Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

E-ISSN: 2278-4136
P-ISSN: 2349-8234
JPP 2019; 8(4): 2077-2079
Received: 13-05-2019
Accepted: 15-06-2019

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Seasonal incidence of sucking insect pests in brinjal and their natural enemies in gird region of Madhya Pradesh, India

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Abstract
A field experiment was conducted at Entomology Research Farm, RVSKVV, College of Agriculture, Gwalior (M.P.) to find out the seasonal incidence of sucking pests of brinjal and their natural enemies and its correlation with weather parameters. The incidence of aphid, jassid and whitefly were started during 43rd SMW and attained their peaks population during 8th, 1st and 1st SMW, respectively. While the activity of *Coccinella* spp. was started from 2nd SMW and reached its peak population during 8th SMW. Correlation studies revealed that the aphid population was correlated positive significantly with morning and evening relative humidity and rainfall (r= 0.34, r= 0.72 and r= 0.41, respectively). Significant positive correlation was observed between population buildup of jassid and whitefly with morning relative humidity (r= 0.49 and r= 0.51, respectively). The correlation studies between natural enemies and weather parameters revealed that the morning and evening relative humidity and rainfall were significantly positive correlated (r= 0.49, r= 0.70 and r= 0.22, respectively), with *Coccinella* spp. population while maximum and minimum temperature and evaporation were found to be negatively correlated (r= -0.60, r= -0.33 and r= -0.43, respectively). Population of *Coccinella* beetle was associated significantly positive with aphid population (r= 0.88).

Keywords: Brinjal, aphid, Jassid, whitefly, Coccinellid beetle, weather parameters

Introduction
Brinjal/ eggplant (*Solanum melongena* L.) is a highly cosmopolitan and popular vegetable grown as poor man's crop in India. It is an important Solanaceous crop of grow in subtropics and tropics areas. In India the area, production and productivity of brinjal was 7.35 lakh ha, 129.87 lakh MT and 1766 kg ha^{-1}, respectively during 2018-19. Whereas, in Madhya Pradesh the area, production and productivity of brinjal 0.50 lakh ha, 918.78 lakh MT and 1835.56 kg ha^{-1}, respectively, during 2018-19 (Anonymous, 2018-19) [1]. It is a good source of minerals (0.30 g) and vitamins *viz*., A, B, C and is rich in total water soluble sugars, free reducing sugars, amide, proteins (1.40 g) among other nutrients.
Many insect pests infest brinjal crop from the time of planting till its harvest. Some important insect pests are brinjal leafhopper (*Amrasca biguttula biguttula* Ishida), aphid (*Aphis gossypii* Glover), whitefly (*Bamisia tabaci* Genn.), shoot and fruit borer (*Leucinodes orbonalis* Guenee) and Coccinellid beetle (*Epilachna vigintioctopunctata*) (Latif *et al*., 2009) [6]. The yield loss due to the pest is to the extent of 70 to 92 percent (Ayyanar *et al*., 2014) [2].
The minimize the losses caused by insect pests in brinjal crop, the weather conditions prevailing in a region play an important role in occurrence and subsequent build-up of pest population. The role of biotic and abiotic factors for reducing the pest population is one of the methods of IPM. Therefore, the study was undertaken to study the impact of weather parameters on sucking insect pests of brinjal and their natural enemies.

Material and methods
The field experiment was conducted at RVSKVV, College of Agriculture, Gwalior (M.P.), brinjal variety; "Local" was transplanted on 20 September 2018, in an area of 9.0 x 9.0 m^2 with 60 X 60 cm2 spacing. All agronomical practices were followed to raise a crop except the plant protection measures. Observation on incidence of insect pests and natural enemies were recorded at weekly interval from their appearance to last picking of fruits of the crop. The population of sucking insect pests *viz*., aphid, jassid and whitefly were recorded in early morning hours by visually counting. Population of sucking pests was observed on three leaves (top, middle and bottom) per plant. For this work, 10 plants were selected randomly. The population of natural enemies was also recorded on randomly selected ten plants at each observation.

The Pearson correlation coefficients between weekly meteorological parameters and pest population were also calculated.

Results and Discussion

Seasonal activity of insect pests of brinjal and their natural enemies:

Brinjal aphid, *Aphis gossypii* (Glover)

The activity of aphid, *Aphis gossypii* (Glover) was started from fourth week of October (43th SMW) at vegetative stage during Octobers 2018 and continued up to February 2019. Which ranged from 1.8 to 8.2 aphids/ 3 leaves per plant. Peak aphid population was observed during 8th SMW (February) with 8.20 aphids/3 leaves per plant. During the peak activity of aphid population the maximum and minimum temperature, morning and evening RH were 27.0 ºC, 12.0 ºC, 84.0% and 51.4%, respectively. The present finding concord with the findings of Kadgonkar *et al.,* (2018) [5], who also reported minimum aphid (*Aphis gossypii*) population during November (45th SW) and maximum during February (8th SW).

Jassid, (*Amrasca biguttula biguttula* Ishida)

The activity of jassid was started from 43rd SMW and continued up to 8th SMW during the study period. The pest population ranged from 1.60 to 7.40 jassid/ 3 leaves per plant. The peak population of jassid was (7.40 jassid/3 leaves/ plant), during 1st SMW (January), when the maximum and minimum temperature, morning and evening relative humidity were 24.0 ºC, 6.2 ºC, 94.7% and 46.7%, respectively (Fig. 1). Kadgonkar *et al.,* (2018) [5] were also reported the maximum population of leaf hopper (*Amrasca biguttula biguttula*) during January, (1st SW).

Whitefly, *Bemisia tabaci* (Genn.)

The activity of whitefly was also started from 43rd SMW and continued up to 8th SMW during the study period *i.e.* harvest of the crop. The whitefly population varied from 2.0 to 7.0 whiteflies/ 3 leaves per plant. The peak population of whitefly (7.0 whiteflies/ 3 leaves/ plant) was recorded during 1st SMW (January), when the maximum and minimum temperature, morning and evening relative humidity were 24.0 ºC, 6.2 ºC, 94.7% and 46.7%, respectively (Fig. 1). Findings of Kadgonkar *et al.,* (2018) [5] are corroborated with the present findings, who observed the maximum population of whitefly (*Bemisia tabaci*) during January, (1st SW).

Natural Enemies

Coccinellid Beetle

The appearance of Coccinellid beetles (*Coccinella septempunctata*, *Menochilus sexmaculatus* and *Coccinella novemnotata*) was recorded in the 44th SMW (October) with the population of 0.4 beetles/ plant, which reached at its peak (2.60 beetles/ plant), during 8th SMW (February). Beetles population was reached with the maximum and minimum temperature were 27.0 ºC and 12.0 ºC, morning and evening RH were 84.0% and 51.4%, respectively. It was observed that peak population of and their natural enemies (*Coccinella septempunctata*, *Memochilus sexmaculetus* and *Coccinella novemnotata*) were in 8th SMW. (Fig.1). Ishwarbhai (2015) [4] was also reported higher incidence of natural enemies with population of aphid.

Correlation studies between sucking insect pests of brinjal and their natural enemies with weather parameters

Correlation studies revealed that the morning and evening relative humidity and rainfall were found to be significantly positive correlated (r= 0.34, r= 0.72 and r= 0.41, respectively). Which is similar to the findings Kadgonkar *et al.,* (2018) [5], who observed that the aphid significant negative correlation with mean relative humidity.

Significant and positive correlation was observed between population buildup of jassid with morning relative humidity (r= 0.49). Chandrakumar *et al*., (2008) [3] was also reported the similar findings that the positive correlation between leafhopper and mean relative humidity. Whereas, maximum and minimum temperature and rainfall were found to be negatively non-significant correlated (r= -0.60, -0.16 and r= -0.17, respectively). While evening humidity observed positive but non-significant correlation (Table 1).

Correlation studies revealed that the morning relative humidity was found to be significant positive correlated (r= 0.50). Chandrakumar *et al*., (2008) [3] was also reported that the whitefly positive correlation with mean relative humidity, which is agreement to the present findings. While negative non-significant correlation were observed among population buildup of whitefly, maximum, minimum temperature and evaporation (r= -0.60, -0.21 and -0.86, respectively). While evening humidity observed positive, but non-significant correlation (Table 1). Both these insects *i.e.* leafhopper and whitefly showed significant positive correlation with mean relative humidity was also reported Kadgonkar *et al.,* (2018) [5].

Correlation studies revealed that the morning and evening relative humidity were found to be significant positive correlated (r= 0.49, r= 0.70, respectively) with Coccinellid beetle population, while, maximum and minimum temperature and were found to be negatively non-significant correlated (r= -0.60, r= -0.33 and r= -0.43, respectively) with *Coccinella* beetle population. While rainfall observed positive but non-significant correlation. Whereas, *Coccinella* beetle significant positively associated with aphid (r = 0.88) (Table 1). Pathan *et al.* (2018) [8] also reported that the *Coccinella* beetle significant positively associated with aphid (r = 0.88), which is similar to the present findings. However, Nagar *et al.* (2017) [7] observed that the *Coccinella* beetle showed a significant effect on the aphid.

Table 1: Correlation coefficient of sucking insect pests of brinjal and their natural enemies with different weather factors

Correlation co-efficient value (r)				
Temperature (Max.)	-0.65	-0.60	-0.60	-0.60
Temperature (Min.)	-0.22	-0.16	-0.21	-0.33
R.H. (Morning %)	0.34*	0.49*	0.51*	0.49*
R.H. (Evening %)	0.72*	0.05	0.05	0.70*
Evaporation (mm)	-0.29	-0.86	-0.86	-0.43
Rainfall (mm)	0.41*	-0.17	-0.13	0.22*
Coccinellids				0.88*

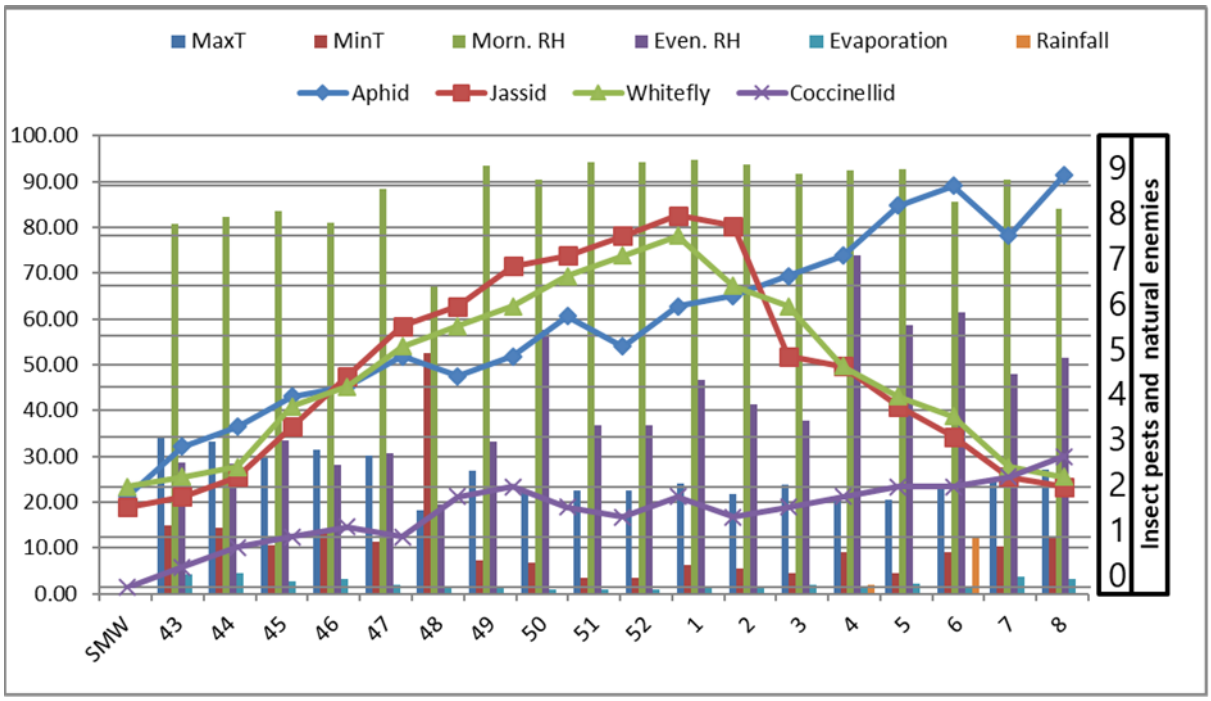

Fig 1: Seasonal incidence of sucking insect pests of brinjal and their natural enemies along with weather parameters during- 2018-19

Conclusions

It may be concluded from the results that peak activity of aphid, jassid and whitefly population were observed 8th (February), 1st and 1st SMW (January), respectively. The predator *Coccinella* beetle population synchronizes with the peak population of aphid. Population of aphid was positively correlated with morning, evening relative humidity and rainfall. While significant and positive correlation was observed between population buildup of jassid and morning relative humidity. Whereas, the whitefly population showed significant positive correlation with morning relative humidity. The correlation study between natural enemies and weather parameters revealed correlated with *Coccinella* beetle population while morning and evening relative humidity were found to be positively correlated. The population of Coccinellid beetle was associated significantly positive with aphid population.

Acknowledgement

The authors thank the Head, Department of Entomology, RVSKVV, College of Agriculture, Gwalior for providing necessary facilities to carry out the research work.

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