Impact of weather factors on Succession and incidence of insect pests in soybean *Glycin max* L.

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 31st to 35th 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*.

Key words: Incidence, insect pests, succession, weather factors

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 (Schmutz *et al.* 2010). 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 (Anon. 2019). 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 "(Anon. 2005 and Anon. 2007). In Madhya Pradesh, soybean occupies an area of 5.24 m ha with production of 6.72 MT and productivity of 1286 kg/ha (Anon. 2019). 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 (Ramesh Babu, 2010).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, *(Melanagromyzasojae)* 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 (Singh and Singh, 1992). This crop suffers a lot due to the attack of number of insect pests (Lal *et al.* 1981).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 (Ahirwar*et al.* (2015). 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.

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.

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 to700 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 at 5^{o}C during winter.

Observations recorded:

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.

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.

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.

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.

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).

Aphid, *Aphis gossypii* (Hemiptera: Aphididae)

Aphid was first appeared during last week of July *i.e.* from 30th 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.* 31th standard week, subsequently, it declined gradually and disappeared during fourth week of September *i.e.* 38th standard week. Present findings are in accordance with Suyal *et al.* (2018).

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^{0}C and 24.14^{0}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 (2012).

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 34th 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.* (2018) and Garg *et al.* (2014).

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^{0}C and 25.79^{0}C respectively, whereas relative humidity and rainfall were 95.57% and 07.79 mm respectively and it confirms with the finding of Patel (2012), and the result was also in accordance with Kujur (2011). 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.* (2018).

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.* 33rd standard week, subsequently, it declined gradually and disappeared during second week of October *i.e.* 40th 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.* (2018) 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^{0}C and 25.57^{0}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.

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 35th 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., (1975) they also reported that the tobacco caterpillar was a serious pest in Madhya Pradesh. Chaudhary, (2009) has also reported the disperson 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 (2012).During the peak population the maximum and minimum temperature were 30.93^{0}C and 25.64^{0}C respectively, Whereas relative humidity and rainfall were 95.57% and 07.79 mm respectively. This result was also in accordance with Kujur j. (2011).

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.*34th standard week, subsequently, it declined gradually and disappeared during third week of September *i.e.* 37th 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.* (2013) and Garg *et al.* (2014).

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 semilooperthe maximum and minimum temperature were 30.57^{0}C and 25.79^{0}C respectively, whereas relative humidity and rainfall were 94.43% and 14.00 mm respectively. The result confirms the findings of Kushram (2016).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 (2012).

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 33rd 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*. (2007) 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^{0}C and 25.57^{0}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 (1992). The maximum temperature showed significant negative correlation with stem fly population it confirms the finding of Motaphale et al. (2017).

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 35th 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*. (2014) and Kushram (2016).

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^{0}C and 25.64^{0}C respectively, whereas relative humidity and rainfall were 95.57% and 07.79mm respectively (Table 4). This result confirms with the finding of Patel (2012).

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

Green stink bug first appeared during first week of august *i.e.* during vegetative stage from 31st standard week in soybean and the population of Green stink bug increased and reached the peak level (5.35Green stink bug /mrl)on last week of August *i.e.* 34th standard week, subsequently, it declined gradually and disappeared during second week of September *i.e.* 36th 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.* (2009).

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^{0}C and 25.79^{0}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. (2006).

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 35th 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.* (2014) and Suyal *et al.* (2018).

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^{0}C and 25.64^{0}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 (2006).

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/mrl) followed by green sting bug (5.35/ mrl), stem fly (5.20 percent), girdle beetle (4.80 percent/ plant), jassid (3.25/three leaves), green semilooper (3.00 larval/mrl), 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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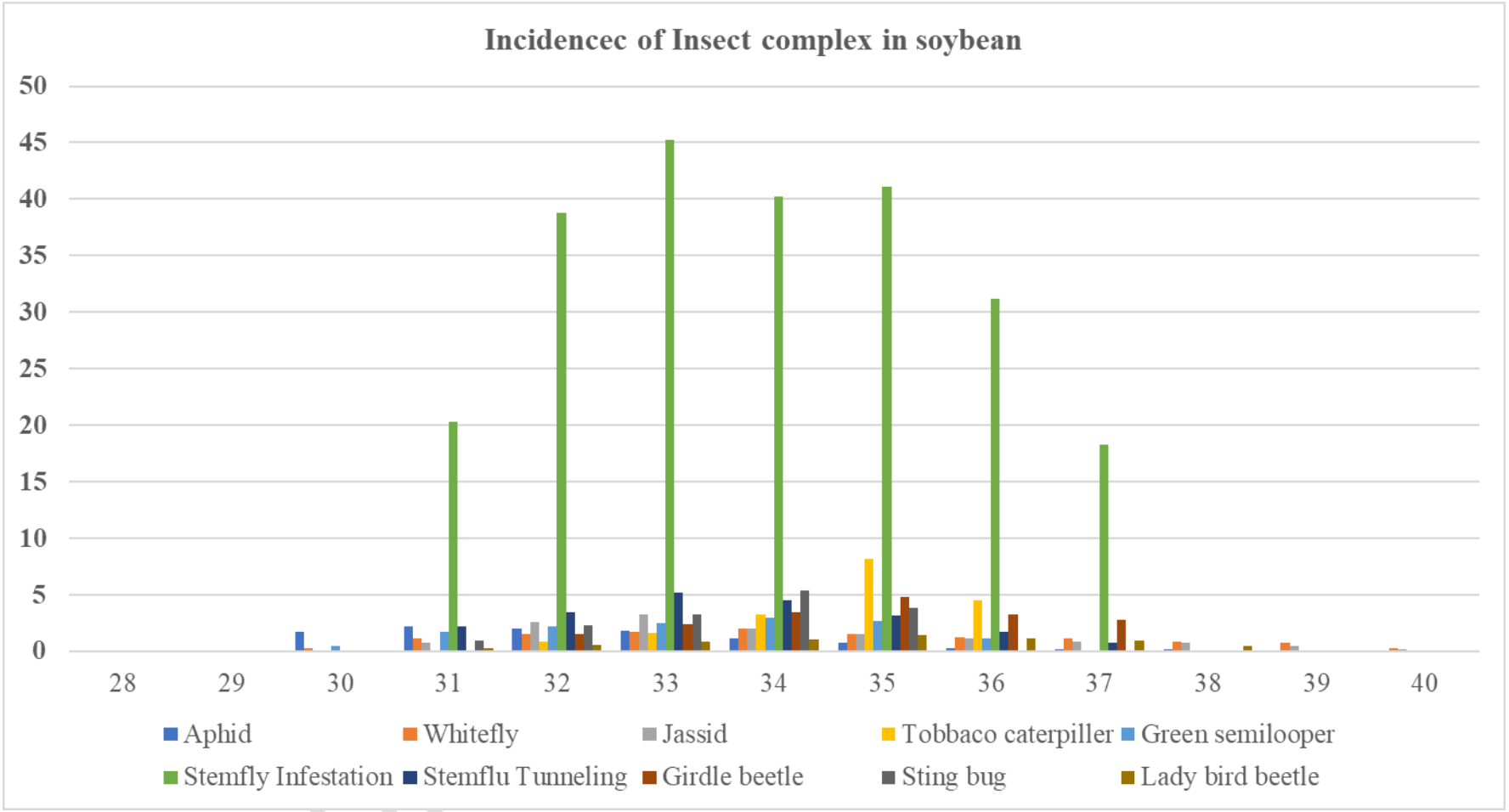
Table 1: Insect-pests recorded on soybean variety RVS-2007-6 at during 2018 kharif season

S. No.	Affected plant part	Common Name	Scientific Name	Order	Family
1	Foliage	Aphid	*Aphis gossypii*	Hemiptera	Aphididae
2	Foliage	Whitefly	*Bemisiatabaci* (Gennadius)	Hemiptera	Aleyrodidae
3	Foliage	Jassid	*Empoascakerri (Pruthi)*	Hemiptera	Cicadellidae
4	Foliage	Tobacco caterpillar	*Spodoptera litura* (Fabricius)	Lepidoptera	Noctuidae
5	Foliage, flowers & Pods	Green Semilooper	*Chrysodeixisacuta* (Walker)	Lepidoptera	
6	Stem	Stem fly	*Melanagromyzasojae* (Zehntner)	Diptera	Agromyzidae
7	Stem	Girdle beetle	*Obereopsis brevis (Swed.)*	Coleoptera	Cerambycidae
8	Foliage	Green stink bug	*Nezaraviridula* (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*		Stem fly		Girdle beetle inf (%)plant	Green Stink bug inf./mrl	Lady bird beetle/plant
				Aphid	White fly	Jassid	Tobacco caterpillar	Green semilooper	%plant inf./mrl	Stem tunneling (%)			
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


Incidencec of Insect complex in soybean
50
45
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Aphid
Whitefly
Jassid
Tobbaco caterpiller
Green semilooper
Stemfly Infestation
Stemflu Tunneling
Girdle beetle
Sting bug
Lady bird beetle

Figure-1

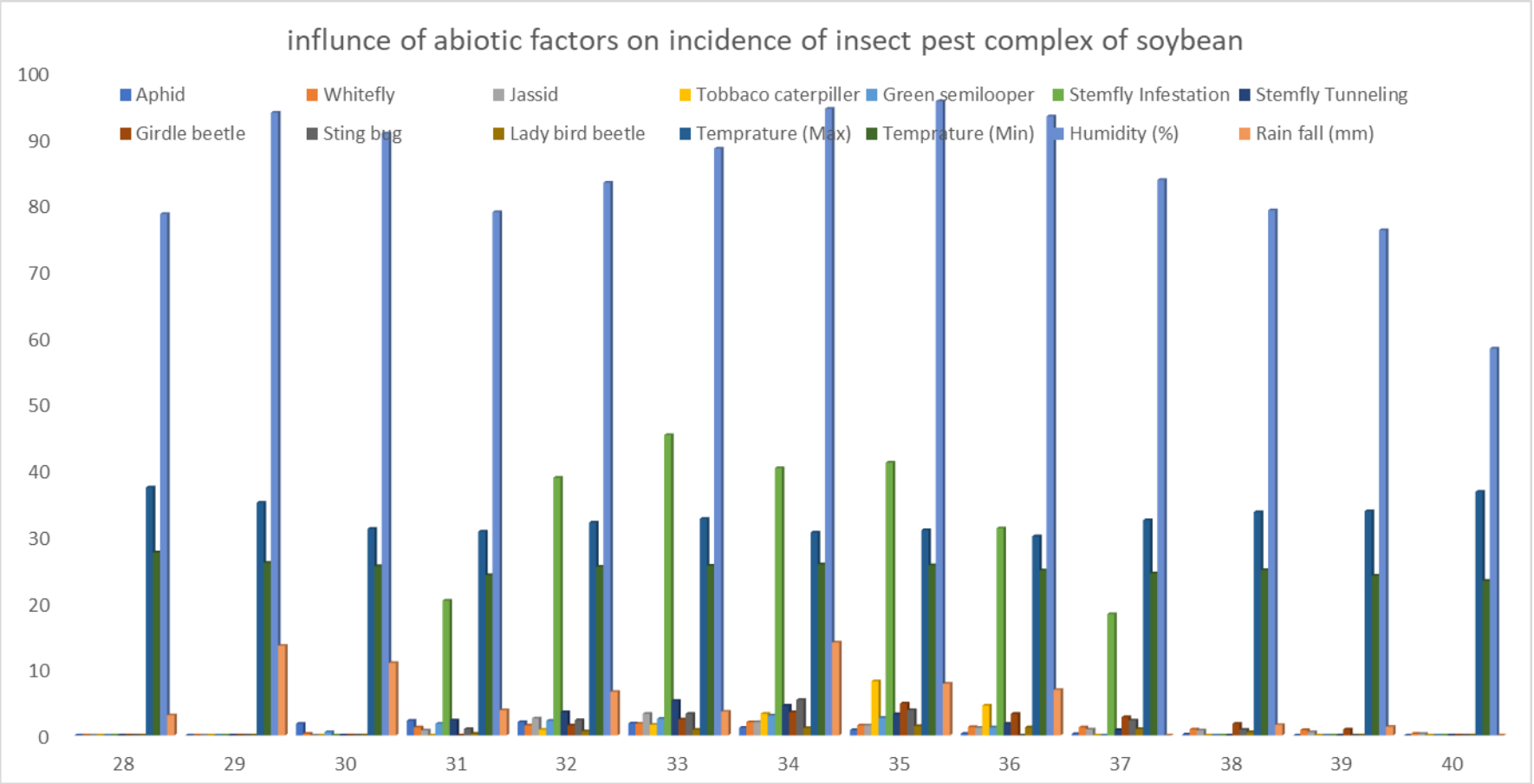
influnce of abiotic factors on incidence of insect pest complex of soybean
Aphid
Whitefly
Jassid
Tobbaco caterpiller
Green semilooper
Stemfly Infestation
Stemfly Tunneling
Girdle beetle
Sting bug
Lady bird beetle
Temprature (Max)
Temprature (Min)
Humidity (%)
Rain fall (mm)
100
90
80
70
60
50
40
30
20
10
0
28
29
30
31
32
33
34
35
36
37
38
39
40

Figure-2

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. (^{0}C)		Relative Humidity (%)	Rainfall (mm)
		Aphid	White fly	Jassid	Tobacco caterpiller	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 (^{0}C)				Relative Humidity (%)		Rainfall (mm)	
		Min.		Max.					
		r	b_{yx}	R	b_{yx}	R	b_{yx}	R	b_{yx}
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**