Journal of Entomology and Zoology Studies

Available online at www.entomoljournal.com

E-ISSN: 2320-7078
P-ISSN: 2349-6800
www.entomoljournal.com
JEZS 2021; 9(1): 1824-1827

Received: 10-10-2020
Accepted: 12-12-2020

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Population dynamics of major insect pests of soybean and their correlation with abiotic factors in Bundelkhand agroclimatic zone of M. P.

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DOI: https://doi.org/10.22271/j.ento.2021.v9.i1z.8399

Abstract
Population dynamics of insect-pests of soybean and there a correlation with abiotic factors were studied at JNKVV, College of Agriculture, Tikamgarh (M.P.).The observations on the incidence of various insect-pests were recorded from germination to harvesting of the crop at weekly intervals. The peak activity of semilooper (5 larvae/mrl) and tobacco caterpillar (1.33 larvae/mrl) were observed in 37th and 38th SMW respectively. Whereas the highest population of jassid (3.17 jassid/ 3 leaves /plant) was recorded during 36th SMW and there was two peaks in whitefly population first was 33rd SMW (9.17 per 3 leaves /plant) and second peak was 37th SMW (14.33 per 3 leaves/plant). However the maximum infestation due to stem fly was observed 18.45% tunnel of the stem in 35th SMW, while the maximum infestation of plant due to girdle beetle was observed 4.33 girdle plant /mrl during 39th SMW. Based on observations and correlation study of insect incidence with weather parameters, it was found that population of semilooper and tobacco caterpillar larva were significant and positive correlated with maximum temperature and evaporation (r = 0.31, 0.35, 0.55 and 0.61 respectively) and negatively correlated with evening humidity (r =.-0.18 and -0.43 respectively). Whereas the population of whitefly and jassid were significant positive correlated with maximum temperature and evaporation (r = 0.36, 0.24, 0.41 and 0.48 respectively) and negatively correlated with evening relative humidity. However stem fly population was significantly positive correlated with maximum temperature and evaporation (r =0.86 and 0.64 respectively) and negatively correlated with rainfall (r =-0.44). The girdle beetle population was also significantly positive correlated with maximum temperature and evaporation (r = 0.89 and 0.71 respectively) and negatively correlated with relative humidity and rainfall (r = -0.60, -0.89 and -0.44 respectively). From the study it may be concluded that there were two peaks in whitefly population (33rd & 37th SMW) and one peak of jassid, semiloope and tobacco caterpillar were recorded at 36th, 37th and 38th SMW respectively. However the maximum infestation of stem fly and girdle beetle were observed during 35th and 39th SMW respectively. It was also concluded that all the insects exhibited significant positive correlation with maximum temperature and evaporation while the stem fly and the girdle beetle showed significant negative correlation with minimum temperature, relative humidity and rainfall respectively.

Keywords: soybean, insect pests, abiotic factor, incidence, correlation

Introduction
Soybean [*Glycine max* (L.) Merrill] is one of the most important oilseed crops of India. It is a unique crop with high nutritional value, providing 40 per cent protein and 20 per cent edible oil besides minerals and vitamins. In India, it is grown in 118.38 lakh ha with an annual production of 104.55 lakh MT and productivity of 883 kg/ha. Madhya Pradesh is known as 'Soybean State' which covers about 58.54 lakh ha area with the production of 41.77 lakh MT and productivity of 714 kg/ha. (Anonymous 2000) [1]. Soybean has luxuriant crop growth, soft and succulent foliage and thus it attracts many insects and provides an unlimited source of food, space and shelter. 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 270, besides 1 mite, 2 millipedes, 10 vertebrates and 1 snail (Singh, 2000) [12]. Among them, girdle beetle *Obereopsis brevis* (Swedenbord), stem fly *Melanagromyza sojae* (Zehntner), tobacco caterpillr *Spodoptera litura* (Fab.), green semilooper *Chrysodeixis acuta* (Walker), white Fly *Bemisia tabaci* (Gennadins) and jassid *Empoasca kerri* (Pruthi) are the major pests in Madhya Pradesh as well as Bundelkhand region. *Spodoptera litura* (fab.),

Chrysodeixis acuta (Walker) and *Helicoverpa armigera* (Hubner) are feeding on foliage, flower and pods causing significant yield loss in India. The sucking pests viz. *Bemisia tabaci* (Genn) and *Thrips palmi* (Karny) cause economic damage (Singh and Singh, 1990) [13]. The green semilooper, *Chrysodeixis acuta* (Walker) and tobacco caterpillar, *Spodoptera litura* (Fabricious) are major insect pests feeding on foliage, flower and pods causing significant yield loss while, stem fly, *Melanagromyza sojae* (Zehn) is a major pest during seedling to reproductive stages (Gupta, 2008) [5]. Sufficient knowledge about the seasonal activity of the insect pest is necessary for monitoring and adopting suitable and timely control measures in a particular region. Despite this earlier research workers have suggested many pesticides, for the management of soybean pests but excessive use of several insecticides has created many pest problems like insecticidal resistance to most of the available insecticides, insecticides also induced resurgence of minor pest and destruction of natural enemies. Keeping the above facts, in view the present study was carried out to study the incidence of insect pests on soybean and their correlation with the weather parameters.

Material and Methods

The field experiment was laid out at research farm of JNKVV, College of Agriculture Tikamgarh (M. P.), India, during *kharif* season of 2015 in a Randomized Block Design with three replications. The cultivar JS-95-60 was sown on 9th July, 2015 with a row to row and plant to plant distance as 30 cm and 15 cm respectively. All the agronomical practices were followed to raise a good crop. Observations on the larval population of leaf eating caterpillar (Tobacco caterpillar, green semilooper) made at three randomly selected spots of one meter row leaving border rows at weekly interval. Larvae counts were made by shaking the plant gently over a white cloth placed between the rows. The observations on girdle beetle were recorded at randomly selected 3 places of one meter row length leaving border rows at weekly intervals. The data were presented in no. of plant infestation. Length of tunneling was also recorded at physiological maturity and present tunneled was computed. The population count on the infestation per cent of stem fly and tunnel in stem caused by its maggots, 6 plants/plot from middle rows were uprooted at random and split open vertically at weekly intervals. Plant height and tunnel length were measured for calculating per cent stem tunneling. The population of sucking pests on the number of white flies and jassid were recorded on three compound leaves (top, middle and bottom) per plant from six randomly selected plants at weekly intervals. Correlation coefficient between weekly meteorological parameters and pest population was calculated.

Results and Discussion

Seasonal incidence of major insect pests of soybean

Semilooper

The first appearance of the larval population of green semilooper was recorded during 30th SMW (23 to 29 July) with the population of 2.33 larvae/mrl, which reached its peak (5 larvae/mrl) during 37th SMW (10 to 16 September). During the peak period the maximum and minimum temperatures were 35.4 ^{0}C and 23.1 ^{0}C, respectively, and morning and evening relative humidity were 92.4% and 49.4% respectively, whereas rainfall and evaporation were 6.6 mm and 4.6 mm respectively. Further, it was observed that the green semilooper larval population declined and reached the lowest level in the 39th SMW and completely disappeared in the 40th SMW. This finding is in confirmation with Panwar (2015) [9] reported that the infestation of green semilooper, *Chrysodeixis acuta* was observed from August to September and its peak observed in 37th SMW at Jabalpur district of Madhya Pradesh.

The correlation studies revealed that a significant and positive correlation was observed between population buildup of green semilooper larvae and maximum, minimum temperature and evaporation r = 0.31, 0.19 and 0.35 respectively). Whereas morning relative humidity and rainfall observed non significantly positive correlation (r = 0.09, 0.08 respectively) with green semilooper larval population while evening relative humidity was found to be negatively correlated (r = -0.18) but to the non-significant level. Yadav (2013) [16] was also revealed that maximum temperature and evaporation exhibited significantly positive correlation with green semi looper.

Tobacco caterpillar

The activity of the tobacco caterpillar started from 35th SMW and continued up to 39th SMW during the study period. The pest population ranged from 0.33 to 1.33 larvae/mrl. The peak population of tobacco caterpillar (1.33 larvae/mrl) was during 38th SMW (17 September to 23 September), when the maximum and minimum temperatures were 33.8 ^{0}C and 23.9 ^{0}C, respectively and morning and evening relative humidity were 91.4% and 52.6% respectively. Thereafter, declined trend was observed and the population reached its lowest level (0.33 larvae/mrl) during 39th SMW and completely disappeared in the 40th SMW. The observation was more or less identicalto those of Choudhary and Shrivastava (2007) and Panwar (2015) [9] they repoted that, *Spodoptera litura* (Fab.) was observed from last August to last September and its peak activity was observed in 37th SMW at Jabalpur district of Madhya Pradesh.

In the present study, correlation studies revealed that significant and positive correlation was observed between population buildup of tobacco caterpillar population and maximum temperature and evaporation (r = 0.55 and 0.61 respectively). Correlation studies further revealed that morning relative humidity and rainfall were found to be negatively correlated (r = -0.01, -0.15 respectively) to non significant level. Whereas evening relative humidity was found significant negative correlated (r= -0.43) but minimum temperature was found positive correlated (r= 0.07) to a non significant level. Yadav (2013) [16] and Suyal *et al.* (2018) [15] revealed that maximum temperature and morning relative humidity exhibited a significantly positive correlation with tobacco caterpillar.

White fly

The white fly was first recorded during 29th SMW (16 July to 22 July) with the population of 1.33 per 3 leaves/plant, which reached its first peak (9.17 per 3 leaves/plant) during 33rd SMW (13 August to 19 August). During the peak activity of white fly the maximum and minimum temperatures were 31.3 ^{0}C and 24.0 ^{0}C, respectively and morning and evening relative humidity were 97.0% and 76.7% respectively. Thereafter suddenly the population of white fly was decreased in 34 SMW and again the population has increased and reached its second peak (14.33 per 3 leaves/plant) during 37th SMW (10 September to 16 September). At that time the maximum and minimum temperature were 35.4 ^{0}C and 23.1 ^{0}C, respectively

and the morning and evening relative humidity were 92.4% and 49.4% respectively. After 37th SMW, the population of white fly was observed in decline trend and reached its lowest level 2.33 per 3 leaves/plant during 40th SMW (01 October to 07 October). Chaturvedi *et al.* (1998) [2] reported 17 insect pests and out of these, two damaged the stems, 10 defoliated the plants, five sucked the cell sap and one damaged the roots at different growth stages of the crop, starting just after the emergence of the cotyledons.

The correlation studies revealed that maximum temperature, rainfall and evaporation had a positive correlation (r = 0.36, 0.21 and 0.24 respectively) with the white fly population While evening relative humidity was found to be negatively correlated (r = -0.19) to the level of significance. However, morning relative humidity and minimum temperature were observed positively correlated (r= 0.10, 0.05 respectively) to non-significant level. Sharma *et al.* (1997) [4] was also reported that mean temperature was most conducive for the population build-up of this pest which confirms the present findings.

Jassid

The first appearance of Jassid was recorded during 32nd SMW (06 August to 12 August) with 0.50 Jassid per 3 leaves/plant. After 32nd SMW, the population of Jassid was observed in increasing number and reached its peak level (3.17 Jassid per 3 leaves/plant) during 36th SMW (03 September to 09 September), when the maximum and minimum temperature were 34.1 ^{0}C and 23.3 ^{0}C, respectively, and morning and evening relative humidity was 89.1% and 53.6% respectively. Thereafter, Jassid population was fluctuated up to 39th SMW. The lowest population of Jassid was observed 0.17 Jassid per 3 leaves / plant in 40th SMW. The finding is in conformity with Ganore (2012) [4] and Kumar *et al.* (1998) [7] have reported the incidence of jassid was observed from August to September and its peak population was observed in 37th SMW.

A correlation study between jassid and abiotic factor revealed that maximum temperature and evaporation were positive correlated (r = 0.41 and 0.48 respectively) with the jassid population, whereas evening relative humidity and rainfall were found to be negatively correlated (r = -0.33, -0.29 respectively) with jassid population to the level of significance. However, minimum temperature observed positive correlated (r= 0.02) to a non-significant level but morning relative humidity observed negative correlated (r= -0.13) to non significant level. Ganore (2012) [4] does not agree with present study and revealed that the incidence of jassid did not exhibit any significant correlation with any weather factors.

Stem fly

The infestation of stem fly started in 32nd SMW (06 August to 12 August) with 1.42% stem tunnel. The maximum infestation was observed 18.45% tunnel of the stem in 35th SMW (27 August to 02 September). During this period maximum and minimum temperature were 33.8 ^{0}C and 23.7 ^{0}C respectively and morning and evening relative humidity were 88.1% and 68.3% respectively. The minimum infestation of 1.42% stem tunnel was recorded in 32th SMW. Jayappa (2000) [6] has also reported that the stem fly, *M. sojae* was observed both in *kharif* and summer seasons and caused 13.1 to 31.90 per cent of stem tunnelling, which confirm the present finding. however the Patil *et al.* (2012) [10] partially differ from the present study and observed that the maximum per cent of stem fly infestation was 36.34 to 40.69%.

Correlation study showed that maximum temperature and evaporation were exhibited positive correlation (r=0.86 and 0.64 respectively) with stem fly infestation, while minimum temperature, morning, evening relative humidity and rainfall were found to be negatively correlated (r = -0.54, -0.66, -0.79, -0.44 respectively) with stem fly infestation to the level of significance. Jayappa (2000) [6] has also reported that the stem fly, *M. sojae* was observed both in *kharif* and summer seasons and caused 13.1 to 31.90 per cent of stem tunnelling, which confirm the present finding.

Girdle beetle

The infestation of girdle beetle was started in 31st SMW (30 July to 05 August) with the infestation of 0.33 girdled plant /mrl. Thereafter the increasing trend of infestation of the girdle beetle was observed and it continued up to 38th SMW. The maximum infestation of plants due to girdle beetle was observed 4.33 girdled plant /mrl during 39th SMW, when maximum and minimum temperature were 34.8 ^{0}C and 20.1 ^{0}C respectively and morning and evening relative humidity were 85.0% and 38.3% respectively. The infestation of the girdle beetle remained stable in 40th SMW (01 October to 07 October). Rai and Patel (1990) [11] Concluded that the low infestation level (0.86-12.09%) during the period of activity may be due to the late planting of the soybean crop and low rainfall which confirm the present finding.

From the present study it has been observed that maximum temperature and evaporation had exhibited a positive correlation (r = 0.89 and 0.71 respectively) with the infestation of the girdle beetle population. While minimum temperature, morning, evening relative humidity and rainfall were found to be negatively correlated (r = -0.66, -0.60, -0.89, -0.44 respectively) with girdle beetle infestation to the level of significance. Netam *et al.* (2013) [8] also support the present findings.

Table 1: Seasonal incidence of major insect pest complex of soybean at Tikamgarh during *kharif* 2015.

SMW	Mean larval population/mrl		3 leaves/plant		Mean% plant infested tunnel by stem fly	Girdled plant/mrl
	Green Semilooper	Tobacco caterpillar	White fly	Jassid		
29	0.00	0.00	1.33	0.00	0.00	0.00
30	2.33	0.00	4.33	0.00	0.00	0.00
31	0.67	0.00	3.83	0.00	0.00	0.33
32	0.33	0.00	4.50	0.50	1.42	1.00
33	0.67	0.00	9.17	0.83	1.48	2.00
34	0.33	0.00	3.50	1.67	3.18	2.33
35	3.00	0.67	13.83	2.17	18.45	2.67
36	3.33	1.00	13.50	3.17	17.66	3.33
37	5.00	1.67	14.33	1.33	11.63	3.67
38	2.33	1.33	5.67	1.50	15.87	4.00
39	0.67	0.33	7.17	1.67	14.87	4.33

40	0.00	0.00	2.33	0.17	16.89	4.33

*mrl- meter row length

Table 2: Correlation between weather factors and insect populations in soybean at Tikamgarh during *kharif* 2015.

Insect pests	Temperature		Relative humidity		Rainfall (mm)	EP (mm)
	Maximum	Minimum	Morning	Evening		
Green semilooper	0.31*	0.19*	0.09	-0.18	0.08	0.35*
Tobacco caterpillar	0.55*	0.07	-0.01	-0.43**	-0.15	0.61*
White fly	0.36*	0.10	0.05	-0.19**	0.21*	0.24*
Jassid	0.41*	0.02	-0.13	-0.33**	-0.29**	0.48*
Stem fly	0.86*	-0.54**	-0.66**	-0.79**	-0.44**	0.64*
Girdled plant	0.89*	-0.66**	-0.60**	-0.89**	-0.44**	0.71*

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