Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
JEZS 2018; 6(4): 1249-1252

Received: 09-05-2018
Accepted: 13-06-2018

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# Dynamics of soybean stem fly *Melanagromyza sojae* and its parasitoids in different phonological stages

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**Abstract**
Among the insect pests of soybean, stem fly, *Melanagromyza sojae* plays an important role in reducing the crop yield. Lack of consistent biological control of the stem fly, *Melanagromyza sojae* Zehntner has necessitated the studies on impact of the parasitoids on seasonal regulation of stem fly population in soybean. In this investigation the seasonal density dependence of *M. sojae* parasitoids and the level of parasitism in soybean field was under taken. The results revealed that the population build up of the host insect reached its peak during the mid-season and declined towards the end of the crop season. Two hymenopteran parasitoids each from Eurytomidae and Pteromalidae had a significant impact on *M. sojae* populations. Average parasitism ranged from 5.00 per cent (*Eurytoma sp*.) and 3.75 (*Chlorocytus sp*.) per cent to as high as 35.55 and 32.10 per cent respectively. The mean seasonal trends of *M. sojae* population and parasitism for the crop season exhibited coexistence of both the parasitoids. The modulation of management practices aimed at conservation of these bio-agents could improve the biological control of *M. sojae* population under field condition.

**Keywords:** Biological control, parasitoids, soybean stem fly

## 1. Introduction
Soybean, *Glycine max* (L.) Merrill (Fabaceae), is a major oilseed crop of the rainfed agro-ecosystems of central and peninsular India. It is grown over an area of 9.95 million ha with production of 12.57 million tonnes, thus playing an instrumental role in the socio economic development of small and marginal farmers of the region. India is the fifth largest producer of soybean in the world after USA, Brazil, Argentina and China [1]. Despite the phenomenal increase in area and production, productivity of the soybean crop is hovering around 1264 kg/ha compared to world productivity of 2233 kg/ha [2]. The low productivity of soybean is attributed to several abiotic and biotic stresses, such as temperature, drought, weeds, insect pests and diseases. Among these, insect pests often pose a serious threat causing severe yield losses ranging from 20 to 100 per cent [3, 4].

Stem fly *Melanagromyza sojae* Zehntner (Diptera: Agromyzidae) has emerged as a major pest in the soybean growing areas of India over the last two decades [5, 4]. Soybean crop is prone to heavy infestation by *M. sojae* at all the stages of growth and development, right from seedling to maturity. The maggot of *M. sojae* enters the stem through the leaf petiole, feeds on the stem pith by mining both upwards and downwards and makes a reddish-coloured tunnel in the affected plant [6]. Infestations in the early crop growth stages cause high seedling mortality and thus reduce the crop stand. Infestations during later growth stages do not kill the damaged plants; however, they may significantly affect the yield-attributing characters of the plant, e.g. reduction in plant height, number of branches per plant, number of trifoliate leaves, leaf area per plant and dry matter accumulation [7]. Average yield loss of 20-30 per cent due to *M. sojae* infestation in soybean has been reported from various parts of the world [8].

Many studies used the intensity of stem tunneling as a measure of infestation and considered merely one or two phenological stages of the host crop for sampling [7, 5, 4]. Only two reports have explored the seasonality of *M. sojae* densities that occur at different phonological phases of soybean [9]. However, this knowledge gap is critical for soybean varieties grown in India. The number of *M. sojae* individuals that the soybean crop can support at various growth stages would have a significant negative influence on the yield-attributing characters, such as plant height or vigour, number of leaves and dry matter accumulation.

A variety of chemical insecticides, such as thiamethoxam, chlorantraniliprole, imidacloprid, triazophos, and profenophos, are being used in a desperate attempt to manage the ravaging effects of *M. sojae* in soybean [1]. However, desired control of *M. sojae* is not achieved, because of its cryptic nature. The maggots and puparia are concealed inside the leaf or stem of the host crop and seem to be well protected from insecticidal applications, as well as natural enemies like predators and parasitoids. Another critical issue in the management of *M. sojae* is the lack of consistent biological control. A variety of parasitoid species has been reported from field collected maggots and puparia of *M. sojae* from various parts of the world [8]. However, the level of parasitism rarely exceeds 50 per cent and it often comes late in the season when the insect has caused significant damage. Unfortunately, there is a lack of quantitative data on seasonality of parasitoid species, which has substantially limited the commercial utilization of parasitoids in suppressing the populations of *M. sojae*. The present study determines the seasonal density dependence of *M. sojae* parasitoids and the level of parasitism in field samples using host density as a predictor variable.

## 2. Materials and Methods

The seasonal incidence of *M. sojae* and its parasitoids were measured in soybean (DSb 21) during the *kharif* seasons (July–October) of 2017 grown in the Research and development Unit, Ugarkhurd in the District Belagavi of Karnataka State in India (16° 40'17" The crop was sown on 25th June during 2017 and maintained by following all the recommended agronomic practices. Starting from the first week after sowing till harvest, about 40-50 infested plants were sampled at weekly intervals. Each sampled plant was observed for the presence of stem fly damage and the numbers of infested plants recorded and converted to per cent infestation. The values of the weekly per cent infestation were plotted against the crop age to study the infestation trend. The samples of damaged plants with stem tunnels were collected in sterile polyethylene bags and brought to the laboratory for dissection. The stems and branches were carefully split open from top to bottom at tunneled regions using a sharp scalpel. The live maggots and puparia recovered from damaged stems and/or branches were recorded. The maggots of *M. sojae* were collected by cutting 2-3 cm fragments of soybean stems. Every 3 days until puparia formation, maggots were carefully transferred with a camel hair brush to a new stem fragment. The pupae were transferred in numbered and dated homeopathic glass vials till the emergence of *M. sojae* adults and/or parasitoids. Stem fragments or puparia separated from one plant were put together inside a 60 ml glass tube, with a piece of tissue paper secured underneath the lid to prevent condensation inside the tube. Tubes were kept for 2-3 weeks until all adult flies or parasitoids emerged. Parasitoids were collected in small, homeopathic vials and provided with a 10 per cent honey solution. Based on the data on parasitoid emergence, the values for percent parasitism were computed and plotted against host density and crop age.

The parasitoids emerged from field-collected samples were examined under a stereomicroscope (Leica S8-APO). Based on preliminary observations, parasitoids species eerged were stored separately in 70 per cent ethanol in properly labelled homeopathic glass vials for future studies. The identity of *M. sojae* parasitoids recovered from puparia of *M. sojae* were identified through National Bureau of Agricultural Insect Resources (erstwhile PDBC/NBAIR) Bangalore by Dr. Ankita Guptha, Scientist (SS), Division of Germplasm collection & characterization, ICAR-NBAIR, Bangalore. The numbers of different parasitoid species that emerged during the soybean growing season were recorded. Proportion of different parasitoids was plotted against crop age at weekly intervals to represent the seasonal trend of density and diversity.

## 3. Results and Discussion

During the season, the infestation of stem fly was observed at seedling stage, starting from the first week after sowing and continued up to the 14th week until harvest when live puparia could still be found inside the infested stems. The infestation was initially low, reaching its peak from the 5th till the 10th week after sowing. The per cent infestation of *M. sojae* during the crop seasons is presented in Fig.1. The results indicated that the infestations remained at relatively low to moderate levels. Average seasonal infestation during 2017 ranged between 6.50 to 43.50 per cent. The peak pest densities coincided with the peak flowering and pod formation stages of the host crop. Similarly, parasitoid populations were low at the beginning of the crop season and built up during the mid-season starting from fifth week after sowing till the end of the season. Average parasitism ranged from 5.00 per cent (*Eurytoma sp*.) and 3.75 (*Chlorocytus sp*.) per cent to as high as 35.55 and 32.10 per cent respectively (Fig. 2). The mean seasonal trends of *M. sojae* population and parasitism for the crop season exhibiting coexistence of both the parasitoids (Fig. 3). Populations of both *M. sojae* and its parasitoid complex built up slowly at the beginning of the season, reached their peak during the midseason and declined towards the end of the season. Though the parasitoid populations could not reduce the percentage of field infestations, they could reduce significantly the pest numbers in the next generation. Two species of hymenopteran parasitoids from two families, namely, Eurytomidae (*Eurytoma melanagromyza* Narendran) and Pteromalidae (*Chlorocytus* sp.) with an average parasitism of 12.50 per cent and 11.14 per cent, respectively, were the most prevalent parasitoid species throughout the season**.** All the parasitoids emerged from the pupae of the host insect. Under field conditions, the adult parasitoids escaped the plant through the exit holes for adult stem flies made by the host larvae before entering pupation.

The results are in close agreement with Jadhav [10], who reported that *M. sojae* infestation in soybean (JS-335) ranged between 10.87 and 32.84 per cent at Bailhongal, Dharwad in Karnataka State of India. According to various reports, stem fly incidence in Dharwad District of Karnataka State ranged between 15 and 65 per cent [11]. From Pantnagar it is reported that *M. sojae* infestation to the extent of 30 to 100 per cent [3]. These deviation in per cent infestation of *M. sojae* may be due to differences in local climatic conditions, soybean varieties grown and agronomic practices. Further, there is a great deal of variation in prevailing temperatures, as well as the onset of the monsoons and amount of rainfall received, during the soybean growing season from the northern to southern regions of the country.

Regarding the parasitoids, *Eurytoma* sp. (Eurytomitidae) and Gronotoma sp. (Eucoilidae) were the most prevalent parasitoids throughout the season, whereas the pteromalid *Sphegigaster* sp. was dominant during the mid-season in Maharashtra [12] which is in agreement with the present investigations.

## 4. Conclusion

This study has demonstrated the potential role of the two parasitoids in regulation of an emerging pest of soybean, *M. sojae*. The quantitative data on seasonality of *M. sojae* and its parasitoids at different phenological stages of soybean will be crucial factor in quantifying *M. sojae* damage in terms of yield loss in soybean and in tailoring the effective pest management strategy against *M. sojae*.

## 5. Acknowledgement

The authors acknowledged the cooperation of Dr. Ankita Guptha, Scientist (SS), Division of Germplasm collection & characterization, ICAR-NBAIR, Bangalore for taxonomic identification of *M. sojae* parasitoids.

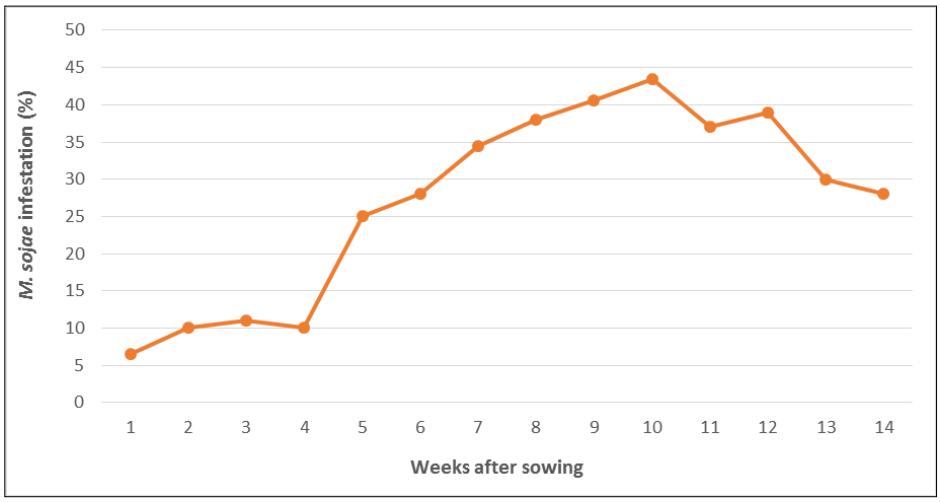


**Fig1:** Infestation of *Melanagromyza sojae* in soybean during *Kharif* 2017

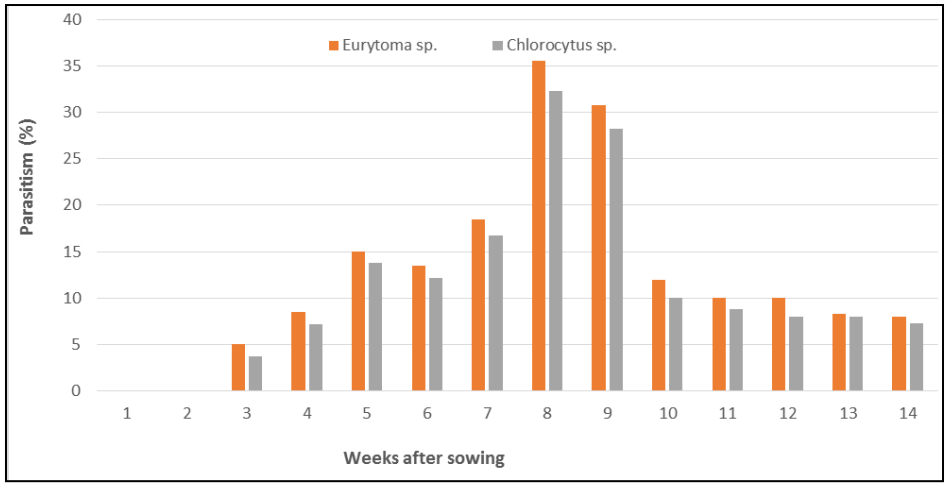


**Fig 2:** Per cent parasitism on *M. sojae* in soybean during *Kharif* 2017

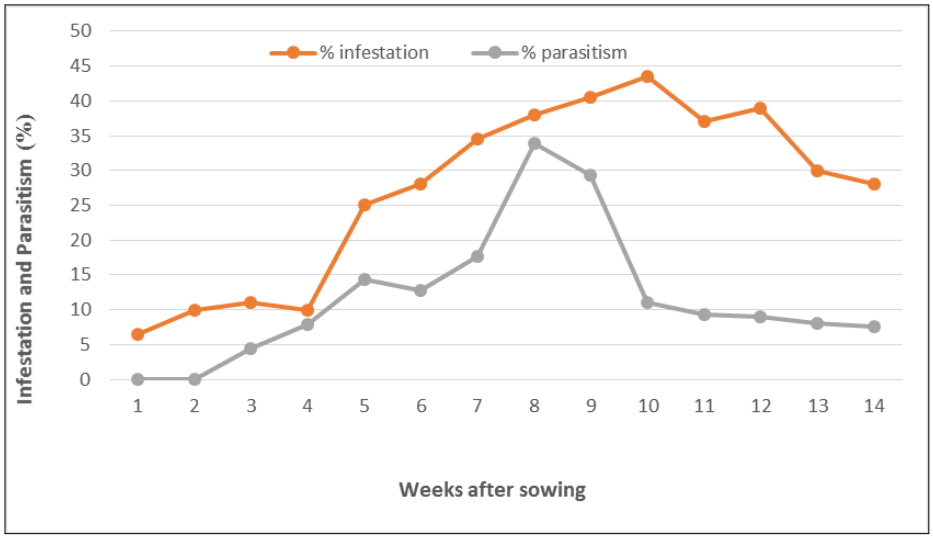


**Fig 3:** *M. sojae* infestation and its parasitoids in field during the *Kharif* 2017

*Melanagromyza sojae* parasitoid inside the stem tunnel.

*Eurytoma melanagromyza* Narendran (Eurytomidae) Hymenoptera

*Chlorocytus sp.* (Pteromalidae) Hymenoptera

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