha H, Somasekhar, Raju J, Hosamani A. Survey of Parasitoid fauna on Groundnut leafminer, *Approaerema modicella* Deventer. Bioinfolet. 2012; 9(4A):435-439.
6. Muthiah C, Kareem AA. Survey of groundnut leaf miner and its natural enemies in Tamil Nadu. International Arachis Newsletter., 2000; 29:62-63.
7. Nair MRGK. Insect and Mites of Crops in India, ICAR New Delhi, 1975, 404.
8. Yadav DN, Patel RR, Patel RC. Natural enemies of the groundnut leafminer, *Approaerema modicella* Deventer (Lepidoptera: Gelechiidae) and their impact on its infestation in Anand (Gujarat). Gujarat Agricultural University Research Journal. 1987; 13:13-16
9. Praveena YV. Studies on groundnut leaf miner *Approaerema modicella* Deventer. in Northern dry zone of Karnataka. M.Sc (Ag) thesis. College of Agriculture, Dharwad, University of Agricultural Sciences, Dharwad, 2010.
10. Srinivasan S, Siva Rao DV. New reports of parasites of groundnut leaf webber, *Approaerema modicella* Deventer (Lepidoptera: Gelechiidae). *Entomon*. 1986; 12:117-119
11. Hawkins BA. Pattern and process in host-parasitoid interactions. Cambridge University Press, Cambridge, UK. 1994, 190.