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Impact of Population Regulating Factors on *Bemisia tabaci* (Gennadius) Infesting Soybean [*Glycine max* (L.) Merr.]

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ABSTRACT

The present investigation on the impact of population regulating factors on Bemisia tabaci (Gennadius) infesting soybean crop (var. PK-416) was carried out at the experimental area of Research Farm, Department of Entomology, CCS HAU, Hisar during Kharif 2017. The whitefly population and nymphal parasitization by Encarsia spp. were observed on three leaves from 10 randomly selected plants at ten-day intervals from June to September. The peak population of whitefly adults i.e., 19.7 per leaf was recorded from 31st July to 9th August, 2017 when temperature ranged from 26.6 ºC to 34.2 ºC and relative humidity ranged from 70.0 to 90.0 per cent. The nymphal population i.e., 24.4 per lead was found maximum from 10th to 19th August, 2017 at temperature ranging from 26.4 ºC to 35.6 ºC and relative humidity ranging from 61.0 to 87.0 per cent. Maximum nymphal parasitization of B. tabaci by Encarsia spp. on soybean (28.4%) coincided with the peak population of whitefly nymphs. Correlation analysis revealed the impact of weather factors on whitefly adult and nymphal population which showed significant negative correlation with maximum temperature [(r = -0.62), (r = -0.59)] and positive with morning relative humidity [(r = 0.62), (r = 0.57)], respectively.

Keywords: *Soybean, Bemisia tabaci, peak activity, Encarsia spp., weather parameters, correlation.*

INTRODUCTION

Soybean [*Glycine max* (L.) Merr.], belonging to the family Fabaceae, is one of the five crops that dominate global agriculture, along with maize, wheat, cotton and rice. It is an important source of food, protein and oil worldwide, and hence intense research is essential to increase its yield under different conditions of biotic and abiotic stresses (Pagano & Miransari, 2016). Soybean contributes 36.0 per cent of total oilseeds production and 18.5 per cent of vegetable oil production in the country (Anonymous, 2019a). Globally, India ranks fourth in terms of area under soybean (11.33 mha) and fifth in terms of soybean production (13.79 mt). Madhya Pradesh (4.60 mt) and Maharashtra (5.15 mt) are the leading states in soybean production (Anonymous, 2019b).

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In Haryana state, this unique dual purpose, short-term legume crop is suitable for diversification, and higher income through grain and oil during *Kharif* season. The productivity of soybean is less than the potential yield of recommended varieties due to various insect pests, diseases and abiotic factors. Luxurious vegetative growth, succulent leaves, unlimited food, shelter and space make it vulnerable to huge diversity of insect-pests.

In India, 270 species of insect-pests have been reported to infest the soybean crop, of these 13 (including defoliators, borers and sap sucking insects) have attained the status of major insect-pest (Singh & Singh, 1990; & Sharma et al., 2014). Whitefly, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is a major insect-pest of national significance on soybean crop which starts infesting 20-25-day old seedlings and remain active through the growing season of the crop (Sharma et al., 2014). Whitefly adults and nymphs directly feed on the cell sap and indirectly the adults vector the yellow mosaic disease in soybean crop and the virus associated with the disease in northern India is an isolate of cotton leaf curl Kokhran virus (Raj et al., 2006), earlier designated as soybean isolate of moong bean yellow India mosaic virus (MYMIW-[Sb]) by Usharani et al. (2004). Yellow mosaic disease has been reported to cause 15.0-75.0 per cent yield loss in soybean crop (Amrate et al., 2020). Population buildup of whitefly on various crops is regulated by various abiotic (temperature, humidity, rainfall, etc.) and biotic (predators, parasitoids, pathogens, etc.) (Naranjo et al., 2009; Naranjo & Ellsworth, 2005; Perring et al., 2018; & Wang et al., 2019). Parasitoids of the genera *Encarsia* are recognized a major biotic factor in limiting its population buildup (Gerling et al., 2001; & Sangha et al., 2018). Numerous studies are available on influence of weather parameters on *B. tabaci* and its parasitization on cotton crop from Haryana, however, such information is lacking on soybean crop. Hence, it was decided to study the impact of population regulating factors on *B. tabaci* infesting the soybean crop.

MATERIALS AND METHODS

Population buildup of whitefly and its parasitoid, *Encarsia* spp. was studied on soybean var. PK-416 grown in an area of 30 square meters at the Research Farm, Department of Entomology, CCS HAU, Hisar during *Kharif* 2017. The crop was sown and raised as per the recommended package and practices of CCS HAU, Hisar except any insecticidal application. Whitefly adult population was recorded from the upper, middle and lower leaves of ten randomly selected plants at 10-day intervals from June to September, 2017.

For estimating the nymphal population of whitefly and its parasitization, thirty sampled leaves were brought to the Biocontrol Laboratory (Department of Entomology, CCS HAU, Hisar) in polybags at 10-day intervals. Observations on healthy and parasitized nymphs were made under a stereo zoom binocular microscope. Black pupae of whitefly were considered parasitized by *Encarsia* spp. (Sharma et al., 2003). The observations on whitefly parasitoid, *Encarsia* spp. were recorded by counting the black parasitized pupae on sampled leaves at ten days intervals and converted into per cent parasitism. The data on weather parameters like temperature, relative humidity and rainfall was obtained from the Agrometeorological Observatory, Department of Agrometeorology, CCS HAU, Hisar. Further, the data was subjected to correlation analysis using OP STAT software (Sheoran et al., 1998) to see the impact of weather parameters on whitefly population and nymphal parasitization.

RESULTS AND DISCUSSION

Peak activity period of whitefly, *B. tabaci* and its parasitization by *Encarsia* spp. on soybean

On soybean var. PK-416, the peak activity of whitefly adults i.e., 19.7 per leaf was observed from 31st July to 9th August, 2017 when temperature ranged from 26.6 ºC (T_{min}) to 34.2 ºC (T_{max}) and relative humidity (RH) ranged from 70.0 (evening) to 90.0 per cent (morning) (Fig. 1). Similarly, Ahirwar et al. (2015) recorded peak activity of *B. tabaci* (3.2 per plant) during the last week of August on soybean crop. However, the peak activity of *B. tabaci* (24.2, 9.1 and 7.2 adults per three leaves) was observed during 36^{th} SMW i.e., first week of September by Garg and Patel (2018), Kumari et al. (2020) and Sapekar et al. (2020) on soybean crop.

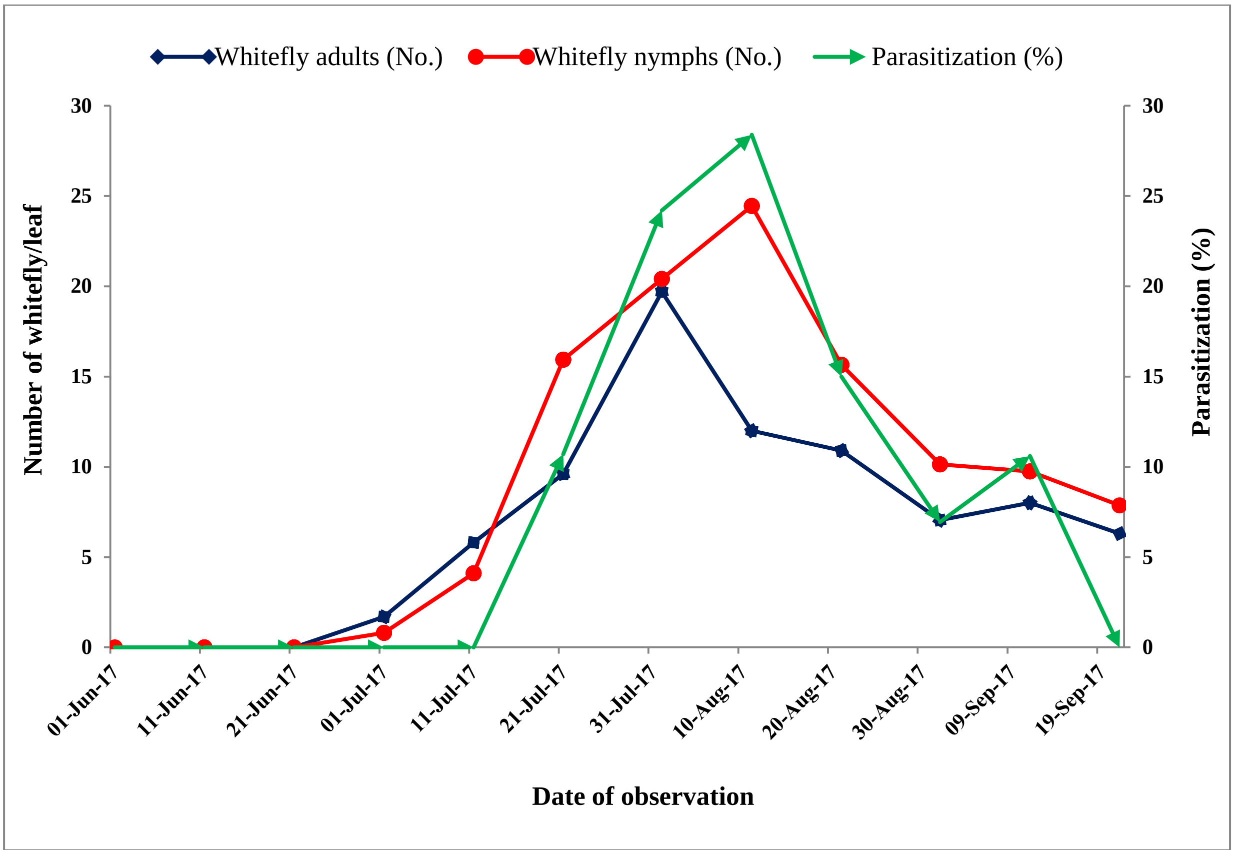

Fig. 1: Peak activity period of whitefly and its parasitization by *Encarsia* spp. on soybean (2017)

The maximum number of whitefly nymphs i.e., 24.4 per leaf and parasitization by *Encarsia* spp. (28.4%) were observed from 10^{th} to 19^{th} August, 2017 where temperature ranged from 26.4 ºC (T_{min}) to 35.6 ºC (T_{max}) and RH ranged from 61.0 (evening) to 87.0 per cent (morning) (Fig. 1). The findings are in close proximity with Sharma et al. (2003) who noted 3.7 to 7.7 per cent parasitization of whitefly nymphs by *Encarsia lutea* Masi from July to September on soybean crop at Hisar. Similarly, Malik and Karut (2012) observed higher densities of whitefly and its parasitoids during August and September. The highest parasitism rate by *E. lutea* was seen on soybean (20.0-20.5%). The present findings are also supported by Kedar et al. (2018) who recorded whitefly population from July-October on soybean and noted the peak activity in the month of August. Moreover, nymphal parasitization by only one parasitoid, i.e., *E. lutea* was recorded from June-September (Kedar et al., 2014).

Correlation of *B. tabaci* and its parasitoid, *Encarsia* spp. with weather parameters on soybean

The correlation analysis revealed that whitefly adult and nymphal population had significant negative correlation with maximum temperature [(r = -0.62), (r = -0.59)] and positive with morning relative humidity [(r = 0.62), (r = 0.57)], respectively, while, no significant correlation was observed between weather parameters and nymphal parasitization by *Encarsia* spp. (Table 1).

Table 1: Correlation of *B. tabaci* and *Encarsia* spp. with weather parameters on soybean (2017)

Weather Parameters	Correlation coefficients (2017)		
	Whitefly Adult	**Whitefly Nymph**	**Parasitization by *Encarsia* spp.**
Maximum Temperature (°C)	-0.62*	-0.59*	-0.44
Minimum Temperature (°C)	0.12	0.11	0.19
Morning Relative Humidity (%)	0.62*	0.57*	0.46
Evening Relative Humidity (%)	0.48	0.47	0.44
Total Rainfall (mm)	-0.48	-0.41	-0.30

*Significant at p=0.05

The present findings are in accordance with Latif and Akhter (2013) who revealed profound effect of temperature and relative humidity on whitefly population on soybean. The findings of Kedar (2014) are in close agreement with the present study, who reported that weather parameters had no effect on per cent nymphal parasitization. In contrary, Marabi et al. (2017) recorded significant positive correlation of maximum temperature with whitefly population on soybean. Studies by Marabi et al. (2017) and Garg and Patel (2018) also revealed significant negative correlation between mean population of whitefly and rainfall [(r = -0.76), (r = -0.80)], respectively] while, Sapekar et al. (2020) revealed non-significant effect of rainfall (r = 0.11) on whitefly population on soybean crop.

CONCLUSION

It is concluded that temperature and relative humidity had a strong influence on the population of *B. tabaci*. A temperature range of 26 to 35 ºC and relative humidity of 70.0 to 90.0 per cent favoured the buildup of *B. tabaci* on soybean crop during the month of August. The nymphal parasitization by *Encarsia* spp. was influenced by the host density in the soybean crop.

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Authors' contribution:
Krishna Rolania was the major advisor. Swati Mehra conducted the experiments, collected and analyzed the data and led the writing of the manuscript in assistance with Mandeep Rathee and Roomi Rawal.

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