

# Impact of Weather Factors on Succession and Incidence of Insect Pests in Soybean *Glycin max* L.

Vinod Kumar <sup>a\*</sup> and A. S. Yadav <sup>b</sup>

<sup>a</sup> Department of Entomology College of Agriculture, RVSKVV, Gwalior (M.P.)-474002, India.

<sup>b</sup> Department of Entomology Krishi Vigyan Kendra, RVSKVV, Morena (M.P.)-476001, India.

## Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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## ABSTRACT

Soybean *Glycin max* L. is economically the most important crop in the world, providing vegetable protein for millions of people and ingredients for hundred of chemical products. It is severely infested by dozen of insect pests on different plant parts throughout its growth stage. The Present study was carried out at Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya- Zonal Agricultural Research Station, Morena (M.P.) to find out the impact of weather factors on incidence of insect pests and their natural enemies of soybean. Eight species of the insect pests and one species of natural enemy was observed during the cropping season. The activities of *Aphis gossypii*, *Bemisia tabaci*, *Empoasca kerri*, *Spodoptera litura*, *Chrysodeixis acuta*, *Melanagromyza sojae*, *Obereopsis brevis*, *Nezara viridula* and *Coccinella septempunctata* was observed from the last week of July to second week of October. The population of *Aphis gossypii* (2.20/ Three leaves), *Bemisia tabaci* (1.98/ Three leaves), *Empoasca kerri* (3.25/ Three leaves), *Spodoptera litura* (8.15 larvae/mrl), *Chrysodeixis acuta* (3.00 larval/mrl), *Melanagromyza sojae* (5.20 percent), *Obereopsis brevis* (4.80 percent/ plant), *Nezara viridula* (5.35/ mrl) and *Coccinella septempunctata* (1.40/plant) reached peak from 31<sup>st</sup> to 35<sup>th</sup> Standard Meteorological Week. Abiotic factors was affected the population of insect pests and natural enemies. Temperature (maximum), relative humidity and rainfall were positively influence the activity *Aphis gossypii*, *Bemisia tabaci*, *Empoasca kerri*, *Spodoptera litura*, *Chrysodeixis acuta*, *Obereopsis brevis*, *Nezara viridula* and *Coccinella septempunctata*. While maximum temperature was negatively influenced the activity of *Melanagromyza sojae*.

**Keywords:** Incidence; insect pests; succession; weather factors.

## 1. INTRODUCTION

Soybean, *Glycine max* (L.) Merr., is a diploidized tetraploid ( $2n=40$ ), in the family Leguminosae, the subfamily Papilionoideae, the tribe Phaseoleae, the genus *Glycine* Willd. and the subgenus Soja (Moench). It is an erect, bushy herbaceous annual that can reach a height of 1.5 metres. Three types of growth habit can be found amongst soybean cultivars: determinate, semi-determinate and indeterminate. It is one of the most important oil seed crops in the country grown for oil and protein production in both the winter (rabi) and autumn (kharif) season. It is a rich source of animal feed protein and cooking oil [1]. It is known as the "GOLDEN BEAN" of the 20th Century. Though, Soybean is a legume crop, yet it is widely used as oilseed. In India area under soybean cultivation is 11.0 million ha and production 13.70 MT [2]. In India, soybean has acquired third position among the oil consumption after groundnut and mustard. Madhya Pradesh contributes about 67% area and 58% production in the country and is called as "Soya state" [3,4]. In Madhya Pradesh, soybean occupies an area of 5.24 m ha with production of 6.72 MT and productivity of 1286 kg/ha [2]. Soybean is infested by more than 275 insect pests on different plant parts of soybean throughout its growth stage and about a dozen of them have been reported causing serious damage from sowing to harvesting [5]. The grub of girdle beetle, [*Obereopsis brevis* (Swed)] bores the main stem and branches resulting in stunting plant growth and sometime whole plant succumb to injury. The stem fly, (*Melanagromyza sojæ*) attacks the soybean throughout the growing season, but the most vulnerable period is within 3-4 weeks after germination. The maggot may reduce the grain yield up to 33 per cent [6]. This crop suffers a lot due to the attack of number of insect pests [7]. It is mainly attacked by gram pod borer, *Helicoverpa armigera* Hubner; leaf eating caterpillar, *Spodoptera litura* Fabricious; green semilooper, *Chrysodeixis acuta* Walker; grey semilooper, *Amynaocto* Guenee; leaf miner, *Aproeremamodicella* Deventer; whitefly, *Bemisia tabaci* Gennadius; stem fly, *Ophiomyia phaseoli* Tryon; thrip, *Caliothrips indicus*; aphid, *Aphis glycine* Koch and jassid, *Empoasca kerri* Pruthi (Ahirwaret al. [8]. Population of insect pests and their natural enemies fluctuates with changing weather conditions. Temperature, relative humidity and rainfall play a crucial role in fluctuate activity of insect pest. Abiotic factors regulate seasonal incidence, population count and development rates of the pests and natural

enemies. As the cultivation of soybean has expanded around the world, crops become susceptible to different environmental and biotic stress which has increased the pest infestations. Among these temperature and relative humidity play key role that regulates population dynamics, development rates and seasonal incidence of pest and their natural enemies.

## 2. MATERIALS AND METHODS

The present studies were conducted during the autumn (*kharif*) season 2018 at Rajmata Vijayaraje Scindia Krishi Vishwa Vidhyalaya Zonal Agricultural Research Station, Morena (M.P.). The experimental area is having uniform topography, gentle slope and adequate drainage. The soybean variety RVS2007-6 was used in the experiment with plot size 8.0 m X 3.0m, no of row/plot 20, row length 3.0m and row to row spacing 40 cm.

### 2.1 Location and Climate

Morena is situated in Chambal region at the latitude of 26°30' North and longitude 78°59' East with an altitude of 195.0 meters from mean sea level, in Madhya Pradesh, India. This Region comes under semi-arid sub-tropical climate with extreme weather condition having hot and dry summer and cold winter. Generally, monsoon sets in during the last week of June.

Annual rainfall up to 700 mm, most of which falls during last June to the middle of September. In this area winter rains are occasional and uncertain. The maximum temperature goes up to 47°C during summer and minimum as low as 5°C during winter.

### 2.2 Observations Recorded

#### 2.2.1 Stem fly

Observation on stem fly was recorded on the randomly selected five plants at weekly interval from germination till harvest of the crop. To record the tunneling caused by the maggot of stem fly the plants were uprooted and open vertically. Plant height and tunnel length were also measured for calculating percent tunneling.

#### 2.2.2 Girdle beetle

To record the seasonal incidence of girdle beetle, observations on randomly selected five plants

were made at weekly interval starting from the initiation of infestation till harvest of the crop. The pest incidence was recorded by counting healthy and damaged plant by girdle beetle and the data would be calculated in percentage.

### 2.2.3 Foliage feeders and their natural enemies

For recording the pest succession of foliage feeders and their natural enemies, the observations were recorded once in a standard week at 5 sites of one meter row length. The insect pests appearing on the crop right from seedling up to harvest were recorded. The crop was kept unprotected for this purpose. The sequence in which the pests appeared was also noted.

### 2.2.4 Sucking pests

Observation on sucking pests were recorded on 3 leaves/plant (top, middle and bottom) in 10 randomly selected plants.

Observations on the incidence of major insect pests were recorded from the first appearance of the pest and it was continued till maturity of the crop at weekly intervals and data were correlated with meteorological parameters.

## 3. RESULTS AND DISCUSSION

Succession of insects and field incidence revealed that eight species of insect pests and one species of natural enemies were observed which were associated with various stages of the soybean crop during kharif 2018-19. The major groups (sucking pest and foliage feeder) of insect pests attacked at the various stages of the crop were aphid, whitefly, jassid, tobacco caterpillar, green semilooper, stem fly, girdle beetle and green stink bug. Only one natural enemy's lady bird beetle was observed on the soybean crop (Table 1, 2, 3 and 4).

### 3.1 Aphid, *Aphis gossypii* (Hemiptera: Aphididae)

Aphid was first appeared during last week of July *i.e.* from 30<sup>th</sup> standard week in soybean during vegetative stage and the population of aphid increased and reached the peak level (2.20 aphid/ three leaves) on first week of August *i.e.* 31<sup>th</sup> standard week, subsequently, it declined gradually and disappeared during fourth week of

September *i.e.* 38<sup>th</sup> standard week. Present findings are in accordance with Suyal et al. [9].

Among the different weather parameters studied, maximum temperature showed highly significant positive correlation with aphid population ( $r = 0.627$ ) and relative humidity showed non-significant but positive correlation with aphid population ( $r = 0.369$ ), while, rainfall showed non-significant positive correlation with aphid population ( $r = 0.323$ ). Whereas, minimum temperature reflected non-significant positive correlation with the aphid population (0.160). During the peak aphid population, the maximum and minimum temperature were 30.71<sup>o</sup>C and 24.14<sup>o</sup>C respectively, whereas relative humidity and rainfall were 88.68% and 03.79 mm respectively (Table 4). The result was somehow similar with the result obtained by Patel [10].

### 3.2 White Fly, *Bemisia tabaci* Gennadius (Hemiptera: Aleyrodidae)

First incidence of white fly was observed in vegetative stage when the crop age was about 25 days old. Results showed that the pest was observed on the crop during the entire cropping season and remained active from fourth week of July *i.e.* from vegetative stage of the crop to second week of October (till maturity stage), population of whitefly reached the peak (1.98/three leaves) at 34<sup>th</sup> Standard Meteorological Week. Incidence of white fly was observed from first week of August to second week of October and the whitefly reached the peak level during last week of August, Similar findings was also reported by Chaudhary et al. [11] and Garg et al. [12].

The results indicated that the maximum temperature ( $r = 0.690$ ) and relative humidity ( $r = 0.543$ ) showed highly significant positive correlation with whitefly population while, minimum temperature and rainfall showed non-significant positive correlation with the whitefly population. During the peak whitefly population, the maximum and minimum temperature were 30.57<sup>o</sup>C and 25.79<sup>o</sup>C respectively, whereas relative humidity and rainfall were 95.57% and 07.79 mm respectively and it confirms with the finding of Patel [10], and the result was also in accordance with Kujur [13]. From the result it was clear that maximum temperature and relative humidity showed highly significant positive correlation with whitefly population. The result confirms the findings of Chaudhary et al. [11].

### 3.3 Jassid, *Empoasca kerri* Pruthi (Hemiptera; Cicadellidae)

First appearance of Jassid was observed in the vegetative stage when the crop age was about 32 days old. From the data it was evident that the pest was present in the crop from first week August i.e. from vegetative stage to third week September till reproductive stage. The population of Jassid increased and reached the peak level (3.25 Jassid/ three leaves) on third week of August i.e. 33<sup>rd</sup> standard week, subsequently, it declined gradually and disappeared during second week of October i.e. 40<sup>th</sup> standard week. The incidence of jassid was observed from first week of August to second week of October, and the peak population of jassid was obtained in third week of August. Chaudhary et al. [11] was found peak population of jassid (5.95/Three leaves) at second week of August his investigation.

The results of jassid population presented in Table 4 indicated that the maximum temperature showed non-significant positive correlation with jassid population ( $r = 0.458$ ) while all other weather parameter also showed non-significant positive correlation with jassid population. During the peak jassid population maximum and minimum temperature were 32.64°C and 25.57°C respectively, whereas relative humidity and rainfall were 88.43% and 03.57 mm respectively. Sutaria et al. (2010a) reported the positive correlation of leaf hopper population with minimum temperature and relative humidity.

### 3.4 Tobacco caterpillar, *Spodoptera litura* (Fabricius) (Lepidoptera: Noctuidae)

Tobacco caterpillar first appearance was observed in the vegetative stage when the crop age was about 39 days old. The data showed that the pest was present in the crop from second week August i.e. from vegetative stage to second week September till reproductive stage. The population of tobacco caterpillar increased and recorded peak (8.15 larvae/mrl) at 35<sup>th</sup> SMW (First week of September). First incidence of tobacco caterpillar was observed at vegetative stage of soybean crop when crop age was about 27 days old and incidence continued till the maturity of the crop, insect was damaging the foliage of soybean crop. Present findings are in accordance with Gangrade et al., [14] they also reported that the tobacco caterpillar was a serious pest in Madhya Pradesh. Chaudhary,

[15] has also reported the dispersion of *Spodoptera obliqua* (Walker) and *Spodoptera litura* (F.) on soybean crop from August to October.

The results of tobacco caterpillar indicated that the maximum temperature showed significant positive correlation with Tobacco caterpillar population ( $r = 0.725$ ) and relative humidity also showed significant positive correlation with Tobacco caterpillar population ( $r = 0.627$ ). Whereas, minimum temperature, and rainfall showed non-significant positive correlation with the Tobacco caterpillar population. and this result was in accordance with Patel [10]. During the peak population the maximum and minimum temperature were 30.93°C and 25.64°C respectively, Whereas relative humidity and rainfall were 95.57% and 07.79 mm respectively. This result was also in accordance with Kujur j [13].

### 3.5 Green Semilooper, *Chrysodeixis acuta* (Walker) (Lepidoptera; Noctuidae)

First incidence of green semilooper was observed in the vegetative stage when the crop age was about 25 days. The data showed that the pest was present on the crop during the entire cropping season i.e. first week of August to second week of September. The population of green semilooper increased and reached the peak level (3.0larvae/mrl) on last week of August i.e.34<sup>th</sup> standard week, subsequently, it declined gradually and disappeared during third week of September i.e. 37<sup>th</sup> standard week. In the present study the incidence of green semilooper was observed from first week of August to second week of September and reached the peak during last week of August. Present findings are in accordance with Netam et al. [16] and Garg et al. [12].

The maximum temperature and relative humidity showed significant positive correlation with Green Semilooper population ( $r = 0.680$ ) and ( $r = 0.538$ ) respectively, while minimum temperature, and rainfall showed non-significant positive correlation with the Green Semilooper population. During the peak population of green semilooper the maximum and minimum temperature were 30.57°C and 25.79°C respectively, whereas relative humidity and rainfall were 94.43% and 14.00 mm respectively. The result confirms the findings of Kushram [17].The maximum temperature and relative

humidity showed significant positive correlation with Green Semilooper population, while minimum temperature, and rainfall showed non-significant positive correlation with the Green Semilooper population this result was in accordance with Patel [10].

### 3.6 Stem Fly, *Melanagromyza sojae* (Zehntner) Diptera: Agromyzidae:

First incidence of stem fly was observed immediately after seedling stage when the crop age was about 32 days old. From the table 3, it is evident that the pest was present on the crop during the entire cropping season *i.e.* from first week of August to reproductive stage of the crop *i.e.* third week of September. The incidence of the stem fly was reached the peak (45.25 percent/mrl) at 33<sup>rd</sup> SMW. In the present investigation, the incidence of stem fly was recorded from first week of August to second week of September and reached the peak level during last week of August. Aske et al. [18] also reported similar results of stem fly incidence in soybean crop.

The results indicated that the maximum temperature showed highly significant negative correlation with stem fly population ( $r = -0.523$ ) while relative humidity and rainfall showed non-significant but positive correlation with stem fly population ( $r = 0.364$  and  $r = 0.366$ ). Minimum temperature showed non-significant but positive correlation with the stem fly population. At the time when the population of stem fly reach at peak, maximum and minimum temperature were 32.64<sup>o</sup>C and 25.57<sup>o</sup>C respectively, whereas relative humidity and rainfall were 88.43% and 03.57 mm respectively. This result matches with the finding of Singh and Singh [6]. The maximum temperature showed significant negative correlation with stem fly population it confirms the finding of Motaphale et al. [19].

### 3.7 Girdle Beetle, *Obereopsis brevis* (Swed.) (Coleoptera; Lamidae)

First appearance of Girdle beetle was observed in the vegetative stage when the crop age was about 39 days old. The data showed that the pest was present on the crop from second week of August till reproductive stage of the crop *i.e.* third week of September. Girdle beetle infestation reached the peak (4.80 percent) at 35<sup>th</sup> SMW. The incidence of Girdle beetle was found from second week of August and it

continue upto second week of October. The peak population of girdle beetle was observed in first week of September. Similarly, incidence of girdle beetle was also seen by Garg et al. [12] and Kushram [17].

The results indicated that the maximum temperature showed significant positive correlation with Girdle beetle population ( $r = 0.653$ ) and relative humidity showed highly significant positive correlation with Girdle beetle population ( $r = 0.529$ ) while, minimum temperature, and rainfall showed non-significant positive correlation with the Girdle beetle population. At the time of peak population of girdle beetle the maximum and minimum temperature were 30.93<sup>o</sup>C and 25.64<sup>o</sup>C respectively, whereas relative humidity and rainfall were 95.57% and 07.79mm respectively (Table 4). This result confirms with the finding of Patel [10].

### 3.8 Green stink bug, *Nezara viridula* (Linn.) (Hemiptera; Pentatomidae)

Green stink bug first appeared during first week of August *i.e.* during vegetative stage from 31<sup>st</sup> standard week in soybean and the population of Green stink bug increased and reached the peak level (5.35 Green stink bug /mrl) on last week of August *i.e.* 34<sup>th</sup> standard week, subsequently, it declined gradually and disappeared during second week of September *i.e.* 36<sup>th</sup> standard week. Thus the population of green stinkbug ranged between 0.00 and 5.35 bug/mrl on soybean crop during the crop period. Incidence of green stink bug was from second week of August to first week of September and the highest population of green stink bug was observed during full developmental stages the result was in accordance with Smith et al. [20].

The results indicated that the maximum temperature and relative humidity showed significant positive correlation with green stink bug population ( $r = 0.672$ ) and ( $r = 0.554$ ) respectively. However, minimum temperature and rainfall were non-significant, but this were positively correlated to the incidence of green stink bug. And at the time of peak population *i.e.* 5.35 bug infested /mrl. Maximum and minimum temperature were 30.57<sup>o</sup>C and 25.79<sup>o</sup>C respectively, whereas relative humidity and rainfall were 94.43% and 14.00 mm respectively (Table 4). This result was in accordance Gupta, P.K. [21].

**Table 1. Insect-pests recorded on soybean variety RVS-2007-6 at during 2018 kharif season**

S. No.	Affected plant part	Common Name	Scientific Name	Order	Family
1	Foliage	Aphid	<i>Aphis gossypii</i>	Hemiptera	Aphididae
2	Foliage	Whitefly	<i>Bemisia tabaci</i> (Gennadius)	Hemiptera	Aleyrodidae
3	Foliage	Jassid	<i>Empoasca kerri</i> (Pruthi)	Hemiptera	Cicadellidae
4	Foliage	Tobacco caterpillar	<i>Spodoptera litura</i> (Fabricius)	Lepidoptera	Noctuidae
5	Foliage, flowers & Pods	Green Semilooper	<i>Chrysodeixis acuta</i> (Walker)	Lepidoptera	
6	Stem	Stem fly	<i>Melanagromyza sojæ</i> (Zehntner)	Diptera	Agromyzidae
7	Stem	Girdle beetle	<i>Obereopsis brevis</i> (Swed.)	Coleoptera	Cerambycidae
8	Foliage	Green stink bug	<i>Nezaraviridula</i> (Linn.)	Hemiptera	Pentatomidae

**Table 2. Incidence of Insect pest complex of soybean at during 2018 kharif season**

SMW	Duration	Crop Age (days)	Crop stage	population/plant/3leaves			No. of larvae/mrl*		%plant inf./mrl	Stem fly Stem tunneling (%)	Girdle beetle inf (%)plant	Green Stink bug inf./mrl	Lady bird beetle/plant
				Aphid	White fly	Jassid	Tobacco caterpillar	Green semilooper					
28	15-21Jul	11	Seedling	0	0	0	0	0	0	0	0	0	0
29	22-28Jul	18		0	0	0	0	0	0	0	0	0	0
30	29Jul-4Aug	25	Vegetative	1.75	0.25	0	0	0.5	0	0	0	0	0
31	5-11Aug	32		2.2	1.2	0.75	0	1.75	20.3	2.25	0	0.95	0.25
32	12-18Aug	39		2	1.5	2.55	0.85	2.2	38.82	3.5	1.5	2.3	0.6
33	19-25Aug	46	Reproductive	1.8	1.75	3.25	1.6	2.5	45.25	5.2	2.4	3.25	0.85
34	26Aug-1Sep	53		1.15	1.98	2	3.25	3	40.28	4.5	3.5	5.35	1.1
35	2-8Sep	60		0.8	1.5	1.5	8.15	2.65	41.1	3.2	4.8	3.8	1.4
36	9-15Sep	67		0.25	1.25	1.15	4.5	1.2	31.2	1.75	3.25	0	1.2
37	16-22Sep-	74		0.2	1.2	0.9	0	0	18.27	0.8	2.75	0	0.95
38	23-29Sep	81		0.15	0.9	0.75	0	0	0	0	0	0	0.5
39	30Sep-6Oct	88	Maturity	0	0.8	0.5	0	0	0	0	0	0	0
40	7-13Oct	95		0	0.25	0.23	0	0	0	0	0	0	0

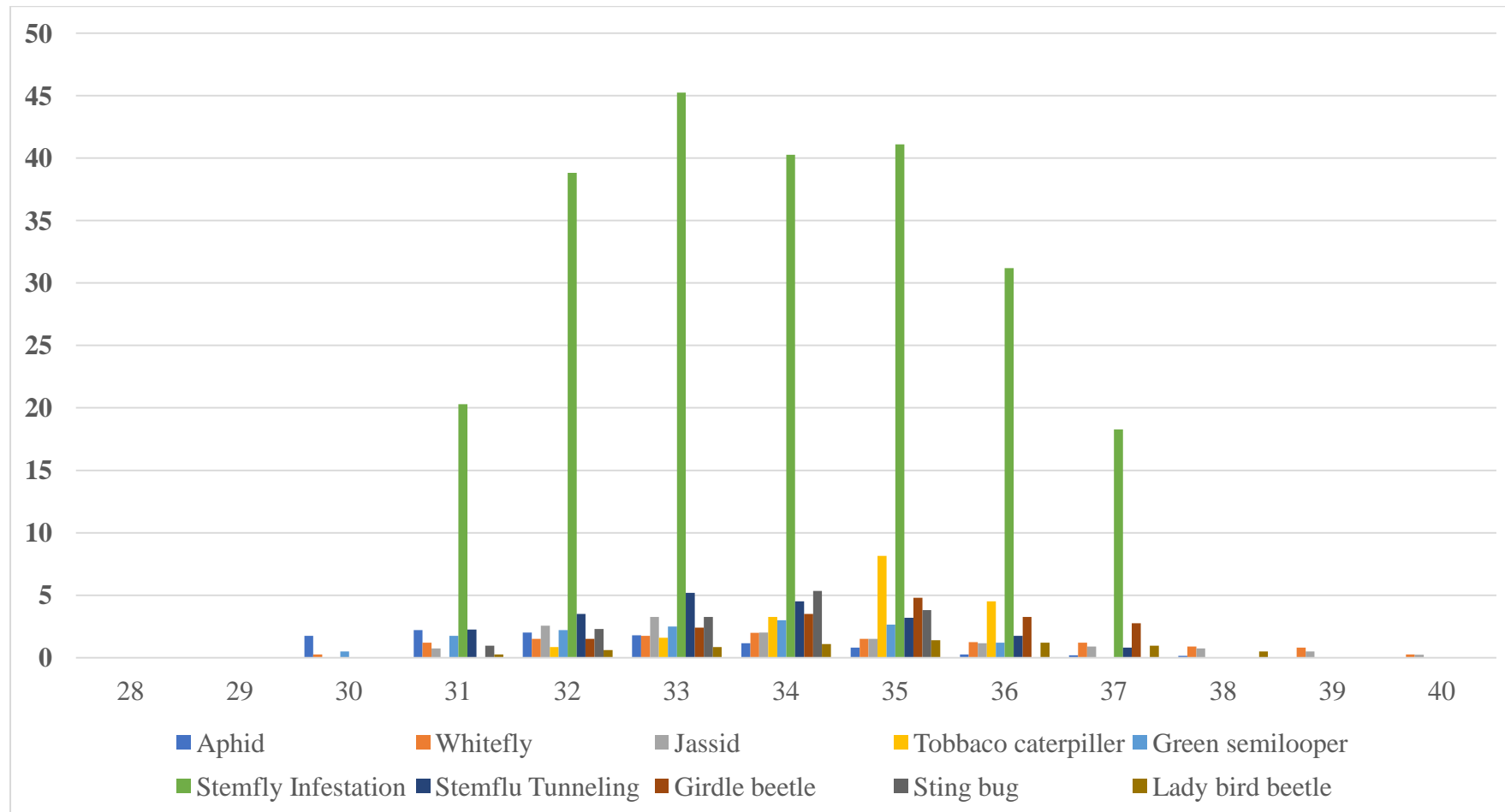


Fig. 1. Incidence of Insect complex in soybean

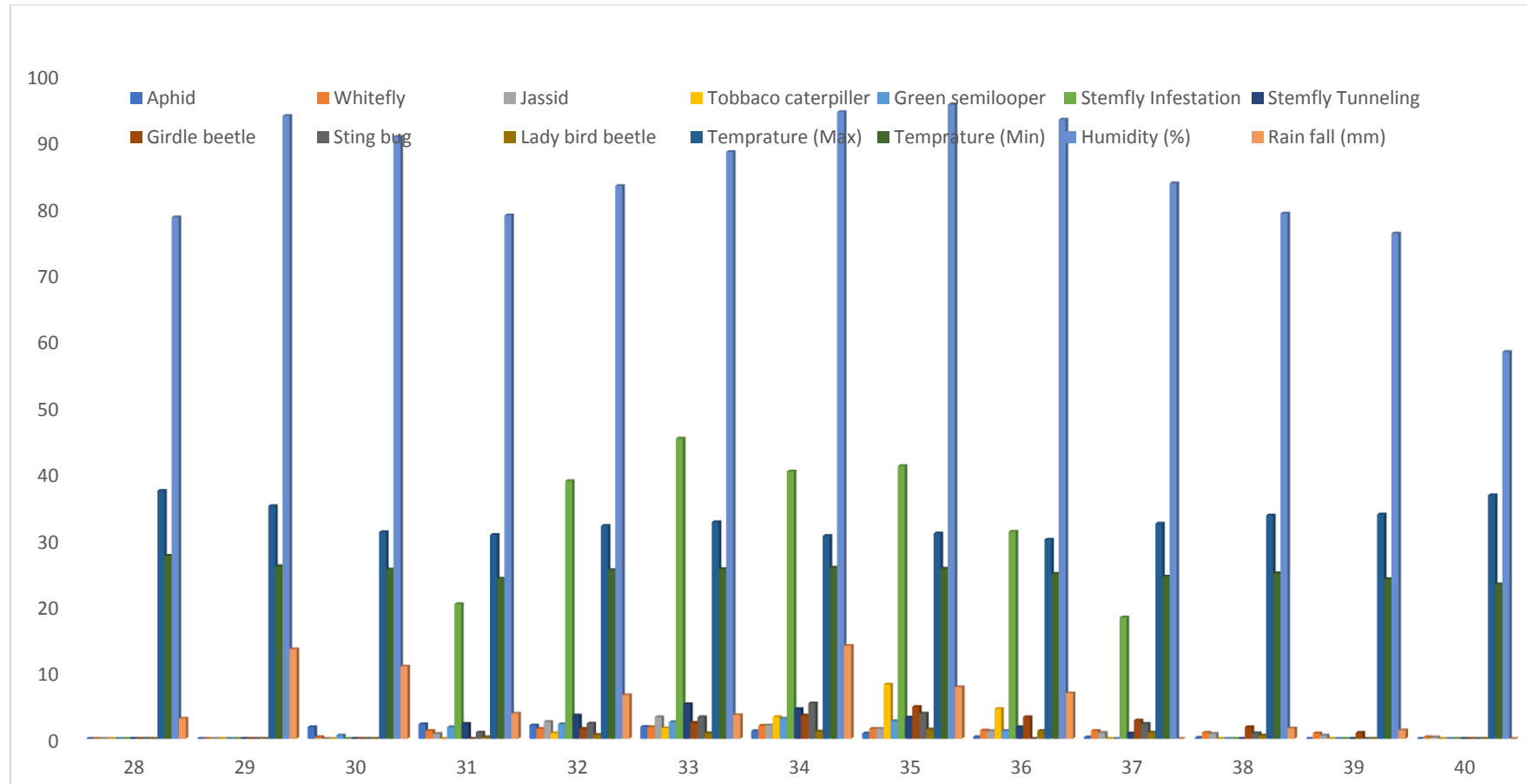


Fig. 2. Influence of abiotic factors on incidence of insect pest complex of soybean



**Table 3. Influence of weather parameters on incidence of Insect pest complex of soybean at during 2018 kharif season**

SMW	Duration	population / plant / 3 leaves			No. of larvae/(mrl)		Stem fly		Girdle beetle infestation (%)	Green Stink bug infestation /(mrl)	Lady bird beetle/ plant	Temp. (°C)		Relative Humidity (%)	Rainfall (mm)
		Aphid	White fly	Jassid	Tobacco caterpillar	Green semilooper	%plant inf./mrl	Stem tunneling (%)				Max.	Min.		
28	15-21July	0	0	0	0	0	0	0	0	0	0	37.36	27.57	78.57	3.03
29	22-28 July	0	0	0	0	0	0	0	0	0	0	35.07	26	93.86	13.5
30	29 July - 4 Aug	1.75	0.25	0	0	0.5	0	0	0	0	0	31.14	25.5	90.71	10.9
31	5-11Aug	2.2	1.2	0.75	0	1.75	20.3	2.25	0	0.95	0.25	30.71	24.14	78.86	3.79
32	12-18Aug	2	1.5	2.55	0.85	2.2	38.82	3.5	1.5	2.3	0.6	32.07	25.43	83.29	6.57
33	19-25Aug	1.8	1.75	3.25	1.6	2.5	45.25	5.2	2.4	3.25	0.85	32.64	25.57	88.43	3.57
34	26Aug-1Sep	1.15	1.98	2	3.25	3	40.28	4.5	3.5	5.35	1.1	30.57	25.79	94.43	14
35	2-8Sep	0.8	1.5	1.5	8.15	2.65	41.1	3.2	4.8	3.8	1.4	30.93	25.64	95.57	7.79
36	9-15Sep	0.25	1.25	1.15	4.5	1.2	31.2	1.75	3.25	0	1.2	30	24.86	93.29	6.86
37	16-22Sep	0.2	1.2	0.9	0	0	18.27	0.8	2.75	2.25	0.95	32.43	24.43	83.71	0
38	23-29Sep	0.15	0.9	0.75	0	0	0	0	1.75	0.85	0.5	33.64	24.93	79.14	1.57
39	30 Sep-6 Oct	0	0.8	0.5	0	0	0	0	0.9	0	0	33.79	24.07	76.14	1.29
40	07-13 Oct	0	0.25	0.23	0	0	0	0	0	0	0	36.71	23.29	58.29	0

**Table 4. Correlation between pests' population and weather parameters at during 2018 kharif season**

S. No	Insect Pests	Weather parameters									
		Temperature (°C)				Relative Humidity (%)				Rainfall (mm)	
		Min.		Max.		R		b <sub>yx</sub>		R	
r	b <sub>yx</sub>	R	b <sub>yx</sub>	R	b <sub>yx</sub>	R	b <sub>yx</sub>	R	b <sub>yx</sub>	R	b <sub>yx</sub>
1.	Aphid	0.160 NS	--	0.627*	0.0107	0.369 NS	--	0.323 NS	--		
2.	Whitefly	0.250 NS	--	0.690*	0.0023	0.543*	0.0361	0.410 NS	--		
3.	Jassid	0.235 NS	--	0.458 NS	--	0.411 NS	--	0.450 NS	--		
4.	Tobacco caterpillar	0.234 NS	--	0.725*	0.0025	0.627*	0.0120	0.220 NS	--		
5.	Green Semilooper	0.242 NS	--	0.680*	0.0043	0.538*	0.0382	0.384 NS	--		
6.	Stem fly	0.171 NS	--	-0.523*	0.0450	0.364 NS	--	0.366 NS	--		
7.	Girdle beetle	0.235 NS	--	0.653*	0.0049	0.529*	0.0422	0.412 NS	--		
8.	Green stink bug	0.243 NS	--	0.672*	0.0042	0.554*	0.0323	0.424 NS	--		
9.	Lady bird beetle	0.233 NS	--	0.734*	0.0006	0.621*	0.0134	0.280 NS	--		

\* Significant (at 5%), NS – Non-significant

### 3.9 Lady Bird Beetle, *Coccinella septempunctata* (Fabricius) (Coleoptera; Coccinellidae)

Lady bird beetle was found active on soybean crop from first week of August to last week of September. The data indicated that Lady bird beetle activity started from vegetative stage of soybean crop and it was more active during reproductive stage of the crop. Lady bird beetle population reached peak (1.40/plant) at 35<sup>th</sup> SMW, declined subsequently and disappeared on 39 SMW. Lady bird beetle is the important predator in soybean crop. Lady bird beetle was observed from second week of August to last week of September and the highest population of lady bird beetle was observed during first week of September (Table 2). The result was more or less similar to Garg et al. [12] and Suyal et al. [9].

The results of lady bird beetle population on soybean crop indicated that the maximum temperature and relative humidity showed highly significant positive correlation with lady bird beetle population ( $r = 0.734$ ) and ( $r = 0.621$ ) respectively, while minimum temperature, and rainfall showed non-significant positive correlation with the lady bird beetle population. During the peak population of lady bird beetle, the maximum and minimum temperature were 30.93°C and 25.64°C respectively, whereas relative humidity and rainfall were 95.57% and 07.79 mm respectively (Table 4). The present findings are more or less similar with Gupta [21].

### 4. CONCLUSIONS

In the present studies eight insect pest and one natural enemy was observed in the whole crop period. Insect pest and natural enemy was active from last week of July to second week of October in the soybean crop. Population was recorded during peak period on tobacco caterpillar (8.15 larvae/m<sup>2</sup>) followed by green stink bug (5.35/m<sup>2</sup>), stem fly (5.20 percent), girdle beetle (4.80 percent/plant), jassid (3.25/three leaves), green semilooper (3.00 larval/m<sup>2</sup>), aphid (2.20/ three leaves) and whitefly (1.98/ three leaves). Abiotic factors were influenced the activity of insect pest and natural enemy. Maximum temperature, relative humidity and rain fall positively affected the population of aphid, whitefly, jassid, tobacco caterpillar, green semilooper, girdle beetle, green stink bug and lady bird beetle whereas maximum temperature negatively affected the population of stem fly.

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### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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