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Seasonal incidence of lepidopteran defoliators of soybean [*Glycine max* (L.) Merrill]

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Abstract
The present investigation on "Seasonal Incidence of Lepidopteran Defoliators of Soybean [*Glycine max* (L.) Merrill]" was conducted during *kharif*, 2019 at ARS, Ummedganj, Agriculture University, Kota. The results revealed that the occurrence of red hairy caterpillar was started in the last week of July, while tobacco caterpillar, green semilooper, gram pod borer and bihar hairy caterpillar appeared on the crop slightly late *i.e.* first week of August. The peak larvae of red hairy caterpillar (2.0/mrl), bihar hariy caterpillar (2.4/mrl) and green semilooper (3.2/mrl) larvae were found in the first week of September. Whereas, the peak of gram pod borer (1.4/mrl) was recorded in second week of September. The correlation study reveals that the red hairy caterpillar population was positively significant correlated with temperature. Whereas, the infestation of tobacco caterpillar and bihar hairy caterpillar was significantly negative correlated with rainfall.

Keywords: Seasonal, incidence, tobacco caterpillar, defoliator, green semilooper, red hairy caterpillar, correlation, peak, infestation

Introduction
Soybean [*Glycine max* (L.) Merrill] is one of the most important oilseed commercial crop of India. It is world's most useful and cheapest sources of protein (Akinyele and Harshbarger, 1983) [1], vitamins, minerals, carbohydrate and other ingredients. Soybean is a leguminous crop mainly but seeds widely used as oilseed. It contains 40% protein, well balanced in essential amino acids; 20% oil, rich in poly unsaturated fats specially Omega 6 and Omega 5 fatty acids; 6-7% total minerals; 5-6% crude fiber and 17-19% carbohydrates (Chauhan and Joshi, 2005) [9]. Madhya Pradesh, Maharashtra and Rajasthan covers an area 52.4, 39.3, and 9.3 lakh ha, respectively. The Rajasthan state stands third occupying the soybean area and second in productivity (1244 kg/ha). The crop covers 92 to 93 per cent area and production by these three states Madhya Pradesh, Maharashtra and Rajasthan (Anonymous, 2018) [2].
There are many problems in cultivation of soybean in India as well as Rajasthan, as all stages of this crop are prone to heavy infestation by insect-pest complex. The crop is infested by more than 275 insect pests throughout its growth stage from germination to matrity (Babu *et al.*, 2017) [3]. In India, 20 insect species have been recorded major pests infesting soybean crop (Singh and Singh, 1990) [13]. Among borers, girdle beetle (*Obereopsis brevis* Swed.) is predominant, among defoliators, tobacco caterpillar (*Spodoptera litura* Fabricius) and green semiloopers (*Chrysodeixis acuta* Walker) are predominant. Immature stages (larva or caterpillar) of both tobacco caterpillar and green semilooper damage the crop mostly at vegetative stage and in severe case, it completely defoliates the crop resulting drastic yield loss. *Spodoptera litura* larvae even damage to soybean pods also (Chaturvedi *et al.*, 1998 and Singh *et al.*, 2000) [8, 14]. Therefore, the present study of the insects-pests and their relative occurrence with reference to different crop stages was conducted, to determine the management strategy pertaining to their nature of damage at most vulnerable or susceptible crop stage so that feasible and economic control measure can be determined for their effective and economic management in the crop.

Materials & Methods
The field experiment to investigate the Seasonal Incidence of Lepidopteran defoliators of Soybean [*Glycine max* (L.) Merrill]" was conducted during *kharif*, 2019 at ARS, Ummedganj, Kota. The experiment was laid out in plots measuring 4.2 m x 5 m (21 m^2) replicated thrice. Soybean variety JS-335 was sown in the second week of July, *kharif* 2019 after onset of

monsoon which is a general practice of sowing in the region adopting all agronomical practices required for raising the crop. Observation of defoliators *i.e.* green semilooper (*Chrysodeixis acuta*), red hairy caterpillar (*Amsacta mooreii*), bihar hairy caterpillar (*Spilosoma obliqua*), tobacco caterpillar (*Spodoptera litura*) and *Helicoverpa armigera* was recorded by counting the number of larvae found in one meter row length area by using '*Vertical Beat Sampling Technique'*. Such five observations were taken at weekly interval from randomly selected places plot wise (leaving border rows) and mean number of larvae per meter row length was calculated.

Simple correlation was worked out between the population of insect pests and abiotic factors by the Karl Pearson's coefficient of correlation formula (Steel and Torry, 1980) [15]:

$$r_{xy} = \frac{\sum XY - \frac{\sum X \sum Y}{n}}{\sqrt{\left[\sum X^2 - \frac{(\sum X)^2}{n}\right]\left[\sum Y^2 - \frac{(\sum Y)^2}{n}\right]}}$$

Where,

r_{xy} = Simple correlation coefficient

X = Variable *i.e.* abiotic component.

(Average temperature, relative humidity and total rainfall)

Y = Variable *i.e.* mean number of insect pests per plant

n = Number of observations.

The correlation coefficient (r) values were subjected to the test of significance using t-test:

$$t = \frac{r}{\sqrt{1-r^2}} \times \sqrt{n-2} \sim t_{n-2} \text{ d.f.}$$

The calculated t-value obtained was compared with tabulated t-value at 5% level of significance.

Results & Discussion

The infestation of tobacco caterpillar, *S. litura* was initiated in the first week of August and touched its peak with 2.4 larvae/mrl in the third week of September (Table 1 & Fig. 1). Thereafter the population declined gradually. The population of tobacco caterpillar exhibited negatively significant correlation with rainfall (r = -0.67). The present finding is accordance with the results obtained by Babu *et al.* (2015) [4] who reported that population of *S. litura* was active from August to mid-October and peak was during third week of September 1.47 larvae/mrl third week of September. The correlation study was also supported by Brahman *et al.* (2018) [7], who reported that negative significant correlation (r = -0.570) between rainfall and *S. litura*.

The infestation of green semilooper commenced from first week of August and reached on peak (3.2 larvae/mrl) during first week of September (Table 1 & Fig. 1). The correlation between its population with temperature (r = 0.21) and relative humidity (r = 0.22) having positively non-significant trend, while correlation with rainfall (r = -0.50) was negatively non-significant. The present findings are in line of Babu *et al.* (2017) [3], who observed that semilooper larval population was started in late July/early August and peak was during 36 standard weeks. Brahman *et al.* (2018) [7], also reported a gradual increasing trend in the population of *C. acuta* which reached maximum during 36th SMW. Similarly, Shinde *et al.* (2018) [12] also observed association of semilooper with all-weather parameter as non-significant.

The population of *H. armigera* appeared in first week of August and peak population (1.4 larvae/mrl) was observed in second week of September (Table 1 & Fig. 1). The larvae of *H. armigera* has positively non-significant correlation with temperature (r = 0.05) and mean relative humidity (r = 0.37), whereas, negatively non-significant correlation with rainfall (r = -0.27). The similar study was supported by Gadhiya *et al*. (2014) [10] that exhibited *H. armigera* on groundnut has significant positive correlation with temperature. Shinde *et al*., (2018) [12] also reported that relation between population of *H. armigera* and all abiotic weather factors was non-significant. Bangale *et al.* (2019) [5] observed that incidence of *H. armigera* (0.36 larvae/plant) commenced from 3rd week of July and touched at peak level (2.4 larvae/plant) in 1st week of September.

The red hairy caterpillar, *A. moorei* was observed throughout the crop growth period and its peak population as 2.0 larvae/mrl during first week of September (Table 1 & Fig. 1). The red hairy caterpillar population was positively significant with temperature (r = 0.53). The correlation with mean relative humidity (r = 0.23) was positively non-significant, while with rainfall (r = -0.06) was negatively non-significant. The results of investigation are in acquiescence with the findings of Rahmathulla *et al.* (2015) [11], who reported that the peak incidence of red hairy caterpillar (*A. moorei*) during the rainy season. The correlation of the incidence of *A. moorei* (r = -0.737) was positively correlated with maximum relative humidity.

The infestation of Bihar hairy caterpillar commenced in first week of August and maximum population as 2.4 larvae/mrl was found during first week of September (Table 1 & Fig. 1). The correlation between larvae of bihar hairy caterpillar population and rainfall was negatively (r = -0.38) non-significant. The correlation with temperature (r = 0.41) and relative humidity (r = 0.23) was positively non-significant. Similar results were also obtained by Yadav *et al.* (2015) [16], who reported that larval population of *S. obliqua* has negative correlation with rainfall. Same result was obtained by Bhamare *et al.* (2019) [6], who found that rainfall (-0.7043*) showed negative correlation with larval population of *S. obliqua* in sole sunflower.

Table 1: Seasonal incidence of lepidopteran defoliators infesting soybean during *kharif*, 2019

SMW No.	Period From - To	Mean temp. (°C)	Mean RH (%)	Rainfall (mm)	Larval Population of lepidopteran defoliators (mrl)				
					Spodoptera litura	*Chrysodeixis acuta*	*Helicoverpa armigera*	*Amsacta moorei*	*Spilosoma obliqua*
30	23 July – 29 July	28.7	81.0	246.0	0.0	0.0	0.0	0.4	0.0
31	30 July – 05 Aug	28.7	76.4	116.0	0.6	0.4	0.2	0.8	1.4
32	06 Aug -12 Aug	28.1	80.5	148.5	0.4	0.6	0.0	0.6	0.8
33	13 Aug -19 Aug	26.4	87.7	331.0	0.8	0.8	0.6	0.8	0.4
34	20 Aug -26 Aug	28.2	74.8	30.0	1.2	2.2	1.0	1.0	1.8
35	27 Aug – 2 Sep	28.3	78.9	57.0	1.6	2.4	0.8	1.4	1.6
36	03 Sep – 09 Sep	29.1	86.9	32.0	1.8	3.2	1.2	2.0	2.4
37	10 Sep – 16 Sep	28.2	86.9	91.0	2.0	2.4	1.4	1.0	2.0
38	17 Sep – 23 Sep	27.2	79.3	26.5	2.4	2.2	1.0	0.6	0.8
39	24 Sep – 30 Sep	26.1	87.5	23.2	1.8	1.8	1.2	0.8	1.6
40	1Oct.- 7 Oct.	28.0	75.5	0.0	1.6	1.6	0.8	1.0	0.6
41	8 Oct – 14 Oct	27.4	80.2	0.0	1.6	1.0	0.0	0.0	1.2
42	15 Oct – 21 Oct	26.3	79.7	0.0	1.2	0.6	0.0	0.0	0.0
Coefficient of correlation (r) for population and mean atm. temp.					-0.21	0.21	0.05	0.53*	0.41
Coefficient of correlation (r) for population and mean RH					0.18	0.22	0.37	0.23	0.23
Coefficient of correlation (r) for population and total rainfall					-0.67*	-0.50	-0.27	-0.06	-0.38

* Significant at 5% level of significance

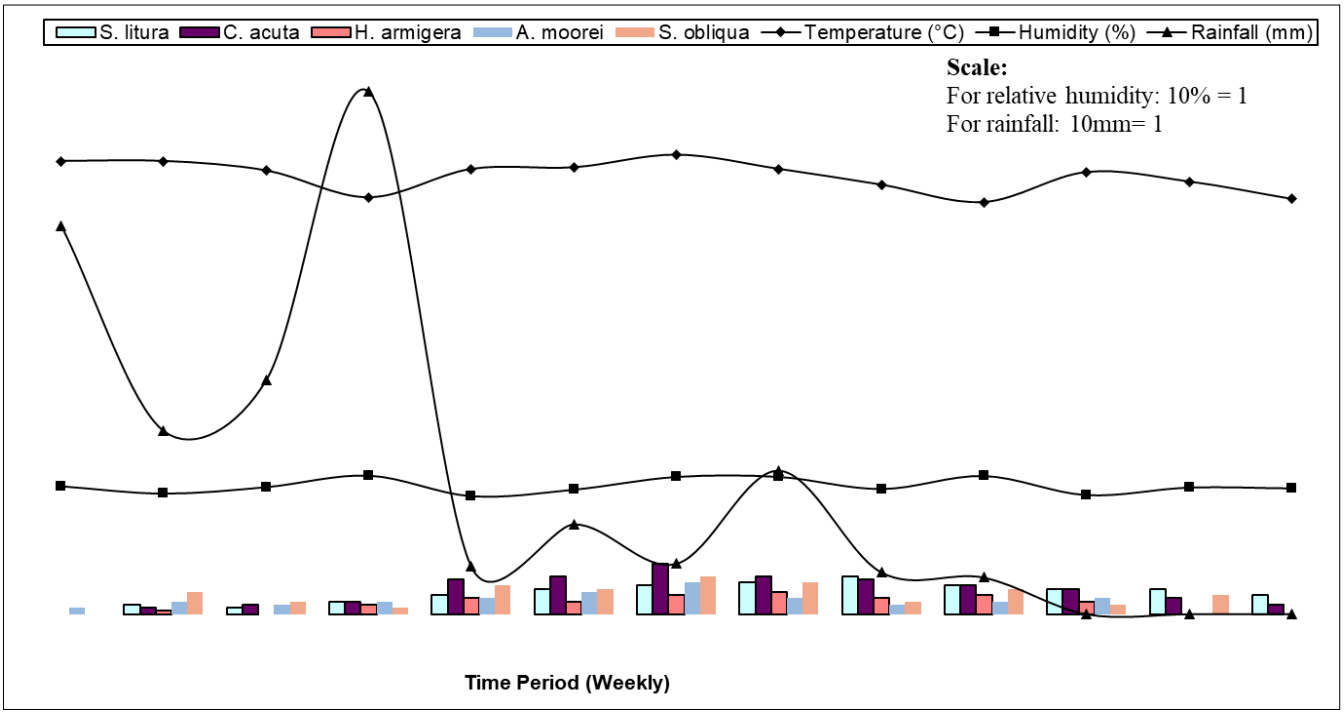

Fig 1: Seasonal incidence of lepidopteran defoliators infesting soybean during *kharif*, 2019

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