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Succession of pests and their natural enemies on soybean

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Abstract

Soybean [*Glycine max* Merrill (L.)] is the world's most important oilseed and grain legume crop and considered as the wonder legume. The investigations were carried out on pest succession of sucking pests on soybean (*Glycine max* L.). Eight pests and three natural enemies were found active on soybean crop. Among the sucking pests, soybean crop invaded by jassid and whitefly which reached the peak level during second week of August (5.95 jassids and 6.85 whiteflies/three leaves). Though, thrips reached the peak level (5.85 thrips/three leaves) on third week of July. Mite attacked during flowering stage and invaded crop till the maturity with peak activity during third week of September (2.99 mite/cm² leaf area). Among the different weather parameters, evening relative humidity showed significant positive correlation with jassid and whitefly population. While, None of the abiotic factors found playing significant role in building up the thrips population in soybean. Mite established significant positive correlation with maximum temperature and sunshine hours. The population of *Chrysoperla* and ladybird beetle had highly significant positive correlation with jassid, whitefly and thrips incidence in soybean while, spider constructed highly significant positive correlation with jassid and thrips and significant positive correlation with whitefly.

Keywords: pests succession, sucking pests, foliage feeder, natural enemies and soybean

1. Introduction

Soybean (*Glycine max* L.) is one of the most important oil seed crop in the country grown for oil and protein production in both the *rabi* and *kharif* seasons. 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.

This crop suffers a lot due to the attack of number of insect pests [2]. It is mainly attacked by gram pod borer, *Helicoverpa armigera* Hubner; leaf eating caterpillar, *Spodoptera litura* Fabricious; green semilooper, *Chrysodeixis acuta* Walker; grey semilooper, *Amyna octo* Guenee; leaf miner, *Aproerema modicella* Deventer; whitefly, *Bemisia tabaci* Gennadius; stem fly, *Ophiomyia phaseoli* Tryon; thrip, *Caliothrips indicus*; aphid, *Aphis glycine* Koch and jassid, *Empoasca kerri* Pruthi [3].

[4] Reported over 99 insect species attacking soybean crop at Jabalpur. According to [5] 100 species of insects found to harbour the soybean at different crop stages in Uttar Pradesh. [6] reported 16 species damaging to soybean crop in Maharashtra.

2. Materials and Methods

The investigations on pests succession sucking pests on soybean (*Glycine max* L.) were carried out at Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *kharif*, 2016. The materials used and methodology adopted during the course of investigation are described hereunder.

Soybean (cv.G-SOY-1) was sown on during *kharif*, 2016 and raised by recommended agronomical practices. For recording observations twenty plants were selected randomly from plot and tagged. Observations were recorded at weekly interval during morning hours starting from second week after sowing to the maturity of the crop. Experimental area was kept free from insecticidal spray throughout the crop season.

Sucking pests (Jassid, Whitefly, Thrips)

Observations on number of sucking pests viz., jassid, whitefly and thrips were recorded at weekly interval on three leaves (top, middle and bottom) from randomly selected plants and

mean number of pest per three leaves was worked out.

Mite

Observations on number of mite (adult and nymph) present in 1 cm² leaf area each on top, middle and bottom leaf were recorded from randomly selected twenty plants.

Foliage feeder

Observations of leaf eating caterpillar, green semilooper and grey weevil (adult) were recorded from 20 randomly selected plants from experimental plot.

Termite

Total number of plants and number of plants damaged by termite were counted from each quadrat (1.5 m x 1.5 m) at weekly interval and per cent plants damage by termite was calculated.

Natural enemies

The number of predators viz., *Chrysoperla*, ladybird beetle, spider were recorded from twenty plants selected randomly from experimental plot at weekly interval.

Correlation studies

Weekly meteorological data on different abiotic factors were obtained from the Agro-meteorological Observatory of Agronomy Instructional Farm, S. D. Agricultural University, and Sardarkrushinagar. These data were utilised to work out simple correlation of the pest population and various abiotic factors. Similarly, correlation was also worked out between various pests and their natural enemies.

3. Results and Discussion

Succession of pests and their natural enemies on soybean

The study on occurrence of major pests of soybean as well as associated natural enemies was carried out on Agronomy Instructional Farm, C. P. College of Agriculture, S. D. Agricultural University, Sardarkrushinagar during *kharif*, 2016 and the results obtained are presented here under.

Sucking pests

Jassid (*Empoasca Kerri Pruthi*)

The results presented in Table 4.1 and Fig. 4.1 on occurrence of jassid on soybean revealed that the pest first appeared in the second week of July i.e. 28th standard week (1.70 jassids/three leaves). Then, its population gradually increased with the crop period and reached the peak level (5.95

jassids/three leaves) during second week of August i.e. 33rd standard week. Then after, its population declined gradually and disappeared on second week of October i.e. 41st standard week. Thus, the population of jassid ranged between 0.00 and 5.95 (Av. 3.14 jassids/ three leaves) with a one peak level during the crop period.

The activity of jassid on soybean recorded during the *kharif* season in present investigation collaborated with the reports of [7] in Sihore, (Madhya Pradesh). They observed that the population of Jassid in soybean reached the peak level in the month of August. [8] Also reported the similar activity of jassid on soybean.

Whitefly (*Bemisia tabaci* Gennadius)

The results presented in Table 4.1 and Fig. 4.1 showed that whitefly appeared during second week of July i.e. 28th standard week (1.80 whiteflies/three leaves) on soybean. Then, its population increased and reached the peak level (6.85 whiteflies/three leaves) on second week of August i.e. 33rd standard week, subsequently, it declined gradually and disappeared during second week of October i.e. 41st standard week. Thus the population of whitefly ranged between 0.00 and 6.85(Av. 3.67 whiteflies/three leaves) on soybean crop during the crop period.

In past, [9] studied the population dynamics of whitefly, *B. tabaci* on soybean and reported its peak activity in third week of August. At Giza, Egypt, [10] also observed the peak activity of whitefly during the month of August on soybean.

Thrips (*Scirtothrips dorsalis* Hood)

The results on seasonal incidence of thrips on soybean are presented in Table 4.1 and Fig. 4.1. It appeared during fourth week of July i.e. 30th standard week (1.50 thrips/ three leaves). Thereafter, it increased gradually and reached the peak level (5.85 thrips/ three leaves) during the third week of August i.e. 34th standard week. Then, it declined subsequently and occupied low level (1.20 thrips/three leaves) during the first week of October i.e. 40th standard week and finally disappeared during second week of October. Thus, the population of thrips recorded from 0.00 to 5.85 (Av. 2.70 thrips/three leaves) on soybean crop during the crop duration. Earlier, [11] recorded the incidence of thrips on soybean. They observed that thrips was active on soybean crop from the month of August to October. [12] Studied the population density of thrips on soybean in Egypt and observed very low incidence of thrips and had only one generation on soybean.



Fig 4.1: Activity of sucking pests on soybean

Mite (*Tetranychus urticae* Koch)

The results on occurrence of mite on soybean are presented in Table 4.1 and Fig. 4.2. It appeared during fourth week of August *i.e.* 35th standard week (0.35 mite/cm² leaf area). Then, its population increased and reached the peak level (2.99 mites/cm²leaf area) on third week of September *i.e.* 38th standard week. Thus the population of mite ranged between 0.00 and 2.99 (Av. 0.64 mite/cm² leaf area) on soybean crop during the course of study.

In past, [13] observed the incidence of red spider mite during the months of July to September. Initially, it was appeared in low number in the month of July and attained the peak during the end of August. Thus, the findings of present works are in accordance with the above worker.

Soil pest

Termite [*Odontotermes obesus* (Rambur)]

The results presented in Table 4.1 and Fig. 4.2 revealed that the damage of termite appeared during the first week of August *i.e.* 32nd standard week and caused 1.00 per cent damage on soybean. Thereafter damage increased gradually and reached peak level (5.10 %) during the first week of September *i.e.* 36th standard week. Then, it declined subsequently and reached low level (2.00 %) during first week of October *i.e.* 40th standard week and disappeared during second week of October *i.e.* 41st standard week. Thus the damage of termite recorded from 0.00 and 5.10 (Av. 1.76 %) on soybean crop during the course of study.

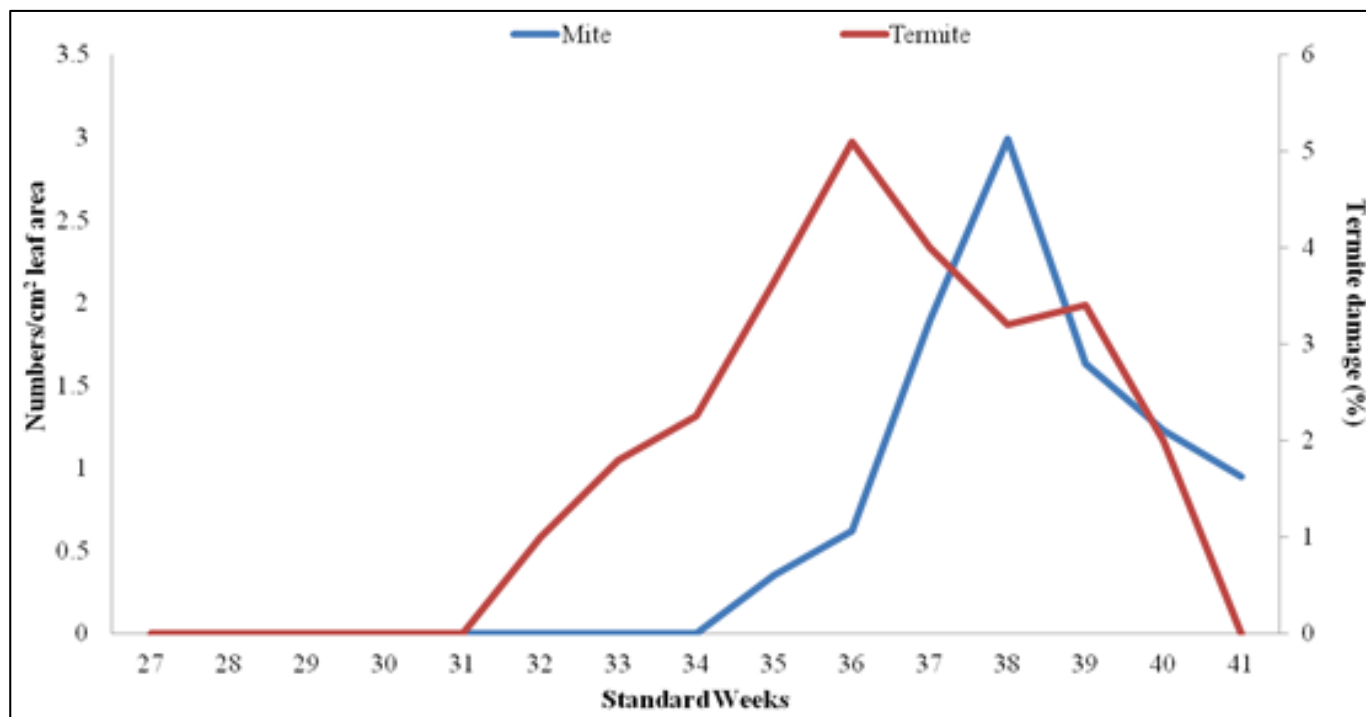


Fig 4.2: Activity of mite and termite on soybean

Foliage feeders

Leaf eating caterpillar (*Spodoptera litura* Fabricius)

The results presented in Table 4.1 and Fig. 4.3 on occurrence of leaf eating caterpillar on soybean crop revealed that the pest first appeared in the second week of August *i.e.* 33rd standard week (0.10 larva/plant). Then, its population slightly increased with the crop period and reached the peak level (0.85 larva/plant) during third week of August *i.e.* 34th standard week. Then after, it disappeared throughout the crop season. The population of leaf eating caterpillar ranged between 0.00 and 0.85 (Av. 0.08 larva/plant) on soybean crop. Thus, the incidence of leaf eating caterpillar was negligible and found for short period on soybean crop [14]. Also reported negligible incidence of tobacco caterpillar on *kharif* shown soybean at Parbhani (Maharashtra).

The results, on occurrence of *S. litura* on soybean crop recorded by above workers are in close conformity with the findings of present investigation. In contrast, [15] reported peak

activity of *S. litura* on soybean during the month of August in Hoshangabad District of Madhya Pradesh. It may be due to the environmental conditions prevailing during the course of investigation.

Green semilooper (*Chrysodeixis acuta* Walker)

The results on population fluctuation of green semilooper on soybean are presented in Table 4.1 and Fig. 4.3. The pest appeared during last week of July *i.e.* 31st standard week (0.20 larva/plant). Then its population slightly increased (0.45 larva/plant) on first week of August *i.e.* 32nd standard week. Subsequently, its population declined gradually and disappeared on third week of August *i.e.* 34th standard week. The population of *C. acuta* ranged between 0.00 and 0.45 (Av. 0.06 larva/plant) on soybean crop during the crop period. Thus, very low incidence of green semilooper was observed during the crop season.

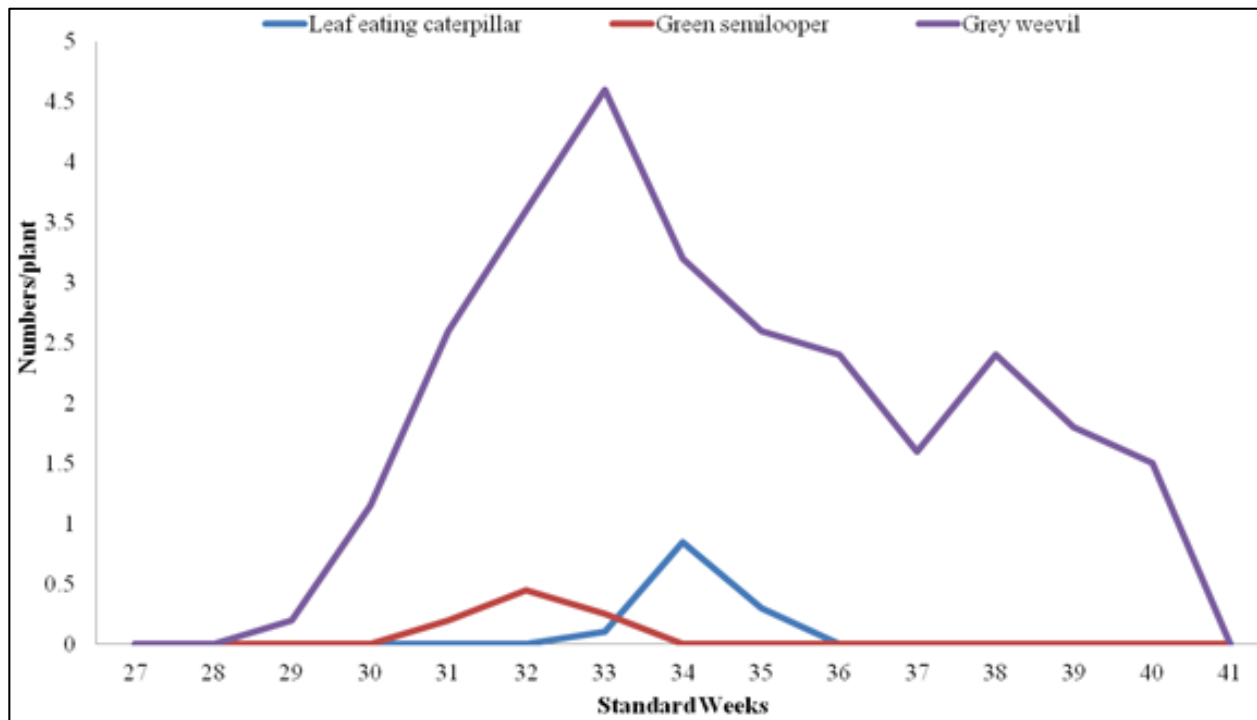


Fig 4.3: Activity of foliage feeders on soybean

Table 4.1: Periodic incidence of pests on soybean during *kharif*, 2016

SW	Month and week	Number of sucking pests/ three leaves			Number of mite/ cm ² leaf area	Number of larva/plant		Number of grey weevil/ plant	Termite Damage (%)	
		Jassid	Whitefly	Thrips		Leaf eating caterpillar	Green semilooper			
27	July	I	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
28		II	1.70	1.80	0.00	0.00	0.00	0.00	0.00	
29		III	2.85	3.35	0.00	0.00	0.00	0.20	0.00	
30		IV	3.70	4.25	1.50	0.00	0.00	1.15	0.00	
31		V	4.20	5.35	2.85	0.00	0.00	2.60	0.00	
32	August	I	5.25	6.15	4.20	0.00	0.45	3.60	1.00	
33		II	5.95	6.85	5.25	0.00	0.10	4.60	1.80	
34		III	5.50	5.40	5.85	0.00	0.85	3.20	2.25	
35		IV	5.20	5.25	5.60	0.35	0.30	2.60	3.65	
36	September	I	4.55	5.70	4.80	0.62	0.00	2.40	5.10	
37		II	3.30	4.20	3.65	1.89	0.00	1.60	4.00	
38		III	2.50	3.40	3.15	2.99	0.00	2.40	3.20	
39		IV	1.75	2.20	2.45	1.63	0.00	1.80	3.40	
40	October	I	0.70	1.25	1.20	1.23	0.00	1.50	2.00	
41		II	0.00	0.00	0.00	0.95	0.00	0.00	0.00	
Mean			3.14	3.67	2.70	0.64	0.08	0.06	1.84	1.76

[16] reported that the green semilooper was appeared on third week of July on soybean in Gird region of Madhya Pradesh. Thus, the findings of present investigation on occurrence of green semilooper on soybean are in accordance with earlier report.

Grey weevil (*Myllocerus* spp.)

The results presented in Table 4.1 and Fig. 4.3 on occurrence of grey weevil on soybean revealed that the pest appeared in the third week of July *i.e.* 29th standard week (0.20 weevil/plant). Then, its population gradually increased with the crop period and reached the peak level (4.60 weevils/plant) during second week of August *i.e.* 33rd standard week. Then after, its population declined gradually and reached the low level (1.60 weevils/plant) during second week of September *i.e.* 37th standard week. Again, it increased slightly and again occupied the low level (1.50 weevils/plant) on first week of October *i.e.* 40th standard week and disappeared on second week of October *i.e.* 41st standard

week. Thus the population of grey weevil ranged between 0.00 and 4.60 (Av. 1.84 weevils/plant) on soybean crop during crop period.

In past, [17] reported low population of *C. acuta* on early sown (June-July) soybean crop in Madhya Pradesh. Thus, the results on occurrence of grey weevil on soybean crop recorded by above workers are in close conformity with the findings of present investigations.

Natural enemies

Chrysoperla

Chrysoperla remained active on soybean crop between fourth week of July and third week of September (Table 4.2 and Fig. 4.4). It appeared during fourth week of July *i.e.* 30th standard week (0.35 adult/plant). Then, its population increased and reached the peak level (1.55 adults/plant) on third week of August *i.e.* 34th standard week. Subsequently, its population declined and disappeared on fourth week of September *i.e.* 39th standard week.

Ladybird beetle

The results presented in Table 4.2 and Fig. 4.4 on occurrence of ladybird beetle on soybean revealed that, it found active on soybean crop between fifth weeks of July to Second week of September. It first appeared in the last week of July i.e. 31st standard week (1.10 adults/plant). After increasing during the first week of August i.e. 32nd standard week (2.00 adults/plant), it declined subsequently and disappeared on third week of September i.e. 38th standard week.

Earlier, [8] and [18] observed the occurrence of ladybird beetle on soybean and reported its peak activity during the first and third week of September at Bhopal (Madhya Pradesh) and Raipur (India), respectively. Thus, the results obtained during present investigations are more or less similar to that reported by earlier workers on the occurrence of ladybird beetle on soybean.

Table 4.2: Periodic incidence of natural enemies on soybean during *kharif*, 2016

SW	Month and week		Number of natural enemies/plant		
			<i>Chrysoperla</i>	Ladybird beetle	Spider
27	July	I	0.00	0.00	0.00
28		II	0.00	0.00	0.00
29		III	0.00	0.00	0.10
30		IV	0.35	0.00	0.30
31		V	0.45	1.10	0.55
32	August	I	1.00	2.00	0.75
33		II	1.30	1.65	1.25
34		III	1.55	1.40	1.80
35		IV	1.05	1.20	2.10
36	September	I	0.75	1.05	1.40
37		II	0.55	0.40	1.25
38		III	0.50	0.00	1.00
39		IV	0.00	0.00	0.70
40	October	I	0.00	0.00	0.60
41		II	0.00	0.00	0.00

Spider

The results on spider population on soybean are presented in Table 4.2 and Fig. 4.4. It is evident from the data that the spider appeared between third week of July i.e. 29th standard week (0.10 spider/plant) and first week of October i.e. 40th standard week (0.60 spider/plant). The peak population was recorded on fourth week of August i.e. 35th standard week (2.10 spiders/plant). Thereafter, its activity declined gradually with crop period and disappeared on second week of October i.e. 41st standard week. Thus the spider remained active for longer period on soybean as compare to other natural enemies (*Chrysoperla* and ladybird beetle).

At Bhopal (Madhya Pradesh), [8] studied the activity of spider on soybean and reported its peak population during the fourth week of August [18]. Also observed the peak incidence of spider during the third week of September at Raipur, India.

Thus, the results on occurrence of spider on soybean crop recorded by above workers are in close conformity with the present findings.

Influence of abiotic factors on incidence of pests of soybean

The results obtained in respect to correlation study between pests incidence in soybean and weather parameters are presented in Table 4.3.

Jassid (*Empoasca kerri* Pruthi)

Among the different weather parameters studied, evening relative humidity showed significant positive correlation with jassid population ($r = 0.64$). Minimum temperature, morning relative humidity, wind velocity and rainfall reflected non-significant positive correlation, whereas maximum temperature and sunshine hours showed non-significant negative correlation with the jassid population (Table 4.3). Morning and evening relative humidity, minimum temperature and rainfall had positive influence on jassid population [19]. Thus, the findings of above worker are more or less similar with the results of present study.

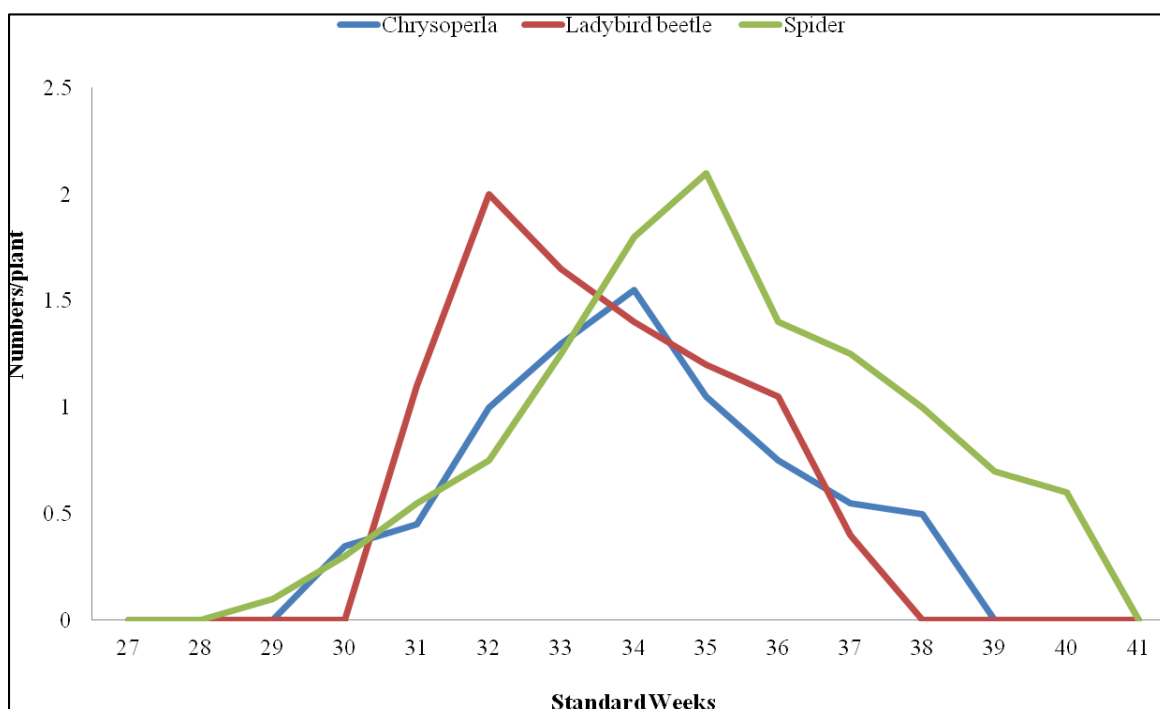


Fig 4.4: Activity of natural enemies on soybean

Table 4.3: Correlation between pests population and weather parameters during *kharif*, 2016

Sr. No.	Pests	Weather parameters						
		Temperature (°C)		Relatively Humidity		Wind velocity (km/hr)	Sunshine (hours/ day)	Rainfall (mm)
		Max.	Min.	Morn.	Even.			
1	Jassid	-0.49	0.37	0.45	0.64*	0.32	-0.36	0.26
2	Whitefly	-0.45	0.37	0.45	0.58*	0.41	-0.30	0.13
3	Thrips	-0.35	0.02	0.15	0.27	0.42	-0.15	0.23
4	Mite	0.55*	-0.22	-0.34	-0.84**	0.08	0.59*	-0.43
5	Grey weevil	-0.44	0.03	0.14	0.36	0.54*	-0.29	0.13
6	Termite	0.08	-0.22	-0.02	-0.44	0.41	0.39	-0.13

Significant at 1 per cent ($r = 0.66$); Significant at 5 per cent ($r = 0.53$).

Whitefly (*Bemisia tabaci* Gennadius)

The results presented in Table 4.3 indicated that the evening relative humidity showed significant positive correlation with whitefly population ($r = 0.58$) while, minimum temperature, morning relative humidity, wind velocity and rainfall showed non-significant positive correlation. But, maximum temperature and sunshine hours had non-significant but negative correlation with whitefly population in soybean.^[20] observed negative correlation of rainfall with population of whitefly on soybean at Jabalpur (Maharashtra). The variation in correlation of rainfall with the incidence of whitefly might be attributed to prevailing weather conditions at different locations.

Thrips (*Scirtothrips dorsalis* Hood)

Relationship between thrips incidence and weather parameters indicated that none of the abiotic factors found playing significant role in building up the thrips population in soybean.

At Junagadh, Gujarat^[21] observed non-significant relation of insect pests population with temperature, sunshine hours, rainfall and rainy days which supported the findings of present investigation.

Mite (*Tetranychus urticae* Koch)

The results on correlation study of mite population with abiotic factors revealed that mite population established significant positive correlation with maximum temperature ($r = 0.55$) and sunshine hours ($r = 0.59$) whereas, evening relative humidity ($r = -0.84$) showed significant negative correlation with mite population.

Grey weevil (*Mylocerus* spp.)

The population of grey weevil exhibited non-significant relationship with all abiotic parameters except wind velocity ($r = 0.54$) which was significant positively correlated with grey weevil incidence on soybean. However, minimum temperature, relative humidity and rainfall were non-significant, but positively correlated to the incidence of grey weevil.

Termite (*Odontotermes obesus* Rambur)

None of the weather parameters developed significant relation with termite damage in soybean. It was positively correlated with temperature, wind velocity and sunshine hours indicated their favorable role in termite damage^[19]. Reported that none of the weather parameters played significant role on damage incidence of termite in soybean is in closely conformity with findings of present study.

Influence of biotic factors on incidence of sucking pests of soybean

The results in respect to correlation study between sucking

pests and their natural enemies are presented in Table 4.4.

Table 4.4: Correlation between pest population and natural enemies during *kharif*, 2016

Sr. No.	Pests	Natural enemies		
		<i>Chrysoperla</i>	Ladybird beetle	Spider
1	Jassid	0.88**	0.85**	0.67**
2	Whitefly	0.82**	0.83**	0.63*
3	Thrips	0.91**	0.79**	0.93**

Significant at 1 per cent ($r = 0.66$); Significant at 5 per cent ($r = 0.53$).

Chrysoperla

It can be seen from the results that population of *Chrysoperla* had highly significant positive correlation with jassid ($r = 0.88$), whitefly ($r = 0.82$) and thrips ($r = 0.91$) incidence. The population of *Chrysoperla* increased with increase in incidence of jassid, whitefly and thrips.

Earlier,^[19] reported that *Chrysoperla* showed significantly positive association with jassid, whitefly and thrips population at Sardarkrushinagar (Gujarat) which closely supported the findings of present investigation.

Ladybird beetle

It is evident from the data that ladybird beetle showed highly significant positive correlation with jassid ($r = 0.85$), whitefly ($r = 0.83$) and thrips ($r = 0.79$) population on soybean.

The results obtained during present investigations are in conformity with those reported by^[19] at Sardarkrushinagar. He observed that ladybird beetle had significant positive correlation with population of sucking pests on clusterbean.

Spider

Spider constructed highly significant positive correlation with jassid ($r = 0.67$) and thrips ($r = 0.93$) and significant positive correlation with whitefly ($r = 0.63$) in soybean.

Earlier,^[22] noted that spider had significant positive correlation with jassid, whitefly and thrips population at Sardarkrushinagar (Gujarat). The observations, made in the present study are in accordance with the finding of earlier worker.

It is clear from the data that the population of natural enemies had highly significant positive association with the sucking pest population. This indicates that as the population of insect pests increased in the soybean, the populations build up of their natural enemies also increased numerically.

4. Conclusion

It can be summarized from the results that eight pests and three natural enemies were found active on soybean crop. Among the sucking pests, soybean crop invaded first by jassid and whitefly which appeared on second week of July *i.e.* 28th standard week. Their population increased gradually and

reached the peak level during second week of August *i.e.* 33rd standard week. Though, thrips appeared later on crop during fourth week of July *i.e.* 30th standard week and reached the peak level on third week of July *i.e.* 34th standard week. Mite attacked during flowering stage and invaded crop till the maturity. Among foliage feeder leaf eating caterpillar and green semilooper associated with crop for short period during the flowering and pod formation stage of crop with very low population. Grey weevil also found feeding the crop for longer period. As a soil pest, termite harboured during first week of August and invaded crop till the harvesting. The results further revealed that soybean crop suffered for quite long by whitefly and jassid as sucking pests and grey weevil as foliage feeder while, thrips, leaf eating caterpillar, green semilooper, mite and termite remained active relative for shorter period. The order of occurrence of the pests on soybean was jassid = whitefly > grey weevil > thrips > green semilooper > termite > leaf eating caterpillar > mite.

Based on duration of occurrence and intensity, jassid, whitefly, thrips and grey weevil were designated as major pests whereas, leaf eating caterpillar, green semilooper, mite and termite achieved a status of minor pests on soybean.

Among the natural enemies the insect predators (*Chrysoperla* and ladybird beetle) found active between fourth week of July and third week of September, while non-insect predator, spider found active from fourth week of July to first week of October. Thus, from the forgoing discussion, it can be inferred that the high incidence of pests and natural enemies concentrated during the month of August in *kharif* sown soybean crop.

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