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Effect of weather parameters on population dynamics of major defoliator insect pests of green gram [*Vigna radiata* (L.) Wilczek]

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Abstract
An experimental field was conducted to study the population dynamics of defoliator insect pests and their correlations with abiotic factors on green gram. Observations on larval population of defoliator insect pests (Lepidopteran pests) on green gram were recorded at weekly intervals in per meter row length (mrl) from randomly selected 10 different sites. The obtained results revealed that the first appearance of Bihar hairy caterpillar on green gram was observed during 33rd SMW and its population attained its first and second peak during 36th and 38th SMW, respectively. Whereas, tobacco caterpillar was first appeared during 33rd SMW and reached its peak at 37th SMW. The larval population of green semilooper was first observed during 33rd SMW which reached its peak during 36th SMW. The incidence of pod borer on green gram was first recorded during 34th SMW and reached its peak during 38th SMW. Correlation studies revealed that sunshine had positive correlation with larval population of Bihar hairy caterpillar, but statistically found to be non-significant. Further, minimum temperature showed significantly negative association with the influence of larval population of Bihar hairy caterpillar. Minimum temperature showed significantly negative correlation with the influence of tobacco caterpillar. The morning and evening RH, sunshine, wind speed and rainfall had positive correlation with larval population of green semilooper, but statistically found non-significant. Correlation studies with pod borer revealed that sunshine had exhibited positive correlation while, maximum and minimum temperature, morning and evening RH, wind speed, evaporation and rainfall were expressed negative correlation, but statistically it was non-significant.

Keywords: Population dynamics, defoliator insect pests, green gram, *Vigna radiata*

Introduction
Green gram [*Vigna radiata* (L.) Wilczek] also known as mungbean is a highly nutritious pulse crop contains 24 to 25 and 59.9 per cent protein and carbohydrate, respectively in the seed. It is a good substitute for non-vegetarian protein in most of the Asian diet. The requirements of pulses are expected to raise further mainly due to increasing population and preference for pulses as the cheapest source of dietary protein and other culinary products. It is used as whole grains as well as "Dal" in a variety of ways in our food. Sprouted green gram is used in the preparation of curry or a savory dish. Its products are considered to be easily digestible and hence the patients prefer it. The annual world production area of green gram is about 5.5 million hectare. India is the primary green gram producer and contributes about 75 per cent of the world's production [1]. It is one of the major *Kharif* pulse crop in India covering 42.57 lakh ha area with the production of 20.09 lakh tones and productivity of 481 kg/ha, whereas, in Madhya Pradesh, it is cultivated in 4.34 lakh ha area with the production of 2.66 lakh tones and productivity of 448 kg/ha [2].

The cultivated area green gram is being shrunk and productivity is also declined since last few decades due to severe incidence of insect pests and diseases. Among the insect pests, about 64 species of different insect pests have been reported which devastating green gram in the field from seedling to maturity stage which cause serious yield losses. Of them Bihar hairy caterpillar (*Spilarctia oblique* Walker), tobacco caterpillar (*Spodoptera litura* Fabricius), green semilooper (*Chrysodeixis acuta* Walker) and pod borer (*Helicoverpa armigera* Hubner) are the major leaf defoliators whereas whitefly (*Bemisia tabaci* Gennadius), jassid (*Empoasca* spp.) and thrips (*Thrips tabaci* Lindeman) are the major sucking insect pests of the crop [3]. The avoidable losses due to pest complex on different varieties of green gram ranged from 27.03 to 38.06% with an average of 32.97% [4].

To manage these pests over dose of chemical insecticides are applied which resulted leading insect resistance, pest resurgence and environmental hazard. Further, weather factors also take part in the key role to fluctuate the pest population during the cropping season [5]. Hence, to understand the fluctuation of pest population due to prevailing weather factors and availability of host was planned which might be helpful for decision making support system towards the integrated pest management program.

2. Materials and Methods

2.1 Experimental Layout

An investigation was conducted on population dynamics of major defoliator insect pests infesting green gram at the Experimental Field of JNKVV, College of Agriculture, Tikamgarh, MP, India during *Kharif* 2018-19. The test crop variety *cv.* TM-37 was grown at the spacing of 30 x 10 cm in 200 square meter area. All the agronomical practices were applied except plant protection measures.

2.1 Observations

The observation on the larval population of Bihar hairy caterpillar (*Spilarctia oblique*), green semilooper (*Chrysodeixis acuta*), tobacco caterpillar (*Spodoptera litura*) and pod borer (*Helicoverpa armigera*) was recorded as soon as their first appearance was noticed at weekly intervals in per meter row length (mrl) from randomly selected 10 different sites in the field. The data of standard meteorological week (SMW) viz. temperature, relative humidity, rainfall, sunshine hours and evaporation was recorded during the course period from Agro-meteorological Observatory Unit, College of Agriculture, Tikamgarh, (MP).

2.3 Data analysis

For the data analysis, obtained data of each larval population of defoliator insect pest counts was sum up together and mean population/mrl was computed for each standard meteorological week (SMW) to know the first occurrence, peaks and population dynamics of pests on green gram. The simple correlation studies between the abiotic factors of each SMW and larval population of defoliator insect pests was analyzed as suggested by Snedecor and Cochran [6]. Thereafter, test of significance of correlation coefficient was workout by following the formula:

$$t = r\sqrt{\frac{n-2}{1-r^2}}$$

Where, 'n' is the number of observation and 'r' is the correlation coefficient, the value of '*t*' is based on (n-2) degree of freedom. The calculated value of '*t*' is compared with tabulated *t*- table value on degree of freedom (n-2) of 5% significance level. Significant values were further subjected to analyzed simple regression equation to know the relationship between dependent and independent variables.

3. Results and Discussion

The perusal of data recorded during *Kharif* season 2018-19 on larval population dynamics of major defoliator insect pests of green gram viz. Bihar hairy caterpillar, tobacco caterpillar, green semilooper and pod borer are presented below in different sub-headings.

3.1 Bihar hairy caterpillar (*Spilarctia oblique*)

The first appearance of Bihar hairy caterpillar on green gram was recorded during 33rd SMW (13th to 19th August) and the population were ranged from 0.50-3.10 larvae/mrl (Fig 1 and Table 1). Similar findings were also reported by Suyal *et al*. (2018) [7] on soybean crop during 32nd SMW. Contrary, Yadav *et al*. (2015) [8] reported that first appearance of Bihar hairy caterpillar was recorded during 39th SMW on black gram. Further, in the present study Bihar hairy caterpillar population was gradually increased and reached at its first peak (3.10 larvae/mrl) at 36th SMW (*i.e.* 3rd to 9th September). Thereafter, its population was started decline and reached its second peak (3.02 larvae/mrl) at 38th SMW (*i.e.* 17th to 23rd September) and available upto the maturity stage of the crop. The results are corroborated with the findings of Yadav *et al*. (2015) [8] who reported the highest population of Bihar hairy caterpillar (29.50 larvae/m²) on black gram was recorded during 40th SMW. Further, Similar findings were also found by Suyal *et al.* (2018) [7] the highest population of Bihar hairy caterpillar on soybean increased gradually and attained peak during 34th SMW.

The correlation studies revealed that sunshine was exhibited positive correlation (r= 0.36) with larval population of Bihar hairy caterpillar, but statistically found to be non-significant (Table 2). These finding are in conformity with the results of Yadav *et al*. (2015) [8] as they reported that sunshine showed significant positive correlation with Bihar hairy caterpillar population. Contrary, Suyal *et al*. (2018) were found negatively non-significant correlation between sunshine and Bihar hairy caterpillar population [7]. Further, in the present study minimum temperature showed significantly negative association (r= 0.62) with the larval population of Bihar hairy caterpillar.

The regression equation being as: $\bar{Y}$= 10.95-0.42x (R^2 = 0.39). From this equation it may be expressed that with every unit increase in minimum temperature there was a decrease of 0.42 larval population of Bihar hairy caterpillar/mrl (Fig 2 and Table 2). These finding are in full conformity with the finding of Yadav *et al*. (2015) [8] and Suyal *et al*. (2018) [7] as they computed minimum temperature showed non-significant negative correlation with Bihar hairy caterpillar population on black gram and soybean, respectively.

The maximum temperature, morning RH, evening RH, wind speed, evaporation and rainfall exhibited negative correlation (r= -0.08, -0.06, 0-0.16, -0.21, -0.24 and -0.19, respectively) with Bihar hairy caterpillar population, but statistically found to be non-significant. These finding are in full conformity with the results of Yadav *et al*. (2015) [8] as they reported that morning and evening RH, rainfall and wind speed showed significant negative correlation with Bihar hairy caterpillar population on black gram. These finding is concurrent with findings of Suyal *et al.* (2018) [7] as they found non-significant negative correlation between morning RH and rainfall population with Bihar hairy caterpillar on soybean.

Table 1: Population dynamics of defoliator insect pests on green gram during *Kharif* 2018-19

Standard meteorological week	Weather factors								Mean larval population/ *mrl*			
	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	Bihar hairy caterpillar	Tobacco caterpillar	Green semilooper	Pod borer
30	28.40	24.20	95.85	83.40	0.97	1.07	2.70	11.10	0.00	0.00	0.00	0.00
31	30.80	24.13	88.42	68.90	0.97	1.17	2.50	5.90	0.00	0.00	0.00	0.00
32	31.80	24.50	92.14	71.30	2.81	1.00	3.20	5.37	0.00	0.00	0.00	0.00
33	31.50	25.10	94.85	76.60	4.12	1.80	2.90	9.65	0.50	0.90	1.50	0.00
34	29.10	24.10	98.14	84.00	2.08	1.60	2.10	11.40	1.00	1.25	2.99	0.50
35	29.40	23.40	97.85	86.40	1.54	1.30	2.10	24.06	1.40	2.39	3.40	1.00
36	26.50	22.40	97.00	90.60	0.34	1.00	1.60	13.80	3.10	2.78	3.80	2.30
37	29.60	20.50	94.28	67.60	4.28	1.50	2.00	1.10	2.50	3.90	3.20	2.80
38	31.90	22.40	86.57	58.70	7.22	1.00	3.00	0.34	3.02	3.00	3.00	3.30
39	34.00	21.10	86.71	40.30	8.00	0.80	3.40	0.00	2.40	2.82	2.20	1.40
40	36.50	19.60	74.71	30.30	8.65	0.80	3.90	0.00	1.20	2.00	1.00	0.50

Where, X_1- Max temp. (^{0}C), X_2- Min temp. (^{0}C), X_3- Morn. RH (%), X_4- Even. RH (%), X_5-Sunshine (hrs/day), X_6- Wind speed (km/hrs), X_7-Evaporation (mm) and X_8- Rainfall (mm)

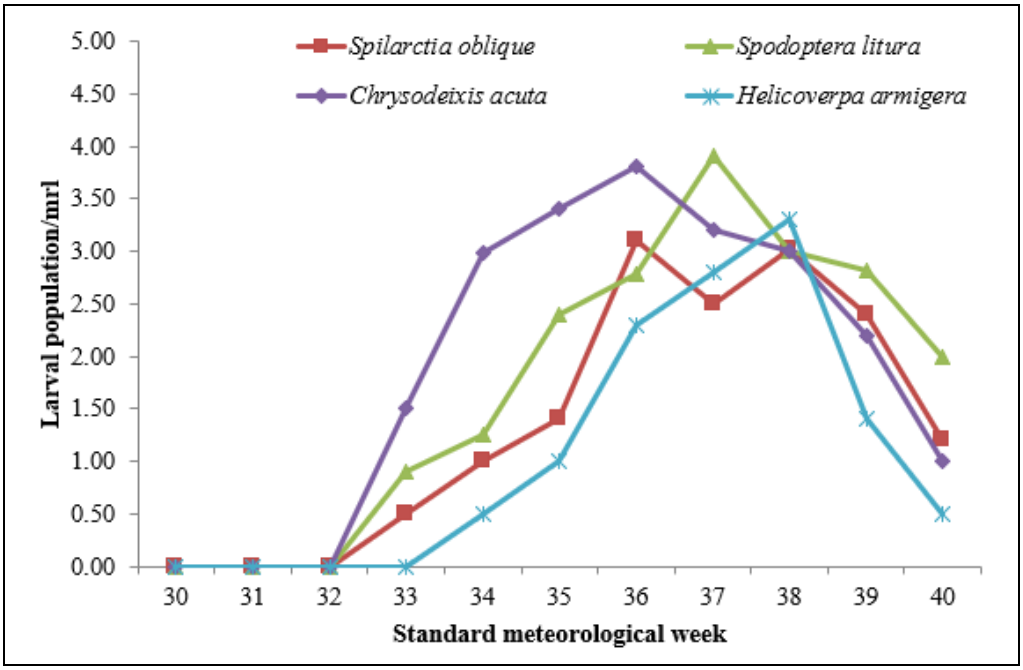

Fig 1: Population dynamics of defoliator insect pests of green gram in relation to weather parameters

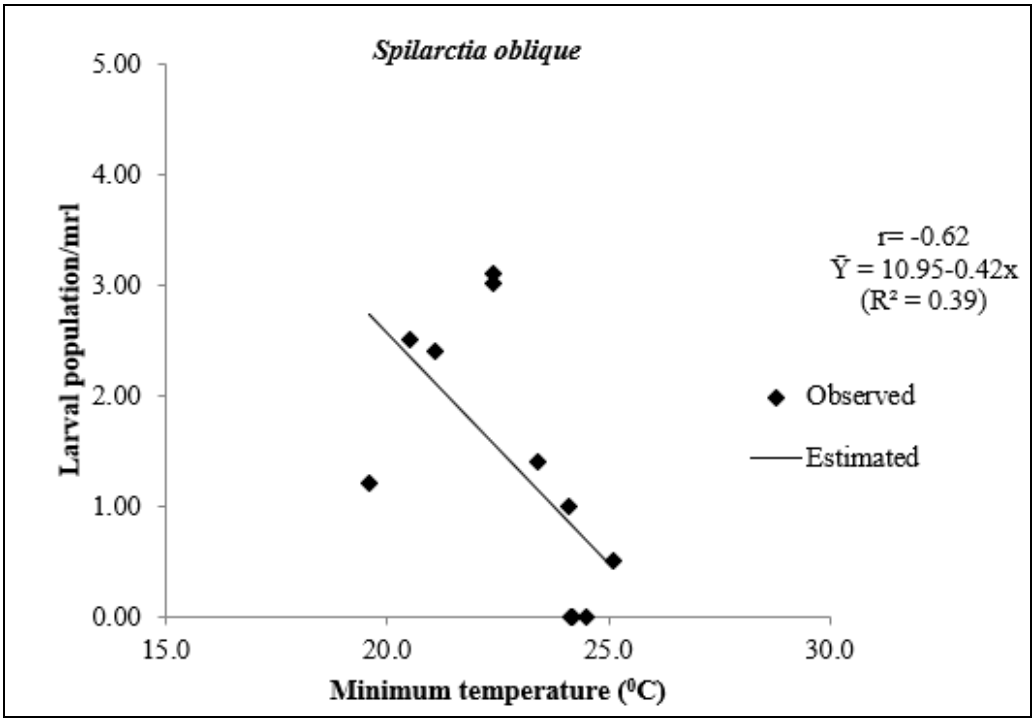

Fig 2: Regression of minimum temperature on larval population of Bihar hairy caterpillar (*S. oblique*) on green gram

Table 2: Correlation (r) and regression co-efficient (byx) of defoliator insect pest with weather factors on green gram

Weather factors	Bihar hairy caterpillar		Tobacco caterpillar		Green semilooper		Gram pod borer	
	r	byx	r	byx	r	byx	r	byx
Max. Temp. (^{0}C)	-0.08 NS	-	0.10 NS	-	-0.35 NS	-	-0.15 NS	-
Min. Temp. (^{0}C)	-0.62*	-0.42	-0.74*	-0.56	-0.32 NS	-	-0.54 NS	-
Morning RH (%)	-0.06 NS	-	-0.18 NS	-	0.32 NS	-	-0.01 NS	-
Evening RH (%)	-0.16 NS	-	-0.29 NS	-	0.21 NS	-	-0.09 NS	-
Sunshine (hours)	0.36 NS	-	0.51 NS	-	0.04 NS	-	0.29 NS	-
Wind speed (km/hr)	-0.21 NS	-	-0.19 NS	-	0.22 NS	-	-0.13 NS	-
Evaporation (mm)	-0.24 NS	-	-0.08 NS	-	-0.56 NS	-	-0.29 NS	-
Rainfall (mm)	-0.19 NS	-	-0.19 NS	-	0.26 NS	-	-0.25 NS	-

NS= Non-significant, *=Significant at 5% level, **=Significant at 1% level

3.2 Tobacco caterpillar (*Spodoptera litura*)

The first occurrence of tobacco caterpillar on green gram was recorded during 33rd SMW (*i.e.* 13th to 19th August). The larval populations of tobacco caterpillar were varied from 0.90-3.90 larvae/mrl (Fig 1 and Table 1). Present findings are in accordance with the findings of Raghuvanshi *et al.* (2014) [9], Suyal *et al.* (2018) [7] and Yadav *et al.* (2015) [8] as they reported the first appearance of tobacco caterpillar on soybean and black gram during 32nd, 32nd and 36th SMW, respectively. Further, in the present study larval population was gradually increased and reached at its first peak (3.90 larvae/mrl) at 37th SMW (*i.e.* 10th to 16th September) and the pest was available upto the maturity of the crop. Similar findings were reported by [10, 11, 12, 13 & 14]. The highest population of tobacco caterpillar reached its peaks on soybean crop during the 40th, 35th, 35th, 35th, 37th and 36th SMW, respectively.

In the present study, correlation studies revealed that maximum temperature and sunshine hours had positive correlation (r= 0.10 and 0.51, respectively) with tobacco caterpillar population, but statistically found to be non-significant (Table 2). These finding are in full conformity with the findings of Yadav *et al.* (2015) [8] and Suyal *et al.* (2018) [7] as they reported that maximum temperature and sunshine had positive correlation with tobacco caterpillar population on soybean, but it was non-significant. Further, in the present study, minimum temperature exhibited significantly negative correlation (r= -0.74) with tobacco caterpillar population.

Further, minimum temperature showed significantly negative correlation (r= -0.66) with the influence of tobacco caterpillarpopulation. The regression equation being as: $\bar{Y}$= 14.63-0.56x (R^2 = 0.54). From this equation it may be estimated that with every unit increase in minimum temperature there was a decrease of 0.56 tobacco caterpillarpopulation/mrl (Fig 3 and Table 2). In this context, Suyal *et al.* (2018) [7] reported that the minimum temperature had negative correlation with tobacco caterpillar population which was expressed non-significant. On the contrary, Kumar *et al.* (2007) [15] and Yadav *et al.* (2015) [8] observed that minimum temperature had positive correlation and non-significant with tobacco caterpillar population. Whereas, in the present investigation morning and evening RH, wind speed, evaporation and rainfall had negative correlation (r= -0.18, -0.29, -0.19, -0.08 and -0.19, respectively) with tobacco caterpillar population, but statistically found to be non-significant. Present findings are corroborated with the findings of Yadav *et al.* (2015) [8] as they observed that rainfall and wind velocity showed non- significant negative correlation with tobacco caterpillar population. On the contrary, morning and evening RH showed positive correlation with the tobacco caterpillar population, but it was non-significant**.**

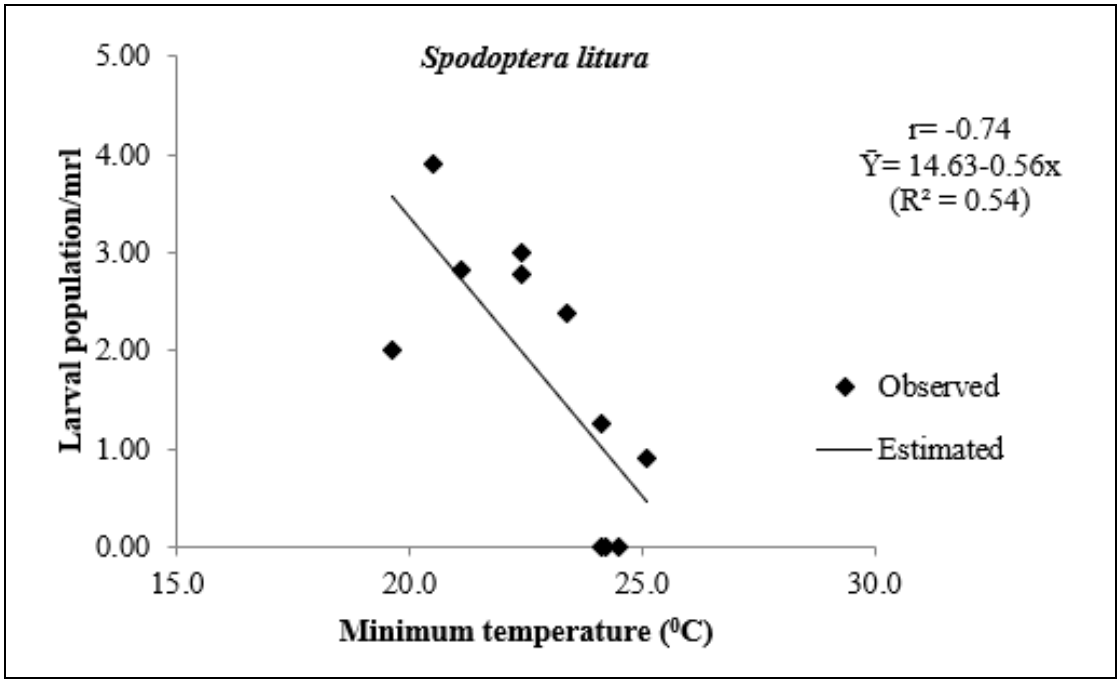

Fig 3: Regression of minimum temperature on larval population of tobacco caterpillar (*S. litura*) on green gram

3.3 Green semilooper (*Chrysodeixis acuta*)

The larval population of green semilooper on green gram was first recorded during 33rd SMW (*i.e*., 13th to 19th August) (Fig 1 and Table 1). Present results are partial agreement with the results of Yadav *et al*. (2015) [8] and Suyal *et al*. (2018) [7] as they reported that first appearance of green semilooper on black gram and soybean was recorded during 36th and 33rd SMW, respectively. After that, its larval population was gradually increased and reached at first peak (3.80 larvae/mrl) during 36th SMW (*i.e.* 03rd to 09th September). Similar findings were also reported by Ahirwar *et al*. (2013) [16] Netam *et al*. (2013) [11], Panwar *et al*. (2015) [17], Babu *et al*. (2017) [18], Brahman *et al*. (2018) [13] and Sonule *et al*. (2019) [14] as they recorded its peak during 40th, 35th, 35th, 33rd to 36th, 35th and 35th SMW, respectively.

The correlation studies revealed that morning and evening RH, sunshine, wind speed and rainfall had positive correlation with larval population of green semilooper, but statistically found to be non-significant (Table 2). Similarly, Yadav *et al*. (2015) [8] reported that morning RH, evening RH, wind speed and rainfall had positive correlation found to be non-significant with larval population of green semilooper, but statistically found to be non-significant. Similar findings were partial accordance with the findings of Babu *et al*. (2017) [18] as computed the Morning RH exhibited significantly positive correlation. Further, Suyal *et al*. (2018) [7] observed that morning RH, evening RH, sunshine, wind speed and rainfall had positive correlation non-significant with larval population of green semilooper. On the contrary, Babu *et al*. (2017) [18] reported that evening RH and sunshine had significantly negative correlation with larval population of green semilooper. Whereas, in the present investigation the maximum temperature, minimum temperature and evaporation exhibited negative correlation with larval population of green semilooper but statistically found to be non-significant. Concurrently, Suyal *et al*. (2018) [7] also reported that minimum temperature was expressed negative correlation found to be non-significant. Contrarily, Yadav *et al*. (2015) [8] observed that maximum temperature, minimum temperature had positive correlation found to be non-significant with larval population of green semilooper.

3.4 Pod borer (*Helicoverpa armigera*)

In the present investigation, the first incidence of pod borer (*H. armigera*) on green gram was recorded during 34th SMW (*i.e.* 20th to 26th August) (Fig 1 and Table 1). The larval populations of pod borer were ranged from 0.50-3.30 larvae/mrl. Similar findings are also reported by Umbarkar *et al*. (2010) [19], Ahirwar *et al*. (2016) [20], Jat *et al*. (2017) [21] and Bairwa and Singh (2017) [22] as they recorded first appearance of pod borer on green gram during 31st, 31st, 36th and 34th SMW, respectively. Further, its larval population was slightly increased and reached at its peak (3.30 larvae/mrl) during 38th SMW (*i.e.* 17th August to 23rd September). Similar findings are partial conformity with the findings of Umbarkar *et al*. (2010) [19], Ahirwar *et al*. (2015) [12], Jat *et al*. (2017) [21] and Sonule *et al*. (2019) [14] as they reported that the larval population of pod borer reached its peaks during 37th, 34th, 37th and 36th SMW, respectively.

In the present study, correlation studies revealed that sunshine was exhibited positive correlation (r= 0.29) with pod bore population, but statistically found to be non-significant (Table 2). Contrary, Ahirwar *et al*. (2015) [12] observed that sunshine had significantly negative correlation with larval population of pod borer, but statistically it was non-significant. Whereas, in the present study maximum temperature, minimum temperature, morning RH and RH, wind speed, evaporation and rainfall were expressed negative correlation (r= -0.15 - 0.54, -0.01, -0.09, -0.29, -0.13 and -0.25, respectively) with pod borer population, but statistically found to be non-significant. Similar findings were found by Umbarkar *et al*. (2010) [19] minimum temperature and evening RH exhibited significant negative correlation with the influence of gram pod borer population. On the contrarily, Tamang *et al*. (2017) [23] reported that spotted pod borer population exhibited highly significant positive correlation with minimum temperature and significant negative correlation with maximum temperature on green gram.

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