Journal of Food Legumes
38(1): 135-140, 2025
DOI: 10.59797/jfl.v38.i1.252

Research Paper

Incidence of leaf folder (*Omiodes indicata* Fab.) and management of defoliators in soybean

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***Received:** August 17, 2024*
***Accepted:** December 11, 2024*

ABSTRACT

The field experiment was carried out to observe the incidence of soybean leaf folder (*Omiodes indicata* Fab.). The crop was sown on six different dates at fortnight intervals. The incidence of leaf folder was observed from three weeks after sowing in an early sown crop and lasted throughout the crop period. While, in late sown crop leaf folder incidence lasts till 9-10 weeks after sowing. The peak population of leaf folder was observed at 3rd MSW on November's first fortnight sown crop (15.10 larvae/MRL) followed by December's second fortnight (13.20 larvae/MRL) and November's second fortnight (12.60 larvae/MRL) at 5th and 8th SMW, respectively. Among the various insecticides evaluated, Chlorantraniliprole + Lambda-cyhalothrin 150 ZC @ 0.5 ml/litre was found more effective compared to other insecticides in terms of both grain yield and B:C ratio.

Key words: Leaf folder, Soybean, Incidence, *Rabi*-Summer, Sowing Dates

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill) is popularly known as the Golden Bean and originated in China and the far East. Soybean is considered one of the important oil seed crops in India with its multiple uses and the seed contains 20 percent oil and 40 percent protein with 6.4 percent lysine, 19.5 percent fat and 20.9 percent carbohydrates (Yadav 2013). Among various insect pests attacking the soybean crop, defoliators like tobacco caterpillar, semi-looper, hairy caterpillar, and *Helicoverpa* feed and damage the leaves throughout the crop period resulting in significant yield loss of up to 40 percent in flubendiamide-treated plots (Swathi 2018). Leaf folder or soybean web worm *Omiodes indicata* was originally described by Fabricius in 1775. Recently the infestation of webworm has been increasing in India, China, and other countries. It's a polyphagous defoliator pest infesting many Leguminosae plants and the larvae feed by staying inside the leaf folds (Anonymous 2021). The occurrence of this pest was documented in Assam, Meghalaya, Maharashtra, Karnataka, and Madhya Pradesh on various pulses. In Karnataka, *O. indicata* was reported on *Phaseolus vulgaris* L., *Cajanus cajan* (L.), *Macrotyloma uniflorum* (Lam.) and *Lablab purpureus* (L.) (Pasam *et al.* 2023). Gangwar and Thakur (1991) reported the severity of this pest in Meghalaya up to 8-9 folds per plant. As soybean is gaining importance worldwide, this defoliator incidence is causing higher yield loss and also decreasing productivity. The incidence of different insect pests of soybean grown in kharif is well reported but information on incidence during *Rabi* summer crop is lacking. The insect pests attacking the soybean during *Rabi*-summer are well documented by Pattar and Kandakoor (2022). So, this study was conducted to understand the incidence pattern of leaf folder infesting soybean during *Rabi*-summer and to evaluate the effective chemical insecticides against the defoliators.

MATERIALS AND METHODS

The field experiment was carried out at Agriculture Research Station (ARS), Bailhongal, Karnataka during *Rabi*-summer 2020-21. The soybean variety (JS-335) was raised in 10 rows of 5 m length with a spacing of 30×10 cm by adopting all the recommended agronomical practices without any insect pest control measures. The crop was sown on six different dates at 15-day intervals, starting from November's first fortnight to January's second fortnight. Observations on defoliators (Leaf folder, Leaf miner and *Spodoptera litura*) were recorded at weekly intervals from sowing till harvesting. The number of larvae per meter row length (MRL) was observed at three places initially and increased to five places later on to give more accuracy. The defoliation was recorded by observing five plants in

which 10 randomly selected leaves from each plant were looked for defoliation and percent defoliation was calculated using the below-mentioned formula.

$$\text{Percent defoliation} = \frac{\text{No. of leaves defoliated}}{\text{Total No. of leaves}} \times 100$$

The soybean (JS-335) crop was grown separately during January first fortnight during the summer season of the year 2021 to evaluate the efficacy of chemical insecticides to manage the defoliators. This experiment consists of 11 treatments with 3 replications in a plot size of 5×3 meters by using a Randomized Block Design. The foliar application of different treatments was done twice at 30 days and 45 days after sowing. The data on the efficacy of insecticides on defoliation was recorded in 3-5 places randomly in each replication and the average is calculated at the day before the first spray and 10 days after 2nd spray (Table 5). Net plot yield (q/ha) was recorded to see the overall damage caused by all defoliators. B:C Ratio was calculated based on the observation. The details of different treatments are given in Table 1.

RESULTS AND DISCUSSIONS

The incidence pattern of various defoliators was observed during *Rabi*-summer (2020-21) on soybeans on six different dates of sowing, from November to January. The incidence of leaf miner, leaf folder, and *Spodoptera litura* were observed during the study period. Among the defoliators, the incidence of leaf folder (*Omiodes indicata*) was higher followed by leaf miner (*Aproaerema modicella*) and *Spodoptera litura*. The damage symptoms by leaf folder and the different life stages of the pest are shown in Fig.1.

Incidence of leaf miner commenced from the third week after sowing and lasted up to the pod development stage in the early sown crop (November first and second fortnight). While the incidence was restricted to 4-5 weeks after the appearance during December and January sown crops. The peak population was observed in November's first fortnight sown crop (14.33) at 53rd Standard Meteorological Week (SMW) followed by December's second fortnight (12.60 larvae/MRL) and January's second fortnight (12.56 larvae/MRL) at 5th and 8th SMW, respectively (Fig. 2-4). The average seasonal population of leaf miner was high in early (Nov 1st FN) and late sown crop (Jan 2nd FN) with 4.11±5.01, 3.34±4.61 larvae/MRL respectively. The results are very much in line with the report of Naresh *et al.* (2017) who recorded higher damage of leaf miner in December's second fortnight and January's first fortnight sown crop compared to November's second fortnight and December's first fortnight crop on groundnut during *Rabi* while Gadad *et al.* (2013) reported that in summer groundnut the leaf miner incidence was observed from 5th to 12th MSW in MARS Dharwad and the peak incidence was observed between 8-9th MSW. Pazhanisamy and Hariprasad (2014) reported that leaf miner incidence started from 5th MSW to 14th MSW and the peak population of 7.4 larvae/plant was observed at 9th MSW during *rabi* season on groundnut in Tamil Nadu.

Another defoliator observed during the study was the leaf folder (*O. indicata*) which affected the crop severely (Fig. 1). The incidence of leaf folder started 3 weeks after sowing and was observed throughout the cropping period in the early sown crop (November first and second fortnight) but it was up to maturity (10-11 weeks after sowing) in case of December and January sown crop. The peak population of leaf folder was observed on November's first fortnight sown crop (15.10 larvae/MRL) at 3rd MSW followed by December's second fortnight (13.20 larvae/MRL) and November's second fortnight (12.60 larvae/MRL) at 5th and 8th SMW, respectively (Fig. 2-4). The seasonal average

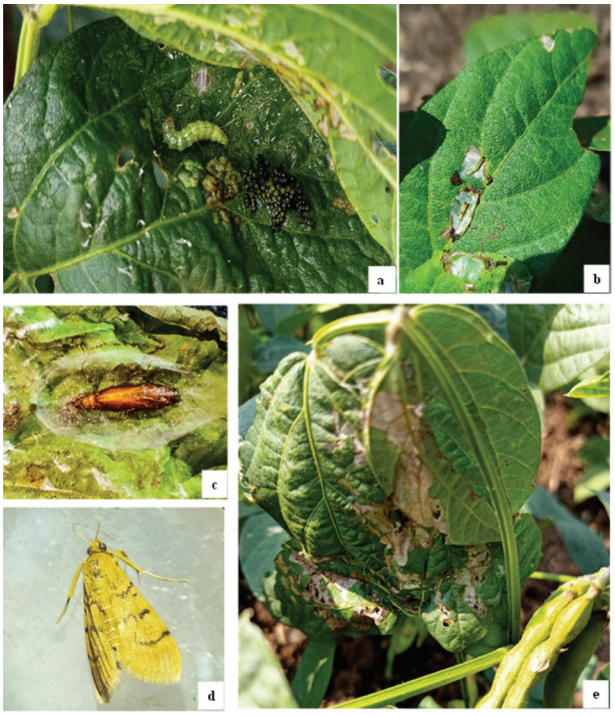

Fig. 1. Leaf Folder (*Omiodes indicata*); a. Larvae feeding on soybean leaves; b. Early instar larvae; c. Pupa; d. Adult of *O. indicata*; e. Damaging symptom.

Table 1. Treatment details

Sl. No.	Treatments	Dosage
T1	Profenofos 50 EC	2ml/litre
T2	Emamectin benzoate 5 SG	0.25g/litre
T3	Spinetoram11.7 SC	1ml/litre
T4	Indoxacarb 14.5 SC	0.5ml/litre
T5	Novaluron 5.25 + Indoxacarb 4.5 SC	1.5ml/litre
T6	Chlorantraniliprole + Lambda-cyhalothrin 150 ZC	0.5ml/litre
T7	Novaluron 5.29 + Emamectin benzoate 0.9 SC	2.5ml/litre
T8	Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0.5ml/litre
T9	Profenofos 40 + Cypermethrin 4 EC	2ml/litre
T10	Chlorantraniliprole 18.5 SC	0.2ml/litre
T11	Control	-

Table 2. Correlation of pest incidence with the weather parameters during *Rabi*-summer.

Sowing time	Weather parameters	Correlation coefficient (r)	
		Leaf miner	Leaf folder
Nov. I FN	Max. Temp. (^{0}C)	-0.358	0.286
	Min. Temp. (^{0}C)	-0.556	0.136
	Relative Humidity (%)	0.149	-0.099
Nov. II FN	Max. Temp. (^{0}C)	-0.23	**0.825***
	Min. Temp. (^{0}C)	0.162	-0.009
	Relative Humidity (%)	0.346	**-0.739***
Dec. I FN	Max. Temp. (^{0}C)	0.077	0.365
	Min. Temp. (^{0}C)	0.129	-0.21
	Relative Humidity (%)	0.068	-0.514
Dec. II FN	Max. Temp. (^{0}C)	-0.029	0.15
	Min. Temp. (^{0}C)	-0.509	-0.175
	Relative Humidity (%)	-0.286	-0.346
Jan. I FN	Max. Temp. (^{0}C)	-0.468	0.09
	Min. Temp. (^{0}C)	**-0.772***	-0.238
	Relative Humidity (%)	0.006	-0.379
Jan. II FN	Max. Temp. (^{0}C)	-0.402	0.142
	Min. Temp. (^{0}C)	-0.401	-0.036
	Relative Humidity (%)	0.124	-0.457

*Correlation is Significant at the 0.05 level; Nov.- November; Dec.- December; Jan.-January; FN- Fortnight; Max. Temp.- Maximum Temperature; Min. Temp.- Minimum Temperature.

of the leaf folder population was higher in the early sown crop and later it decreased to a smaller extent in further sowing dates and increased in the late sown crop. The average population was 4.90±5.72, 4.66±4.49, 4.00±4.32, 4.08±4.79, 3.42±3.71 and 3.91±4.73 in different crops sown from November first fortnight to January second fortnight.

The leaf folder incidence was not reported in soybean previously in *Rabi*-summer crop. However, Batagi (2018) documented soybean leaf webber (*O. indicata*) as one of the defoliators with peak population at August third week (3.61 larvae/ MRL) in Shivamogga, Karnataka in *Kharif* season and Niranjankumar (2018) also reported *Omoides indicata* as lablab webworm as an emerging pest on legumes with the peak population of 2.35 larvae/ MRL during *Kharif* and 3.10 larvae/MRL during the fourth week of January in *Rabi* season.

Based on the above results, the relationship between insect pests, natural enemies and weather parameters is expressed in terms of simple correlation. Leaf folder population was significant and positively correlated with maximum temperature (0.825*) and negatively with relative humidity (-0.739*) during November's first fortnight. Leaf miner exhibited a significant negative correlation with minimum temperature (-0.772*) when the crop was sown in January's first fortnight (Table 2). The results are in line with Gagad *et al.* (2013) who reported leaf miner exhibited a significant negative relationship with minimum temperature in groundnut crop during *Rabi*-summer at MARS Dharwad and Naik *et al.* (2015) reported leaf folder exhibited a significant positive correlation with maximum temperature on French bean in Mandya.

Defoliation was comparatively less in early sown crops while it followed the increasing trend from November to January sown crops. The highest defoliation was observed in January's second fortnight (44.25%) sown crop (Table 3) which was similar to Swathi (2018) who reported that early sown crop had less defoliation while late sown crop exhibited higher defoliation percent on soybean during *Kharif* season at Dharwad.

The comparison between the incidence of leaf folder with leaf miner is represented graphically for better understanding. The present study showed a different pattern of defoliator incidence as compared with traditional *Kharif* crop. The dominance of leaf

Table 3. Maximum defoliation recorded during the cropping period

Maximum defoliation (%)					
Nov I FN	Nov II FN	Dec I FN	Dec II FN	Jan I FN	Jan II FN
32.15	37.15	42.15	40.25	43.26	44.25

Nov.- November; Dec.-December; Jan.-January; FN- Fortnight.

Table 4. Cost economics influenced by insecticides in soybean during summer (2020-21)

Treatments	Dosage	Yield (q/ha)	Total plant protection cost (INR/ ha)	Total Production cost (INR/ha)	Gross returns (INR/ ha)	Net returns (INR/ha)	B:C ratio
Profenofos 50% EC	2ml/litre	8.70^{de}	1200	43700	52200	8500	1.19
Emamectin benzoate 5% SG	0.25g/litre	11.00^{bc}	1745	44245	66000	21755	1.49
Spinetoram 11.7% SC	1ml/litre	11.50^{b}	11900	54400	69000	14600	1.27
Indoxacarb 14.5% SC	0.5ml/litre	9.50^{cd}	1175	43675	57000	13325	1.31
Novaluron 5.25% + Indoxacarb 4.5% SC	1.5ml/litre	10.80^{bc}	4920	47420	64800	17380	1.37
Chlorantraniliprole + Lambda-cyhalothrin 150 ZC	0.5ml/litre	13.60^{a}	5363	47863	81600	33737	1.70
Novaluron 5.29% + Emamectin benzoate 0.9% SC	2.5ml/litre	11.70^{b}	6060	48560	70200	21640	1.45
Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5%ZC	0.5ml/litre	12.30^{ab}	1719	44219	73800	29581	1.67
Profenofos 40% + Cypermethrin 4% EC	2ml/litre	11.80^{b}	2200	44700	70800	26100	1.58
Chlorantraniliprole 18.5% SC	0.2ml/litre	12.10^{ab}	4000	46500	72600	26100	1.56
Control	-	7.50^{e}	0	42500	45000	2500	1.06
SEm±	-	0.58	-	-	-	-	-
CD (P=0.05)	-	1.71	-	-	-	-	-
CV (%)	-	9.16	-	-	-	-	-

Note: **Market price of soybean** INR. 6,000/q and **production cost** = INR. 42,500/ha.

Cost of insecticides: Profenofos 50% EC-150rs (250ml), Emamectin benzoate 5% SG-349rs (50g), Spinetoram 11.7% SC-1190rs (100ml), Indoxacarb 14.5% SC-235rs (100ml), Novaluron 5.25% + Indoxacarb 4.5% SC-820rs (250ml), Chlorantraniliprole + Lambda-cyhalothrin 150 ZC-858rs (80ml), Novaluron 5.29% + Emamectin benzoate 0.9% SC-606rs (250ml), Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5%ZC-275rs (80ml), Profenofos 40% + Cypermethrin 4% EC-275rs (250ml), Chlorantraniliprole 18.5% SC-200rs (10ml).

Labour wage: 300 rupees per day; **Spray volume required**: 500 litres per hectare.

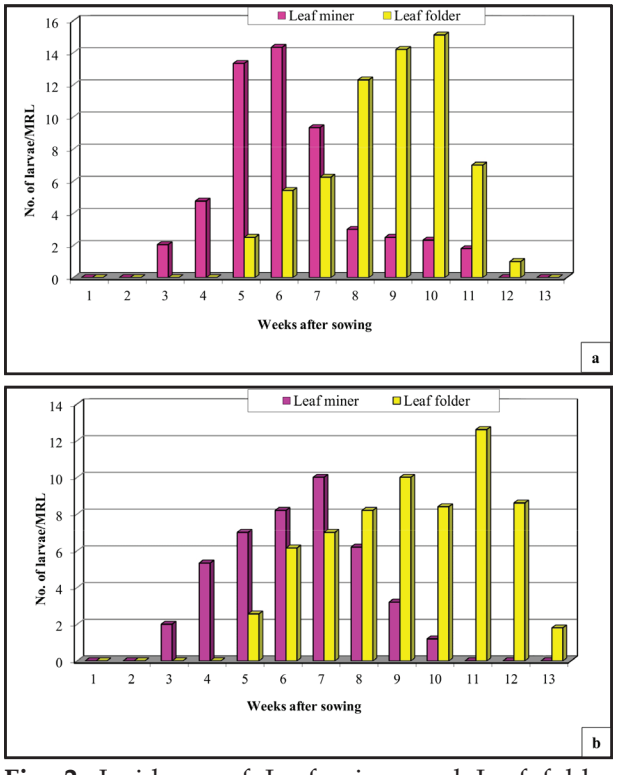

Fig. 2. Incidence of Leaf miner and Leaf folder in November sowing regiment; Sowing time: a. November first fortnight; b. November second fortnight

Table 5. Effect of insecticides on defoliation in soybean in summer-2021

Treatments	Dosage	Defoliation (%)	
		DBS	10 days after 2nd spray
Profenofos 50 EC	2ml/litre	20.89 (27.20)^{a}	34.81 (36.61)^{fg}
Emamectin benzoate 5 SG	0.25g/litre	19.87 (26.47)^{a}	31.87 (34.37)^{def}
Spinetoram 11.7 SC	1ml/litre	20.45 (26.89)^{a}	31.24 (33.98)^{cdef}
Indoxacarb 14.5 SC	0.5ml/ litre	20.34 (26.81)^{a}	33.41 (35.31)^{efg}
Novaluron 5.25 + Indoxacarb 4.5 SC	1.5ml/ litre	17.99 (25.10)^{a}	26.10 (30.72)^{ab}
Chlorantraniliprole + Lambda-cyhalothrin 150 ZC	0.5ml/ litre	18.21 (25.26)^{a}	24.21 (29.47)^{a}
Novaluron 5.29 + Emamectin benzoate 0.9 SC	2.5ml/ litre	18.01 (25.11)^{a}	27.99 (31.94)^{abcd}
Thiamethoxam 12.6 + Lambda-cyhalothrin 9.5 ZC	0.5ml/ litre	19.54 (26.23)^{a}	30.15 (33.30)^{bcde}
Profenofos 40 + Cypermethrin 4 EC	2ml/litre	18.64 (25.58)^{a}	29.15 (32.68)^{bcde}
Chlorantraniliprole 18.5 SC	0.2ml/ litre	18.34 (25.36)^{a}	27.15 (31.40)^{abc}
Control	-	18.67 (25.60)^{a}	37.50 (37.76)^{g}
SEm±	-	NS	1.99
CD (P=0.05)	-	NS	5.86
CV (%)	-	10.65	10.31

*DBS-Day before spray; DAS-Days after spray; NS- Non-significant; Figures in parentheses are arc sine transformed values; Means followed by the same alphabet in a column indicates non-significance among them (P = 0.05) by DMRT.

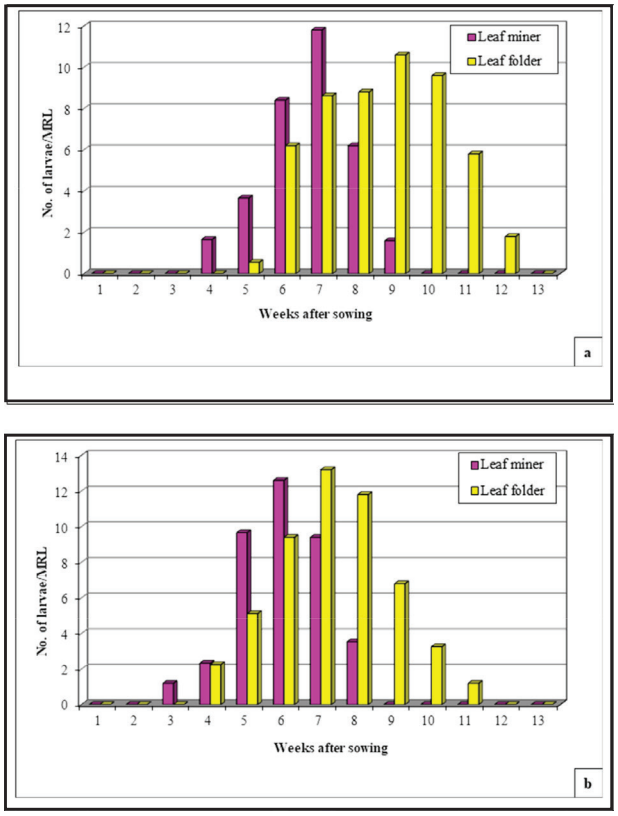

Fig. 3. Incidence of Leaf miner and Leaf folder in December sowing regiment; Sowing time: a. December first fortnight; b. December second fortnight

folder and Leaf miner infestation leads to a lower incidence of commonly observed soybean defoliator *Spodoptera litura* during *rabi*-summer and Bihar Hairy Caterpillar wasn't recorded during the study period.

The effect of different treatments on defoliation, in Chlorantraniliprole + Lambda-cyhalothrin 150ZC @ 0.5 ml/litre the defoliation was lesser and was superior among other treatments. Followed by Novaluron 5.25 + Indoxacarb 4.5 SC @ 1.5 ml/litre and chlorantraniliprole 18.5 SC @ 0.2 ml/litre which was found to be the next best treatment. The highest defoliation recorded in profenofos 50% EC found to be less effective. The detailed results are shown in Table 5. The present findings are in line with Patil *et al.* (2014) who reported chlorantraniliprole was most effective followed by spinosad against soybean defoliators. Also, the results were nearly similar to the reports of Venkataiah *et al.* (2021) who reported Emamectin benzoate (5 SG) at 0.4 gram per litre and Chlorantraniliprole (18.5 SC) at 0.3 ml per litre were found effective against soybean defoliators.

Grain yield was recorded in each plot and converted into q/ha. The treatment recorded higher yield was chlorantraniliprole + lambda-cyhalothrin 150 ZC @ 0.5 ml/litre (13.60 q/ha) followed by thiamethoxam 12.6 + lambda cyhalothrin 9.5 ZC @ 0.5 ml/litre (12.30 q/ha) which was on par with Chlorantraniliprole 18.5 SC @ 0.2 ml/litre (12.10 q/ha). The cost benefit ratio varied from 1.06 in control to maximum of 1.70 in chlorantraniliprole + lambda-cyhalothrin 150 ZC @ 0.5 ml/litre treated plot, thiamethoxam 12.6 + lambda cyhalothrin 9.5 ZC (1.67), Chlorantraniliprole 18.5 SC @ 0.2 ml/ litre (1.56), profenofos 40 + cypermethrin 4 EC @ 2 ml/litre (1.58), emamectin benzoate 5 SG (1.49), novaluron 5.29 + emamectin benzoate 0.9 SC @ 2.5 ml/litre (1.45) were the next best treatments (Table 4). The results are nearly similar to Patil *et al.* (2014) who reported Chlorantraniliprole was most effective against defoliators and also had a higher B:C Ratio among different treatments. Swathi *et al.* (2019) reported the highest CBR ratio in Chlorantraniliprole 18.5 SC (17.14) and Panta *et al.* (2021) with 1.62 BC ratio in Chlorantraniliprole 0.2 ml/litre treatment on cowpea.

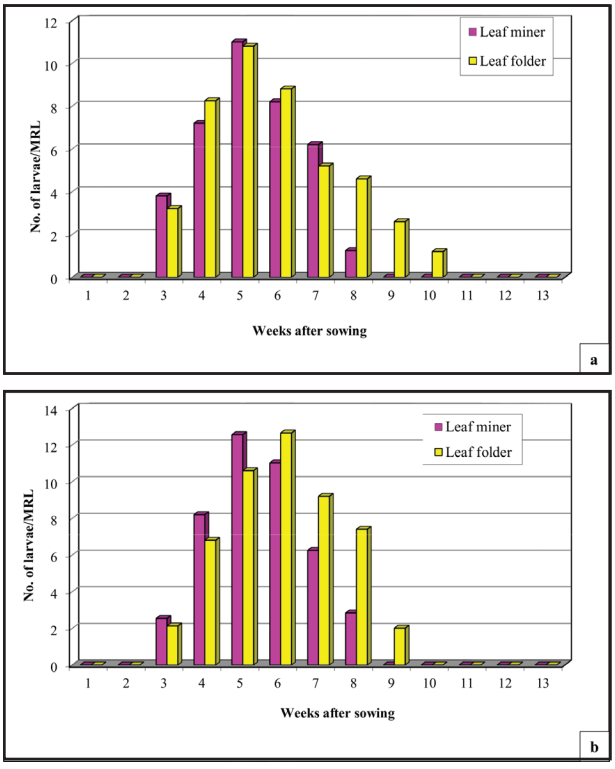

Fig. 4. Incidence of Leaf miner and Leaf folder in January sowing regiment; Sowing time: a. January first fortnight; b. January second fortnight

The study concluded that leaf folder (*O. indicata* Fab.) is one of the major defoliators during the *Rabi*-summer and was helpful for the farmers of this region to take appropriate measures and to reduce the yield losses caused by the defoliators when grown in a non-traditional way.

CONCLUSION

Based on the present observations, the study concludes that the best insecticide treatment as recommended for the control of defoliators in soybean is Chlorantraniliprole + Lambda-cyhalothrin 150 ZC @ 0.5 ml/litre followed by Thiamethoxam 12.6% + Lambda-cyhalothrin 9.5% ZC and Chlorantraniliprole 18.5% SC in terms of yield also, we can consider Profenofos 40% + Cypermethrin 4% EC as it shows better B:C ration than Chlorantraniliprole 18.5% SC.

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