Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2020; 8(4): 64-68

Received: 13-05-2020
Accepted: 15-06-2020

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Succession and incidence of sucking insect pests and their natural enemies on Indian bean, *Lablab purpureus* var. *typicus* (L.) sweet in relation to meteorological parameters

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Abstract
Studies on succession and incidence of sucking insect pests and their natural enemies on Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet were conducted to espy the influence of weather parameters on occurrence and abundance of sucking insect pests. It was noticed that infestation of the aphid commenced in the third week of August (34th SMW) and leafhopper and whitefly in the second week of August (33rd SMW). The peak population of aphid (196.8 aphids/ plant) was recorded in the second week of October (41st SMW), leafhopper (20.4/ three leaves) in the fourth week of September (39th SMW) and whitefly (27.2/ three leaves) in the first week of October (40th SMW). The minimum temperature showed a positive significant correlation with leafhopper and whitefly population (r= 0.83 & 0.64). The relative humidity showed negative significant correlation (r= -0.74) with aphid population. The population of both the predators showed a significant positive correlation with the population of sucking insect pests.

Keywords: Indian bean, Incidence, population, sucking insect pests, natural enemies

Introduction
Indian bean, *Lablab purpureus* var *typicus* (L.) Sweet commonly known as hyacinth bean, Egyptian bean, dolichos bean or *Sem* belongs to family Fabaceae and is one of the important pulse cum vegetable crops grown in fields as well as in kitchen gardens throughout the tropical regions in Asia and Africa. The green pods have high nutritive value comprising protein 3.8 g, carbohydrate 6.7 g, vitamin -A 312 IU, mineral 0.9 g, fat 0.7 g and oxalic acid 1 mg/100 g. The crop provides silage, green manure and excellent source for soil Nitrogen fixation. It is also grown for medicinal and ornamental purposes. It helps in relieving constipation and weight loss due to good fibre content (Bose *et al*., 1993) [2]. In India, *L. purpureus* var. *typicus* as a field crop is mostly confined to the peninsular region and cultivated to a large extent in Karnataka and adjoining districts of Tamil Nadu, Andhra Pradesh and Maharashtra. Insect pests are the major constraints in achieving high productivity of Indian bean. The crop is invaded by aphid, *Aphis craccivora* (Koch); leafhopper, *Empoasca fabae* (Harris); *Empoasca krameri* Ross & Moore and *Empoasca kerri* Pruthi; pod borer, *Etiella zinckenella* (Treit.); white fly, *Bemisia tabaci* (Genn.); stem fly, *Ophiomyia phaseoli* (Tryon); hairy caterpillars, *Ascotis imparta (*Walk.*);* Bihar hairy caterpillar, *Spilosoma obliqua* (Walk.) and (Thejaswi *et al*., 2008) [12]. Among these, aphids, leafhoppers and whitefly have been reported as the major sucking insect pests infesting Indian bean (Godwal, 2010) [6]. The knowledge on succession and incidence of insect pests at different phenology of Indian bean crop in relation to weather parameters such as temperature, relative humidity and rainfall is essential for efficiently managing different pest species. Correlating the weather parameters with insect pest populations gives a comprehensive relationship between pest populations and each of the meteorological parameter. This type of study also helps in determining the most susceptible crop stage/ phenology to a particular pest species (Anvesh *et al*., 2020) [1]. The study will give an idea about peak period of insect pests activity which may be helpful in developing pest management strategy.

Materials and Methods
The present investigations were conducted at Horticulture Farm of S.K.N. College of Agriculture, Jobner (Rajasthan) on Indian bean crop under field conditions during *Kharif,*

2019. Geographical location of Jobner pertains to 26° 06' North latitude, 75° 28' East longitude and an elevation of 427 metres above mean sea level (MSL).

a) Experimental layout: To study the succession and incidence of sucking insect pests of Indian bean and their natural enemies, Indian bean variety Bauni was sown on 25th July in five plots of 1.8 X 1.8 m^2 size keeping row to row and plant to plant spacing of 45 and 45 cm, respectively. The recommended agronomic package of practices was adopted for raising the crop excluding plant protection measures. The crop was allowed to have natural infestation.

b) Observations: The population of aphids, leafhoppers, whiteflies and natural enemies were recorded visually, using magnifying lens, whenever required, early in the morning (6.00 to 9.00 AM) from five randomly selected and tagged plants in each plot at weekly interval from their appearance to last picking of pods. The observations were recorded as follows:

i. Aphid, *Aphis craccivora* Koch: The population of aphid (nymph and adult) was recorded on 10 cm terminal shoots from five tagged plants in each plot early in the morning by visual counting method.

ii. Leafhopper, *Empoasca fabae* (Harris): The population of both nymphs and adults was recorded as per method described by Rawat and Sahu (1973) on three leaves from upper, middle and lower canopy of each tagged plants

iii. Whitefly, *Bemisia tabaci* (Genn.): The population of both nymphs and adults was counted visually on three leaves from upper, middle and lower canopy of each tagged plants. For counting the whitefly population, the leaf was held at the petiole by thumb and fore finger and twisted until the entire underside of leaf became clearly visible (Butter and Vir, 1990) [3].

iv. Natural enemies: The populations of natural enemies were recorded from five randomly selected and tagged plants in each plot at weekly interval from their appearance till last picking of the pods.

c) Statistical analysis: The simple correlation was computed between the mean population of aphid, leafhopper and whitefly with weather parameters, *viz.;* maximum and minimum temperatures, average relative humidity and rainfall (Panse and Sukhatme, 1967) [10]. Similarly, correlation was also computed between weather parameters and natural enemies.

Results and Discussion

A study on succession and incidence of sucking insect pests of Indian bean and their natural enemies in relation to meteorological parameters, *viz.*, maximum and minimum temperatures, relative humidity and rainfall is carried out on variety Bauni. During the study, aphid, *Aphis craccivora* Koch, leafhopper, *Empoasca fabae* (Harris) and whitefly, *Bemisia tabaci* (Genn.) were recorded as the major sucking insect pests infesting Indian bean. Among natural enemies lady bird beetle, *Menochilus sexmaculatus* Fab and syrphid fly, *Xanthogramma scutellare* Fab. were observed as major predatory species in the Indian bean crop. (Table -1 and Fig. -1). The correlation coefficient between sucking insect pests, predators and abiotic factors is presented in Table- 2.

Aphid, *Aphis craccivora* Koch: In the present study the infestation of aphid commenced in the third week of August (34th SMW) which increased gradually and reached to peak (196.8 aphids/ plant) in the second week of October (41st SMW) at 33.7 ^{0}C maximum, 17.6 ^{0}C minimum temperature and 53.0 per cent relative humidity and there after the population started declining. The maximum and minimum temperatures and rainfall showed a non-significant correlation and relative humidity showed negative significant correlation (r= -0.74) with aphid population.

The present findings are in partial agreement with Godwal (2010) [6] who reported the initiation of *A. craccivora* on Indian bean in the first week of September and peak in the second week of October (194.80 aphids/ shoot). Likewise, Kumar (2016) [8] reported the initiation of aphid population in the 37th SMW and peaked in 42nd SMW (194.80 aphids/ shoot). Jakhar *et al.* (2017) [7] reported the incidence of aphid in the first week of September and peaked in the second week of October which supports the present finding. Kumar *et al.* (1987) [9] reported high relative humidity and optimum temperature of 18°C favoured multiplication of the aphid, *A. craccivora*. The peak activity of the pest was recorded during November and February.

Leafhopper, *Empoasca fabae* (Harris): The incidence of leafhopper commenced in the second week of August (33rd SMW) which gradually increased and reached to peak (20.4/ plant) at 32.8 ^{0}C maximum, 24.3 ^{0}C minimum, 75.0 per cent relative humidity and 12.2 mm rainfall in the fourth week of September (39th SMW), thereafter, started declining. The minimum temperature showed positive significant correlation with leafhopper population (r= 0.83), while maximum temperature, relative humidity and rainfall showed a non-significant correlation.

The results are partially in agreement with Kumar (2016) [8] who reported the initiation of leafhopper in 36th SMW and peak in 42nd SMW (19.80/ three leaves). The leafhopper had non-significant relation with abiotic factors. Likewise, Jakhar *et al.* (2017) [7] observed the appearance of leafhopper in the third week of September and peak in the second week of October. The weather parameters showed a non-significant correlation with the leafhopper population. Dalwadi *et al.* (2007) [4] reported very low population of *E. kerri* during early phase of the crop and maximum (7.85 hoppers/ leaf) during first week of March.

Whitefly, *Bemisia tabaci* (Genn.): The incidence of whitefly, *B. tabaci* commenced in the second week of August (33rdSMW) which gradually increased and reached to its peak (27.2/ plant) in the first week of October (40th SMW) at 33.3 ^{0}C maximum, 22.7 ^{0}C minimum, 67.0 per cent relative humidity and 00.6 mm rainfall, thereafter, the population of whiteflies declined. The minimum temperature showed positive significant correlation with whitefly population (r= 0.64) whereas, maximum temperature, relative humidity and rainfall showed a non-significant correlation.

The present finding corroborates with that of Kumar (2016) [8] who recorded the initiation of whitefly population in 36th SMW and peak in 41st SMW (23.48/ three leaves). The correlation of whitefly population with minimum temperature revealed significantly negative but non-significant with relative humidity and maximum temperature. Gangurde and Kumar (2014) [5] recorded the initiation of whitefly, *B. tabaci* population from 41st SMW attaining peak (8.28/ leaf) during 4th SMW. It indicated significant negative correlation with temperature.

Natural enemies: The predatory lady bird beetle, *Menochilus sexmaculatus* Fab and syrphid fly, *Xanthogramma scutellare* Fab. were recorded predating the sucking insect pests, *viz.*, aphid, *A. craccivora*, leafhopper, *E. fabae* and whitefly, *B. tabaci* on Indian bean field. The population of lady bird beetle commenced in the last week of August (35th SMW) and reached to maximum (6.4/ five plants) with the peak population of aphid, *i.e.* second week of October. The correlation matrix indicated a non-significant correlation with maximum temperature, minimum temperature rainfall and relative humidity (r= 0.14, 0.32, - 0.39, - 0.60, respectively). The population of syrphid flies commenced in the first week of September (36th SMW) and reached to maximum (7.4/ five plants) in the first week of October. The correlation matrix indicated a non-significant correlation with maximum temperatures (r= 0.24), minimum temperature (r= 0.51), relative humidity (r= -0.30) and rainfall (r= -0.37). The population of both the predators showed a significant positive correlation with the population of sucking insect pests.

The present findings are partially in conformity with Godwal (2010) [6] who reported coccinellid predator, *M. sexmaculatus* predating on aphid. *M. sexmaculatus* had significant negative correlation with minimum temperature and non-significant correlation with maximum temperature and relative humidity. The shoots infested by different sucking insect pests and natural enemies are depicted in Plate-I

Table 1: Succession and incidence of sucking insect pests and their natural enemies on Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet

S. No.	SMW*	Date of observation	Temperature (^{0}C)		Average relative humidity (%)	Total rainfall (mm)	Mean population				
			Max.	Min.			Aphids/ shoot	Leafhoppers/ 3 leaves	Whiteflies/ 3 leaves	*Menochilus/ sexmaculatus* 5 plants	*Xanthogramma scutellare*/ 5 plants
1	33	13.08.2019	30.5	19.8	87	43.0	0.0	0.2	0.6	0.0	0.0
2	34	20.08.2019	34.0	20.0	75	00.8	1.2	1.4	2.2	0.0	0.0
3	35	27.08.2019	33.9	19.5	83	44.2	4.4	8.2	6.4	0.2	0.0
4	36	03.09.2019	33.8	22.9	83	06.6	11.0	16.6	12.8	0.6	1.2
5	37	10.09.2019	36.3	24.9	70	00.0	28.4	19.4	14.2	1.4	2.4
6	38	17.09.2019	35.2	23.3	63	00.0	50.4	18.2	19.0	4.2	5.6
7	39	24.09.2019	32.8	24.3	75	12.2	102.2	20.4	20.8	5.4	6.8
8	40	01.10.2019	33.3	22.7	67	00.6	164.4	16.8	27.2	5.8	7.4
9	41	08.10.2019	33.7	17.6	53	00.0	196.8	9.4	16.4	6.4	4.2
10	42	15.10.2019	34.7	17.7	55	00.3	154.2	4.6	8.2	4.4	2.6
11	43	22.10.2019	32.8	13.0	57	00.0	92.4	2.4	4.6	2.0	0.8
12	44	29.10.2019	32.0	15.1	61	00.0	46.4	0.0	0.0	0.8	0.2

*Standard meteorological week

Table 2: Correlation coefficient between population of sucking insect pests, predators and abiotic factors

Particulars	Correlation coefficient (r)				
	Insect pests Predators				
	Aphid, *A. craccivora*	Leafhopper, *E. fabae*	Whitefly, *B. tabaci*	*Menochilus sexmaculatus*	*Xanthogramma scutellare*
Maximum temperature	0.24 (NS)	0.54 (NS)	0.39 (NS)	0.14 (NS)	0.24 (NS)
Minimum temperature	- 0.19 (NS)	0.83**	0.64*	0.34 (NS)	0.51 (NS)
relative humidity	- 0.74**	0.10 (NS)	- 0.16 (NS)	- 0.43 (NS)	- 0.30 (NS)
Rainfall	- 0.47 (NS)	- 0.21 (NS)	- 0.33 (NS)	- 0.39 (NS)	- 0.37 (NS)
Menochilus sexmaculatus	0.78**	0.60*	0.87**		
Xanthogramma scutellare	0.65*	0.73**	0.94**		

* Significant at 5 per cent level of significance

** Significant at 1 per cent level of significance

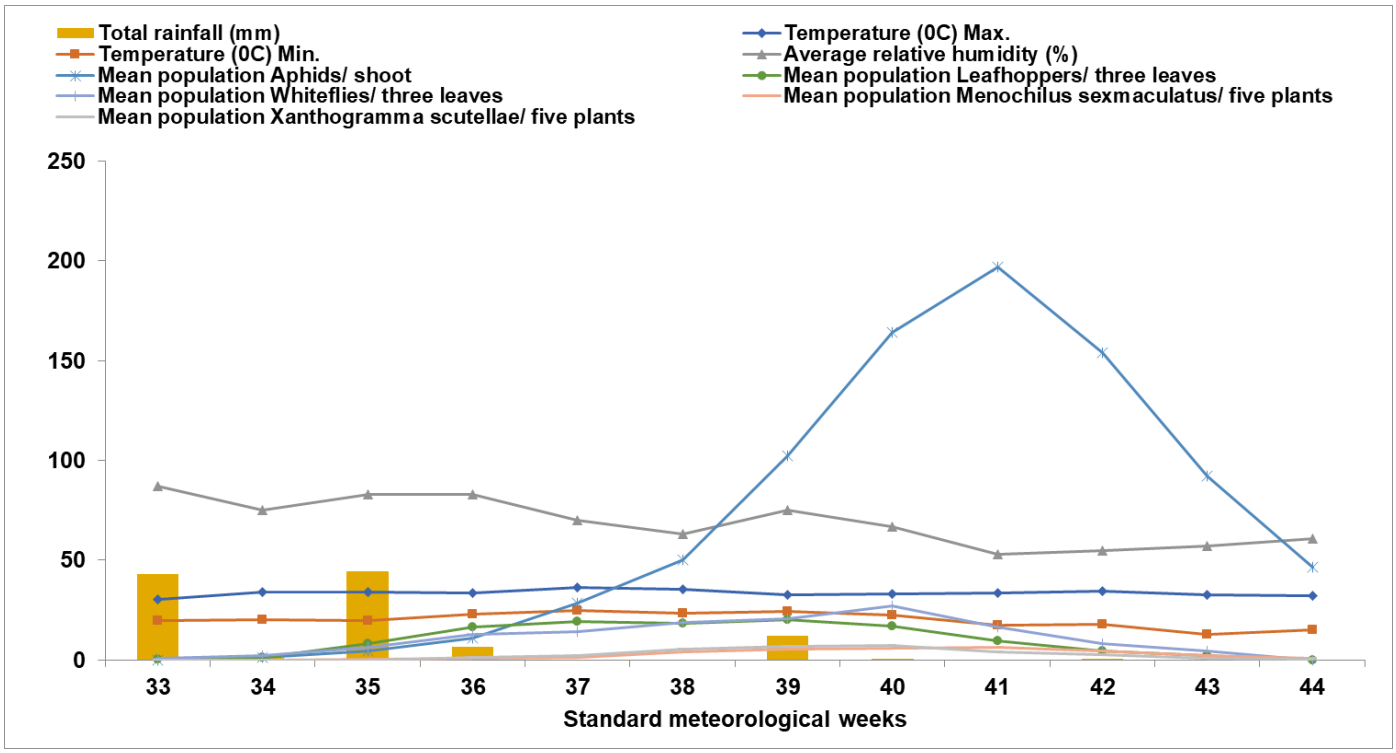

Fig 1: Succession and incidence of sucking insect pests and their natural enemies on Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet

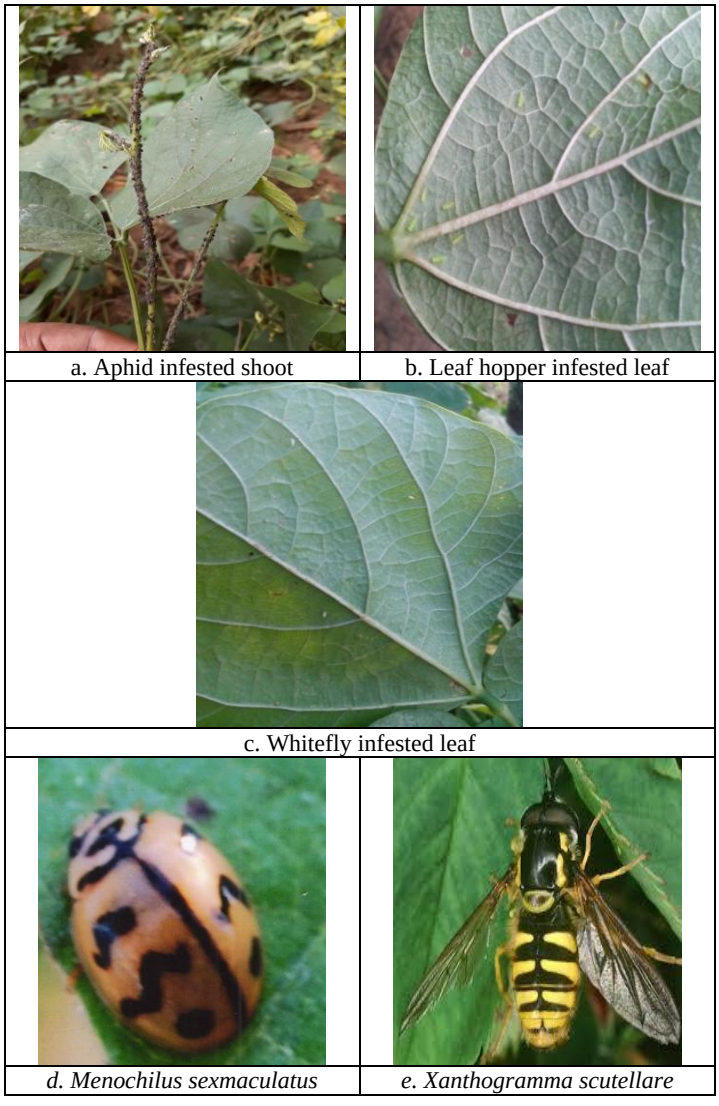

Plate 1: Sucking insect pests and their natural enemies on Indian bean

Conclusion

The aphid, *A. craccivora*, leafhopper, *E. fabae* and whitefly, *B. tabaci* were the major sucking insect pests. Among natural enemies, ladybird beetle, *M. sexmaculatus* and syrphid fly, *X. scutellare* were observed feeding on sucking insect pests. The population of natural enemies, ladybird beetle, *M. sexmaculatus* and syrphid fly, *X. scutellare* coincide with the population of sucking insect pests. The peak population of aphid (196.8 aphids/ plant) was recorded in the second week of October (41st SMW), leafhopper (20.4/ three leaves) in the fourth week of September (39th SMW) and whitefly (27.2/ three leaves) in the first week of October (40th SMW).The minimum temperature showed a positive significant correlation with leafhopper and whitefly population (r= 0.83 & 0.64). The relative humidity showed negative significant correlation (r= -0.74) with aphid population. The population of both the predators showed a significant positive correlation with the population of sucking insect pests.

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