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Seasonal incidence of insect pests on soybean and impact of various abiotic factors on their incidence

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Abstract
Field experiment on seasonal incidence of insect pests on soybean and impact of various abiotic factors on their incidence was conducted during *kharif* season of 2019 on soybean crop at College of Agriculture, Dhule. The present investigation was carried out with an object to study the seasonal incidence of insect pests on soybean and their natural enemies and their correlation with the weather parameters. During seasonal abundance study, the tobacco leaf eating caterpillar reached its peak activity during third week of September (13.67/mrl), where the peak incidence of green semilooper was also noticed in the third week of September (8.67/mrl). The peak infestation of girdle beetle recorded during third week of August (3.40 %). The peak incidence of Aphids recorded during the fourth week of August (18.40/ 5cm twig). The peak incidence of Jassids recorded during the second week of September (6.40/3 leaves). The peak incidence of White flies recorded during the fourth week of August (2.20/3 leaves). The activity of predator cocconelid beetle was its peak during fourth week of August (3.33/plant). However, the correlation between incidence of tobacco caterpillar, green semilooper, girdle beetle, aphids, jassids, white flies and coccinellid predators were negatively non-significant correlation with minimum temperature and wind speed while maximum temperature, morning and evening relative humidity showed positively non-significant correlation. The correlation between incidence of tobacco caterpillar, green semilooper, girdle beetle, aphids, jassids, white flies and coccinellid predators were positively significant correlation with rainfall, rainy days and evaporation while significantly negative correlation with sunshine hours.

Keywords: soybean insect pests, seasonal incidence, abiotic factors, tobacco leaf eating catterpillar, green semilooper, girdle beetle

Introduction
Soybean (Glycine max (L.) Merril) is known as the “Golden Bean” of the twentieth century. It has emerged as an important commercial crop in many countries and international trade of soybean is spread globally. It occupies an area of 108.39 lakh ha and its production is 114.83 lakh MT. Madhya Pradesh ranks first in total area (54.09 lakh ha and 51.50%) and production (59.170 lakh MT and 70.06%) in the country and is known as “soya state” in India (SOPA 2018). The luxuriant crop growth, soft and succulent foliage attracts many insects and provides unlimited source of food, space and shelter. More than 150 insect pests cause damage to soybean in various parts of Maharashtra in different stages of crop, and damage due to these insect-pests is one of major constrains for soybean production.
Recently, emphasis is being given on ecological based pest management strategies. The main components of any pest management programme is to study the incidence period of the pest, population distribution on crop and regular monitoring or survey of field. Seasonal incidence studies helps in planning need based application of insecticides as it clearly reveals the insect’s peak activity as well as insect free periods during crop growth. The insect pest population shows fluctuations depending on various abiotic (environmental factors) and biotic (natural enemies) factors of an area. In the current experiment an attempt was made to know the effect of abiotic factors on the pest population trend on soybean crop during *kharif* 2019.

Materials and Methods
The field experiment was conducted during *kharif* season of 2019, at the experimental farm of Entomology Section, College of Agriculture, Dhule-424004, (Maharashtra). In the experiment, the variety Phule Sangam was grown for this study. Later the seeds were sown in main field

with a spacing of 45 × 10-15 cm^2 and all the agronomical practices *viz.* fertilizer application and intercultural operations were followed as recommended for soybean crop in this area to raise the crop. No chemical pesticides were applied throughout the crop period to get a natural pest incidence on the crop.

Seasonal incidence of insect pests on soybean was studied on a separate plot of $100m^2$. The pest population was recorded in this unprotected plot at 7 days interval from the occurrence or initiation of pest infestation and was continued up to maturity. Weekly observations on seasonal incidence of soybean pests were recorded from sowing to till maturity. In case of Sucking pests number of aphids from 5 cm terminal twigs, No. of white flies and jassids from three leaves (upper, middle, bottom part of the plants) and population of thrips were recorded from 5 tender shoots of plant of five randomly selected tagged plants were recorded. The population of tobacco leaf eating caterpillar and green semilooper were recorded separately. The average larval population per meter row length was recorded from randomly selected three locations of one meter row length, during early in the morning. Observation on girdle beetle was recorded on randomly selected 100 plants from unsprayed plot and from that healthy and affected plants were counted for calculating the percent infestation of girdle beetle. Observations on the predators *viz.*, coccinellids, chrysopa and spider were recorded from randomly selected three locations of one meter row length. Weekly data of pest population were correlated with the prevailing climatic factors such as maximum Temperature, minimum temperature, morning and evening relative humidity, rainfall and natural enemy population prevailing in the field. The correlation coefficient (r) analysis was carried out by using Microsoft Excel software.

Results and Discussion

Seasonal incidence of insect pests, predators and the influence of thermohygro parameters *viz.* temperature (maximum and minimum), relative humidity (morning and evening), rainfall, rainy days, sunshine hrs., evaporation and wind speed on population of pests and predators were assessed and presented in Table 3 and depicted in Fig 3.. It is evident from the data that the occurrence of tobacco caterpillar commenced from 32nd SMW and continued till 41st SMW which ranged from 0.70 to 13.67 larvae/mrl. The population was above ETL (4 larvae/mrl) during 34th SMW onwards. The incidence of tobacco leaf eating caterpillar was gradually increased from first week of August 2019 (0.70 larvae/mrl) to third week of September (13.67 larvae/mrl). The population was decreased in next one week from 13.67 larvae/mrl to 1.33 larvae/mrl, due to maturity of crop. It indicates that green semilooper population was commenced from 33th SMW and continued till 40th SMW which ranged from 1.33 to 8.67 larvae/mrl and exist in the field with 8.67 larvae/mrl during 38th SMW. The population was above ETL (2 larvae/mrl) during 34th SMW onwards. The incidence of green semilooper was gradually increased from second week of August 2019 (1.67 larvae/mrl) to third week of September (8.67 larvae/mrl). The population was decreased in next two weeks from 8.67 larvae/mrl to 1.33 larvae/mrl, due to the maturity of crop. The data on percent infestation of girdle beetle is presented in Table 3. It indicates that percent infestation of girdle beetle was commenced from 33rd SMW and continued till 36th SMW which ranged from 1.40 to 3.40 percent and exist in the field with3.40 percent during 34th SMW. Data presented revealed that the aphids commenced from third week of August 12.80 aphids/5 cm twig/plant and gradually increased up to fourth week of September (i.e. 18.40 aphids/5 cm twig/plant). There was a gradual decreased in population in third week of October and subsidized next two weeks, due to maturity of crop. Data revealed that the white fly commenced from second week of August 0.60 whiteflies/3 leaves/plant and gradually increased up to first week of September (2.20 whiteflies/3 leaves/plant). There was a gradual decreased in population in second week of September and subsidized next four weeks, due to rainfall and maturity of crop. Jassids commenced from fourth week of August 2.40 jassids/3 leaves/plant and gradually increased up to second week of September (6.40 jassids/3 leaves/plant). There was a gradual decreased in population in third week of September and subsidized next four week, due to rainfall and maturity of crop. The population of coccinelid beetle was noticed during fourth week of August then it gradually increased and reached (3.67/plant) in second week of September. The population of coccinelid beetle was directly dependent upon the incidence level of aphids and jassids in field. Data from present findings revealed that the incidence of tobacco leaf eating caterpillar, green semilooper, girdle beetle and sucking pests *viz*., aphids, jassids and white flies and natural enemies like coccinelid beetles were recorded during kharif season 2019. The result of this findings are reported by various researchers [9, 12, 13].

The present findings are in a conformation with the peak incidence of tobacco caterpillar in second week of September [4 and 13]. Similarly the peak incidence of green semilooper was recorded in second fortnight of August [2 and 8]. Hence, these results are in confirmation with present investigation. The present findings are in a conformation with the peak incidence of whitefly recorded in second week of August [2].

Correlation of weather parameters with pests of soybean

The data on average population of tobacco caterpillar, green semilooper, jassids and whiteflies recorded under field conditions were correlated with meteorological parameters such as maximum temperature, minimum temperature, relative humidity, rainfall, rainy days, Sunshine, evaporation and wind speed and also Pearson correlation coefficient values (r) were computed. These are narrated in Table 2**.**

The correlation between incidence of tobacco caterpillar (r = -0.563 & -0.477), green semilooper (r =-0.563 & -0.477), girdle beetle (r =-0.563 & -0.477), aphids (r =-0.563 & -0.477), jassids (r =-0.563 & -0.477), white flies (r =-0.563 & -0.477) and coccinellid predators (r =-0.563 & -0.477) were negatively non-significant correlation with minimum temperature and wind speed, respectively. The maximum temperature showed positively non-significant correlation with tobacco caterpillar (r = 0.163), green semilooper (r =0.091), girdle beetle (r =0.293), aphids (r =0.133), white flies (r =0.128) and coccinellid predators(r=0.005) while negatively non-significant with jassids (r=-0.184).The correlation between incidence of tobacco caterpillar (r = 0.213 & 0.300), green semilooper (r = 0.213 & 0.300), girdle beetle (r = 0.213 & 0.300), aphids (r = 0.213 & 0.300), jassids (r = 0.213 & 0.300), white flies (r = 0.213 & 0.300) and coccinellid predators (r = 0.213 & 0.300) were positively non-significant correlation with morning and evening relative humidity. The correlation between incidence of tobacco caterpillar (r = 0.676, 0.744 & 0.681), green semilooper ((r = 0.676, 0.744 & 0.681), girdle beetle (r = 0.676, 0.744 & 0.681), aphids ((r = 0.676, 0.744 & 0.681), jassids (r = 0.676,

0.744 & 0.681), white flies (r = 0.676, 0.744 & 0.681) and coccinellid predators (r = 0.676, 0.744 & 0.681) were positively significant correlation with rainfall, rainy days and evaporation while significantly negative correlation with sunshine hours (r =0.752).

The temperature and evaporation were found to be significantly positively correlated with whitefly population during kharif season [7]. Similar findings at par with present results that evening R.H. showed positive correlation but morning R.H. and sunshine hours showed negative correlation, statistically non-significant with peak aphid infestation [6]. The correlation studies revealed that sunshine hours showed significant positive correlation with stem tunnelling [3]. The population of lady bird beetle on second week of August and population showed statistically non-significant positive correlation with temperatures, but negatively correlated with relative humidity which is partial conformity with the present findings [2]. The peak activity of green semilooper, *Chrysodeixis acuta*; (0.7 larvae per meter row) observed during second fortnight of August [2 and 10]. The green semiloooper recorded a peak of 3.00 larvae/ mrl during 34th MW [14]. The peak larval population of tobacco caterpillar (*Chrysodexis acuta*) observed at 34th SW when maximum and minimum temperature was 32°C and 28.2°C, respectively [1]. There was no significant correlation exhibited between the larval population and weather parameters. It is observed that maximum level of Trichoplusia ni population attained during 39th SW showed significant positive correlation with minimum temperature and evening relative humidity in black gram [13]. The results revealed that the maximum incidence of tobacco caterpillar in soybean crop was recorded during 41st SMW and 42nd SMW, respectively [5]. The maximum temperature and sun shine hours showed a significant positive correlation with the larval population of tobacco caterpillar while, significant negative correlation with rainfall during both the years. Whereas, maximum temperature had significant positive impact on population of tobacco caterpillar while rainfall had significant negative effect. It is observed that semilooper larval population was recorded late July/ early August and their peak activity observed during 33-34, 33-36 and 37-39 standard weeks, in 2012, 2013 and 2014, respectively [11]. Among the weather factors, morning relative humidity showed significant (r = 0.954) and positively, highly influence on the larval population per mrl whereas evening humidity (r = -0.644) and sunshine hrs (r = 0.367) negatively and significantly influence the larval population per mrl. The various weather parameters significantly caused 92 percent variations in larval population per mrl. The findings of these researchers are in partial agreement as they did not study completely similar to present investigation. Further the climatic conditions vary place to place which affect the activities of insect pests.

Table 1: Seasonal incidence of the insect pests on soybean during *kharif* 2019

SMW	Month/ Date	No. of tobacco leaf eating caterpillar/mrl	No. of Green semilooper/ mrl	% infestation of girdle beetle	No. of aphids/ 5cm twigs	No. of Jassid/3 leaves	No. of white flies /3 leaves	No. of Coccinelid preadators/ plant	Temperature (^{0}C)		Relative Humidity (%)		Rainfall (mm)	Rainy days	Sunshine (hrs.)	Evaporation (mm)	Wind speed (kmp)
									Max	Min	Morn	Eve					
31	30-05	0.00	0.00	0.00	0.00	0.00	0.00	0.00	28.2	22.1	88.7	83.6	66.4	5	0.3	1.2	5.8
32	Aug19 06-12	0.70	0.00	0.00	0.00	0.00	0.00	0.00	28.9	21.4	91	75.3	97.4	5	1.8	1.7	4.5
33	13-19	2.67	1.67	2.80	0.00	0.00	0.60	0.00	31.6	20.8	88	59	15.7	3	3.3	4.3	3.2
34	20-26	4.67	3.67	3.40	12.80	0.00	1.60	0.00	32.4	21.1	84	62	9.3	1	3.6	3.9	5
35	27-02	6.33	2.67	2.20	18.40	2.40	2.20	3.33	31.1	20.9	91	62	75	3	3	3.5	2.4
36	Sep19 03-09	9.33	5.33	1.40	16.60	3.40	2.20	2.67	31.4	21.7	93	72	42.6	2	1.4	2.9	2.3
37	10-16	11.33	7.67	0.00	14.40	6.40	1.40	3.67	29.6	21	90	75	37.8	4	0.8	2.1	3.8
38	17-23	13.67	8.67	0.00	9.80	3.10	1.20	1.67	32	21	92	61	37.8	4	4.6	3.2	3
39	24-30	8.33	3.33	0.00	8.80	0.80	0.00	1.67	31	20.5	93	70.4	35.8	2	3.5	2.5	2.2
40	Oct19 01-07	5.67	1.33	0.00	6.40	0.00	0.00	2.67	32.5	20.2	90	55	34.2	1	7.1	4	2.8
41	08-14	1.33	0.00	0.00	0.00	0.00	0.00	0.00	32.7	19.1	88.7	45.4	0	0	8.2	3.7	1.6
42	15-21	0.00	0.00	0.00	0.00	0.00	0.00	0.00	32	17.7	88.1	49.9	14.8	2	4.7	3	1.9

SMW= standard meteorological week.

(The pest population is of respective week while weather parameters are of previous week)

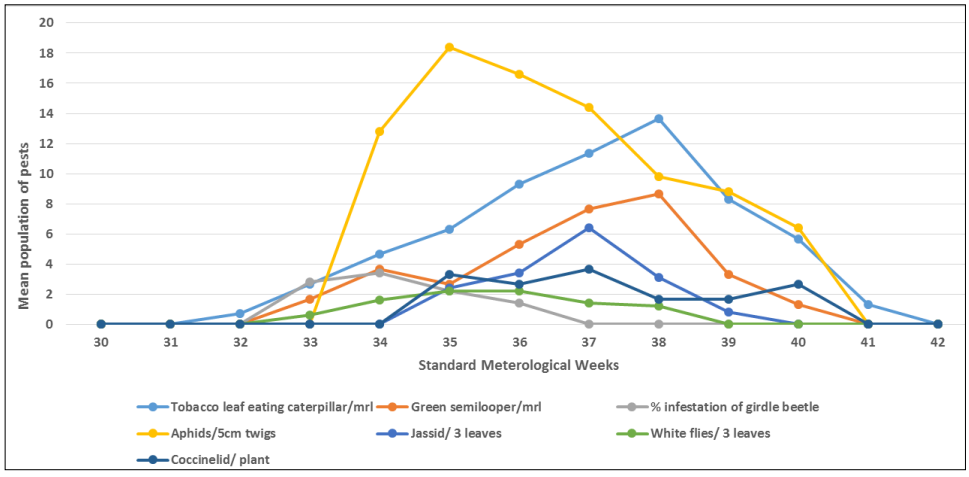

Fig 1: Seasonal incidence of the insect pests on soybean during *kharif* 2019

Table 2: Correlation of insect pests population on soybean with weather parameters

Pests	Correlation coefficient values (r)								
	Temperature (oC)		Relative humidity (%)		Rainfall (mm)	Rainy days	Sunshine (hrs.)	Evaporation (mm)	Wind speed (KMP)
	Maximum	Min.	Morning	Evening					
Tobacco leaf eating caterpillar	0.163$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$
Green semilooper	0.091$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$
Girdle beetle	0.293$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$
Aphids	0.133$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$
Jassid	-0.184$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$
White fly	0.128$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$
Coccinelid preadators	0.005$^{(NS)}$	-0.563$^{(NS)}$	0.213$^{(NS)}$	0.300$^{(NS)}$	0.676*	0.744**	-0.752**	0.681*	-0.477$^{(NS)}$

*- significant at 5% level (p+=0.05) = 0.576, **- significant at 1% level (p+=0.01) = 0.708

Conclusion

Studies on seasonal incidence of insect pests and their natural enemies of soybean crop provide basic information about seasonal occurrence of insect pest and their predators. Statistically significant correlation and regression values indicate that population of pests fluctuates with weather parameters. This provides an opportunity for the development of management strategies significant for the control of these pests. These results will support in devising the pest monitoring system and ecological sound integrated pest management modules. The correlation between incidence of tobacco caterpillar, green semilooper, girdle beetle, aphids, jassids, white flies and coccinellid predators were negatively non-significant correlation with minimum temperature and wind speed while maximum temperature, morning and evening relative humidity showed positively non-significant correlation.

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