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Studies on insect-pests of soybean (*Glycine max*) with special reference to seasonal incidence of lepidopteran defoliators

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Abstract
The field experiment was conducted at BTC College of Agriculture and Research Station, Bilaspur, Chhattisgarh, during 2016-17. Study about seasonal incidence of pre-dominant lepidopteran insect-pests in soybean crop the soybean leaf folder (*Omiodes indicata* Fab.), tobacco caterpillar (*Spodoptera litura* Fab.), green semilooper (*Chrysodexis acuta* Walker), leaf webber (*Anarsia ephippias* Mullar) and pod borer (*Helicoverpa armigera* Hub.) were major defoliator insect causing damage at various growth stages of the soybean crop. The peak activity of *Omiodes indicata* Fab. (1.67 larvae/mrl) and *Spodoptera litura* Fab. (1.47 larvae/mrl) were observed during third week of September. Whereas, *Chrysodeixis acuta* (1.0 larvae/mrl), *Anarsia ephippias* (0.6 larvae/mrl) and *Helicoverpa armigera* (0.67 larvae/mrl) were recorded during first week of September, third week of August and fourth week of August, respectively.

Keywords: seasonal incidence, peak activity, lepidopteran defoliator and soybean

Introduction
Soybean [*Glycine max* (L.) Merrill] belonging to family Leguminaceae, sub-family Papilionaceae, is one of an important oilseed cash crop of India. It is a unique crop with high nutritional value, thus it also known as "Miracle bean, Golden bean, and Crop of the planet". It has provide 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) [7]. Total area of soybean in India is 10.91 million ha. with production of 10973.80 mt in 2015 with an average national yield of 951 kg/ha. Soybean occupied 42% of India's total oilseeds and 25% of edible oil production (Anonymous, 2015) [3]. In Chhattisgarh, the total area of soybean is 1.34 lakh ha. with 1.307 thousand MT production in 2016 with an average yield of 975 kg (Anonymous, 2016) [4]. Bilaspur is a district of Chhattisgarh occupies 0.205 thousand ha. area of soybean and productivity are 1517 kg/ha (Anonymous, 2009) [2].

Soybean has luxuriant crop growth, soft and succulent foliage, unlimited source of food, space and shelter there by it invites many insect-pests. During the introduction of soybean in India in the early seventies, only about a dozen minor insect pests were recorded, while in 1997, this number has swelled to an alarming figure of 270, besides 1 mite, 2 millipedes, 10 vertebrate and 1 snail pest (Singh, 1999) [16]. In India, 20 insect species have been recorded major pests infesting soybean crop (Singh and Singh, 1990) [17]. The soybean defoliators mainly include tobacco caterpillar *Sopdoptera litura* (Fab.) and green semilooper, *Chrysodeixis acuta*. Immature stages (larva or caterpillar) of both tobacco caterpillar and green semilooper damages the crop at vegetative stage and in severe case, it completely defoliate the crop and dramatic yield loss. *Spodoptera litura* larvae even damages to soybean pods also (Chaturvedi *et al.*, 1998, Mandal *et al.*, 1998, Singh *et al.*, 2000, Patil 2002 and Sastawa *et al.*, 2004) [6, 12, 14, 15]. The Bihar hairy caterpillar, *S. obliqua* is a voracious feeder which feeds gregariously on soybean leaves. In case of severe infestation, the entire crop is damaged badly thus causing 40 per cent defoliation of leaf area. The tobacco caterpillar, *S. litura* is a serious pest and its incidence is being observed in all the soybean growing areas of northern Karnataka during *Kharif* season. After feeding the leaves, it also feed on tender pods, consequently damaging 30 to 50 per cent of pods (Anonymous, 2007) [5].

Methods and Materials
To study the seasonal incidence of pre-dominant lepidopteran insect pest, weekly count of the pest was started from August 09, 2016 by counting the number of larvae found in one meter row length at five randomly selected spots in five central rows and thereafter, mean number of larvae per meter row was worked out.

The larvae of tobacco caterpillar, young larvae first feed gregariously and scrape the leaves, older larvae defoliate the crop and also damage the pod. The damaging symptoms of leaf folder are seen in leaves. They fold the leaf and eat chlorophyll content. The larva of green semilooper starts feeding from the margin of leaf. The weekly meteorological data on temperature, relative humidity, rainfall, sun shine hours and wind velocity will also be recorded for whole of the cropping season from the meteorological observatory located at BTC CARS, Bilaspur (C.G.). The graphical super-imposition technique will also be employed to depict the seasonal incidence of the pest.

Results and Discussion

The seasonal incidence of lepidopteran defoliators were recorded on soybean crop (*Glycine max* L. Merrill), starting from August 2, 2016 to October 25, 2016 at weekly intervals. The prevailing weather conditions during the experimental period are shown in table 1.

4.2.1 Seasonal incidence of soybean leaf folder, *Omiodes indicata* Fabricius (Lepidoptera: Crambidae)

The First appearance of *Omiodes indicata* on soybean crop was observed during first week of August with an average population of 0.47 larvae/mrl (Table 2). The overall average larval population was ranged between 0.13 to 1.67 larvae/mrl during the observational period. The highest population (1.67 larvae/mrl) was recorded in third week of September, the environmental conditions prevailed during this period were maximum, minimum and average temperature 33ºC, 23.74ºC and 28.37ºC, morning, evening and average relative humidity 91.86%, 69.71 and 80.79.

Table 1: Meteorological data during experimental period (2016-17) at Bilaspur (C.G.)

S. No	Week No.	Date	Temperature (˚C)			Relative humidity (%)			Rainfall
			Max.	Min.	Avg.	Morning	Evening	Average	(mm)
1	27	Jul 02- 08	30.43	23.71	27.07	86.8	82.14	84.47	119.4
2	28	Jul 09- 15	30.49	24.15	27.32	94.61	82.43	88.52	59.6
3	29	Jul 16- 22	30.91	23.15	27.03	95.61	77	86.31	96.2
4	30	Jul 23- 29	30.69	23.82	27.26	92.71	77	84.86	80.6
5	31	Jul 30- Aug 05	31.6	23.26	27.43	95.71	80.43	88.07	76.2
		Average	30.82	23.62	27.22	94.73	79.8	87.27	432*
6	32	Aug 06- 12	29.54	23.26	26.4	94.29	80.86	87.58	56.06
7	33	Aug 13- 19	29.26	23.49	26.36	90.14	76	83.07	17.2
8	34	Aug 20- 26	31.97	24.57	28.27	92	71.43	81.72	1
9	35	Aug 27- Sep-02	32.86	30.06	31.46	91.58	71.56	81.57	76.6
		Average	30.91	25.345	28.13	92	74.96	83.48	150.86*
10	36	Sep 03- 09	30.78	23.74	27.26	93	77.57	85.29	28
11	37	Sep 10- 16	32.51	23.8	28.16	93.57	72.14	82.85	19
12	38	Sep 17- 23	33	23.74	28.37	91.86	69.71	80.79	7.2
13	39	Sep 24- 30	31.06	22.83	26.95	94.29	75.14	84.72	123.6
		Average	31.84	23.53	27.69	93.18	73.64	83.41	177.8*
14	40	Oct 01- 07	32.71	23.37	28.04	95.14	74.42	84.78	9
15	41	Oct 08- 14	32.34	20.4	26.37	93.57	55.71	74.64	25.1
16	42	Oct 15- 21	32.23	22.51	27.37	90.86	38.14	64.5	0
17	43	Oct 22- 28	32.31	21.17	26.74	83.86	39.42	61.64	0
		Average	32.4	21.86	27.13	90.87	51.92	71.4	34.1
								Total	794.76*

* Total rainfall

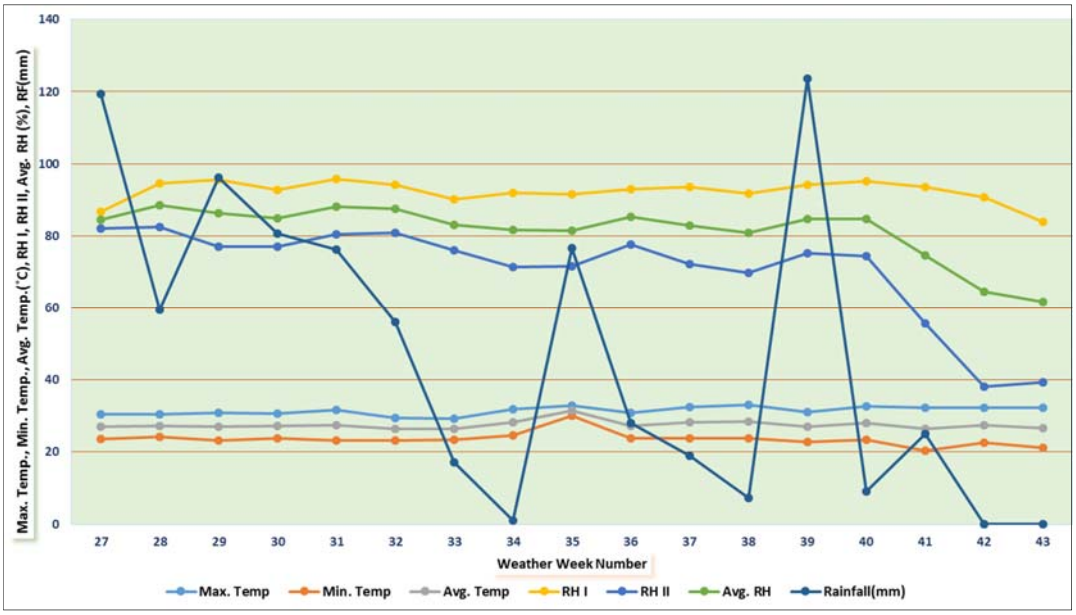

Fig 1: Meteorological data during experimental period (2016-17) at Bilaspur (C.G.)

Respectively, with total rainfall of 7.2 mm. The population started declining from second week of October onwards and reached to 0.33 larvae/mrl during last week of October.

Simple correlation co-efficient (r) between *Omiodes indicata* and meteorological parameters

The correlation co-efficient between soybean leaf folder with different weather parameters *i.e.* temperature, rainfall and relative humidity which play an important role in fluctuation of insect population were also worked out. The larval population of Omiodes indicata exhibited positive and significant correlation with maximum temperature (r = 565) and negative but non-significant correlation was noticed with rainfall (r = -0.276). Remaining weather variables were not found to be significantly correlated with *Omiodes indicata* (Table 3).

4.2.2 Seasonal incidence of tobacco caterpillar, *Spodoptera litura* Fabricius (Lepidoptera: Noctuidae)

The activity of *Spodoptera litura* (0.67 larvae/mrl) on soybean crop was started in fourth week of August (Table 2) with an overall larval population ranged from 0.13 to 1.47 larvae/mrl. The peak population (1.47 larvae/mrl) noticed during third week of September, the weather conditions prevailed during this period were maximum (33ºC), minimum (23.74ºC) and average (28.37ºC) temperatures, morning (91.86%), evening (69.71%) and average (80.79%) relative humidity, and rainfall (7.2 mm). From second week of October, population started declining and reached to a lowest (0.33 larvae/mrl) during last week of October. The present findings are in conformity with Kamal (2000) [10], Choudhary and Shrivastava (2007) [8], Chaudhari, (2009), Dhanraj, P.G. (2013) [9] and Ahirwar *et al.* (2015) [1].

Simple correlation co-efficient (r) between *Spodoptera litura* Fab. and meteorological parameters:

The correlation coefficient between *Spodoptera litura* (larvae/mrl) and different weather variables indicated a positive and significant correlation with maximum temperature (r = 0.663), whereas negative significant correlation was noticed with rainfall (r = -0.570). Remaining weather variables were not found to be significantly correlated with *Spodoptera litura*. The present findings are in line with that Dhanraj, P.G. (2013) [9] reported that the rainfall revealed significantly negative correlation, while maximum temperature found to be positive correlation.

4.2.3 Seasonal incidence Green semilooper, *Chrysodeixis acuta* Walker (Lepidoptera: Noctuidae)

The beginning of *Chrysodeixis acuta* on soybean crop was observed during the 31st standard week (0.33 larvae/mrl). The overall average larval population was ranged between 0.13 to 1.00 larvae/mrl during first week of August to third week of October (Table 2). There was a gradual increases in the population of *Chrysodeixis acuta* which reached maximum during 36th standard meteorological week (1.00 larvae/mrl). The weather variables viz. maximum, 30.78ºC; minimum, 23.74ºC and average, 27.26ºC temperature; morning, 93%; evening, 77.57% and average 85.29% relative humidity and a total rainfall of 28 mm was recorded during its peak period of activity. The larval population was started declining during second week of October and reached to a lowest (0.13 larvae/mrl) during third week of October. Thereafter, no population of *Chrysodeixis acuta* was observed in the crop. Similar findings were reported by Singh and Singh (1987) [6], Patel A. (2012) [13] and Kayan R. K. and Ameta O. P. (2017) [11].

Table 2: Seasonal incidence of lepidopteran defoliators in soybean, *Glyine max* during experimental period, 2016

	Average population* (No. of larvae /mrl)					Total
Date of observation	***Omiodes indicata***	***Spodoptera litura***	***Chrysodeixis acuta***	***Anarsia ephippias***	***Helicoverpa armigera***	
2/8/2016	0.47	0	0.33	0.13	0	0.93
9/8/2016	0.27	0	0.33	0.33	0.27	1.2
16/8/2016	0.13	0	0.4	0.6	0.13	1.26
23/8/2016	0.67	0.67	0.47	0.13	0.53	2.47
30/8/2016	0.8	0.13	0.53	0.27	0.67	2.4
6/9/2016	1.4	0.47	1	0.53	0.6	4
13/9/2016	1.6	1	0.8	0.33	0.53	4.26
20/9/2016	1.67	1.47	0.47	0.27	0.6	4.47
27/9/2016	0.53	0.13	0.27	0.2	0.13	1.26
4/10/2016	1.6	1.13	0.33	0.13	0	3.19
11/10/2006	0.67	0.8	0.2	0	0	1.67
18/10/2016	0.6	0.53	0.13	0	0	1.26
25/10/2016	0.33	0.33	0	0	0	0.66

*Average of three replication

Table 3: Simple correlation co-efficient (r) of insect pest complex on soybean with different meteorological parameters

Insect-pests	Temperature (ºC)			Relative humidity (%)			Rainfall (mm)
	Maximum	Minimum	Average	Morning	Evening	Average	
Omiodes indicata Fab.	0.565*	0.164	0.389	0.311	0.192	0.223	-0.276
Spodoptera litura Fab.	0.663*	-0.157	0.167	0.092	-0.148	-0.111	-0.570*
Chrysodeixis acuta Walker	-0.036	0.433	0.342	0.345	0.584*	0.568*	-0.012
Anarsia ephippias Mullar	-0.617*	0.343	0.007	0.146	0.654*	0.593*	0.113
Helicoverpa armigera Hub.	0.143	0.678*	0.625*	0.071	0.399	0.358	-0.003

* Significant at 5% level

Simple correlation co-efficient (r) between *Chrysodeixis acuta* and meteorological parameters

The population of green semilooper exhibited a significant positive correlation with evening and average relative humidity with 'r' value of 0.584 and 0.568, respectively. While the other variables were not found significantly

correlated with larval population. The present findings are contradictory with Patel A. (2013).

4.2.4 Seasonal incidence of Leaf webber, *Anarsia ephippias* Mullar (Lepidoptera: Arctiidae)

The first appearance of *Anarsia ephippias* on soybean crop was recorded during first week of August (0.13 larvae/mrl) which ranged from 0.13 to 0.6 larvae/mrl during the observational period (Table 2). The highest larval population (0.6 larvae/mrl) was noticed during third week of August. The weather condition prevailed were maximum (29.26ºC), minimum (23.49ºC) and average (26.36ºC) temperature, with morning (90.14%), evening (76%) and average (83.07%) relative humidity along with total rainfall (17.2 mm). From third week of September, population started declining and reached to a lowest (0.13 larvae/mrl) during first week of October. Thereafter, no population of *Anarsia ephippias* was observed on the crop.

Simple correlation co-efficient (r) between *Anarsia ephippias* and meteorological parameters

The larval population of *Anarsia ephippias* exhibited significant negative correlation with maximum temperature (r = -0.617), while it was significantly positively correlated with evening and average relative humidity (r = 0.654 and 0.593, respectively).

4.2.5 Seasonal incidence of pod borer, *Helicoverpa armigera* Hub. (Lepidoptera: Noctuidae)

The first appearance of pod borer (0.27 larvae/mrl) on soybean crop was observed during 32nd standard week. The overall average larval population was ranged between 0.13 to 0.67 larvae/mrl during the observational period (Table 2). The highest pod borer population (0.67 larvae/mrl) was recorded during 35th standard week. The weather condition prevailed during this period were maximum, minimum and average temperature; 32.86ºC, 30.06ºC and 31.46ºC, morning, evening and average relative humidity 91.58%, 71.56% and 81.57% respectively. The total rainfall of 76.6 mm was recorded during the period. The pest population started declining and reached to lowest (0.13 larvae/mrl) during last week of September. Thereafter, no population of *Helicoverpa armigera* was observed on the soybean crop. Similar findings were reported Kayan R. K. and Ameta O. P. (2017) [11], who also reported that the maximum incidence of gram pod borer was recorded in the 36th SMW during 2012.

Simple correlation co-efficient (r) between *Helicoverpa armigera* and meteorological parameters

The larval population of *Helicoverpa armigera* exhibited significant positive correlation with minimum (r = 0.678) and average (r = 0.625) temperature. Remaining weather variables were not found to be significantly correlated with the larval population of *Helicoverpa armigera.* The present findings are in conformity with Kayan R. K. and Ameta O. P. (2017) [11].

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