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Population Dynamics of Gram Pod Borer (*Helicoverpa armigera* Hubner, 1805) and its Larval Parasitoid (*Campoletis chlorideae* Uchida, 1957) on Chickpea

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out to study the population dynamics of gram pod borer (*Helicoverpa armigera* Hubner, 1805) and its larval parasitoid (*Campoletis chlorideae,* Uchida, 1957) on chickpea during the *Rabi* season 2020-21 at College of Agriculture, JNKVV, Tikamgarh (M.P.). The egg and larval population of gram pod borer (*Helicoverpa armigera*) were first observed on vegetative stages at 49th SW (i.e. 3rd to 9th December) and 50th SW (i.e. 10th to 16th December), respectively and were available till the maturity of crop with two peaks i.e. first and second peak at 3rd SW and at 9th SW, respectively. The result of correlation studies revealed that both number of eggs and larval populations were found significant positive correlation with maximum temperature and evaporation. While, both of these egg numbers and larval populations were found to be significant negative correlation with morning RH. The larval parasitoid population (*C. chlorideae*)

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first appeared at vegetative stage of the crop at 51st SW (i.e. 17th to 23rd December) (0.20 parasitoid/*mrl*) with two peak points first at 3rd SW and second at 6th SW. The result of correlation studies revealed that the larval parasitoid population found significant positive correlation with morning RH, whereas it was exhibited significant negative correlation with maximum and minimum temperature and evaporation, respectively.

Keywords: Helicoverpa armigera; campoletis chlorideae; population dynamics; chickpea.

1. INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a most popular legume crop of Fabaceae family which is grown across the world. It is also known as gram, Bengal gram, Chana, Garbanzo bean, Egyptian pea etc. in various region of the world. It is one of the most important pulse crop of India hence it is considered as 'King of pulses' and also 'the poor man's meat' [1]. Chickpea contain highest nutritional composition among any dry edible legume having 23% protein, 47% starch, 56% fat, 6% crude fiber, 6% soluble sugar, 3% ash and oil contains many medicinal and nutritionally important tocopherols, sterols and tocotrienols which are helpful for lowering blood cholesterol [2,3].

India is the largest producer of chickpea in the world with contributing 71 and 70 percent global area production, respectively, and ranks first in area and production of chickpea. Though, it is stay behind from several countries in terms of productivity because of poor adoption of plant protection measures by the chickpea growers [4]. In India, the cultivation of chickpea was occupied during 2020-21 in 10 million ha area with production and productivity of 11.91 million tones and 1192 kg/ha, respectively [5]. The foremost chickpea producing states in India are Madhya Pradesh (26.99%), Maharashtra (20.12%), Rajasthan (19.02%), Gujarat (10.74%) and Uttar Pradesh (6.38%) which are solely contributed about 50% of the Indian pulse production. In Madhya Pradesh, chickpea was cultivated in 2.16 million ha area with the production and productivity of 3.21 million tones and 1488 kg/ha, respectively during 2020-21 [5].

The productivity of chickpea crop has not witnessed any significant jump as compared to the cereal crops, because of several biotic and abiotic constraints. Among the biotic constraints the infestation of insect pests is one of the major limiting factors of chickpea production [6]. Chickpea is infested by nearly 60 different types insect pests among which gram pod borer (*Helicoverpa armigera*), cutworm (*Agrotis ipsilon* Hufnagel, 1766), termite (*Odontotermes obesus* Rambur, 1842) and black bean aphid (*Aphis fabae* Scopoli, 1763) are the major pests (Acharjee and Sharma, 2013 and Chandrashekar *et al.,*[7]. Of them, *H. armigera* is one of the most devastating pests causing severe yield loss and infesting several crops such as cereals, pulses, cotton, vegetables and fruit crops as well as wild hosts. *H. armigera* is distributed throughout India and account for 50 to 60% losses in grain yield Balikai *et al*., [8]. The build-up of larval population of *H. armigera* is dynamically influenced by different weather factors. Moreover, their populations are also significantly regulated by their natural enemies particularly larval parasitoid (*Campoletis chlorideae*). Hence, keeping the above facts in mind the present study was planned to know the effect of biotic and abiotic factors of gram pod borer in chickpea to find out suitable and feasible tactics by understanding its biology and build up of this pest.

2. MATERIALS AND METHODS

A field experiment was conducted to study the population dynamics of gram pod borer (*Helicoverpa armigera* Hubner, 1805) and its parasitoid (*Campoletis chlorideae* Uchida, 1957) on chickpea during the *Rabi* season 2020-21 at Experimental Field of College of Agriculture, JNKVV, Tikamgarh (M.P.), India. The crop variety JG-12 was shown with 30cm x 10cm spacing in total 270 square meter area. All the recommended agronomical practices were followed and the crop was kept free from insecticidal spray.

Observations on the number of eggs and the larval population of *H. armigera* were recorded weekly from one meter row length (*mrl*) at randomly selected ten different sites of the experimental field. Similarly, larval parasitoid (*Campoletis chlorideae*) of *H. armigera* was also recorded from one per *mrl* at randomly selected ten different sites in the field. All these observations was started from the first appearance of the insects and continued till their availability or maturity of the crop. The obtained

data was statistically analyzed through simple correlation coefficient and regression equation among the gram pod borer and its parasitoid with weather parameters by using the formula as described by Snedecor and Cochran [9].

3. RESULTS AND DISCUSSION

3.1 Egg Population of *H. armigera*

The data presented in Table 1 and Fig. 1 revealed that the egg population of gram pod borer was ranged between 0.30-4.80 eggs/*mrl* during *Rabi* season. The incidence of the number of eggs (0.30 eggs/*mrl*) was first appeared on vegetative stage of chickpea crop at 49th SW (i.e. 3rd to 9th December). The number of eggs increased in the following weeks and reached its first peak (2.50 eggs/*mrl*) at 3rd SW (i.e. 15th to 21st January). After that, eggs number slightly declined (1.30 eggs/*mrl*) at 4th SW (i.e. 22nd to 28th January) and (1.10 egg/*mrl*) at 5th SW (i.e. 29th January to 4th February). Then the number of eggs slightly increased again and reached its second peak (4.80 eggs/*mrl*) at 9th SW (i.e. 26th February to 4th March). Later on, the number of eggs gradually declined as the crop reached the maturity stage. The present findings are corroborated with the findings of Dindor *et al.* [10] as they reported that the egg population of gram pod borer first appeared from 49th SW. The two peaks incidence were observed in the finding of Tekam *et al*. [11] indicating a close conformity to present findings.

3.2 Correlation between the Number of Eggs of the Gram Pod Borer and Weather Factors

Correlation studies revealed that the number of eggs showed significantly positive correlation with maximum temperature and evaporation (r = 0.56 and r = 0.56, respectively) (Table 2). The regression equations being as $\bar{Y}$ = -2.61 + 0.17x (R^2 = 0.32) and $\bar{Y}$ = -0.26 + 0.59x (R^2 = 0.31). From these equations it may be expressed that with every unit increase in maximum temperature and evaporation there was an increase of 0.17 and 0.59 eggs number/*mrl* (Fig. 2 and 3, respectively). While, minimum temperature and sunshine exhibited positive correlation (r = 0.21 and r = 0.45, respectively) with the influence on the number of eggs but statistically found to be non-significant. Further, morning RH exhibited significantly negative correlation (r = -0.53) with egg population. The regression equations being as $\bar{Y}$ = 12.65 - 0.12x (R^2 = 0.28). From this equation it may be expressed that with every unit increase in morning RH there was a decrease of 0.12 egg number/*mrl* (Fig. 4).

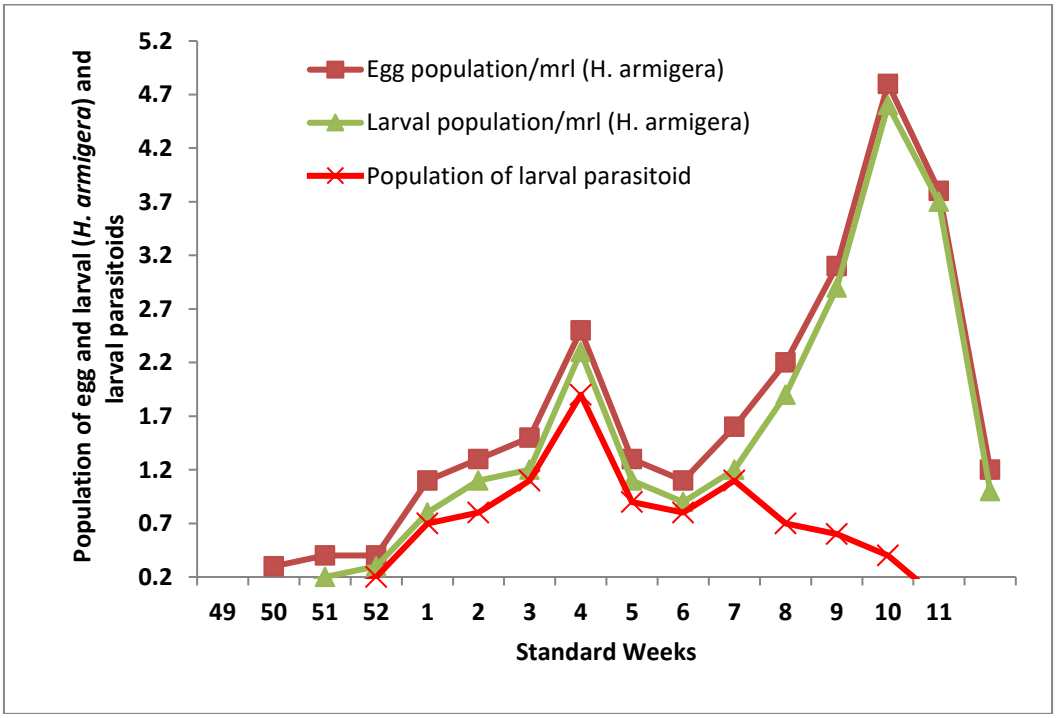

Fig. 1. Occurrence of egg and larval population of *H. armigera*, and larval parasitoid population of *C. chlorideae* in chickpea during *Rabi* 2020-21

Table 1. Population dynamics of egg and larval population of *Helicoverpa armigera* and their larval parasitoid on chickpea crop during *Rabi* 2020-2021

Standard weeks	Number of eggs/*mrl* *(H. armigera)*	Larval population/*mrl* *(H. armigera)*	Population of larval parasitoid (*C. chlorideae*/*mrl*)
49	0.30 #	0.00#	0.00#
50	0.40	0.20	0.00
51	0.40	0.30	0.20
52	1.10	0.80	0.70
1	1.30	1.10	0.80
2	1.50	1.20	1.10
3	2.50	2.30	1.90
4	1.30	1.10	0.90
5	1.10	0.90	0.80
6	1.60	1.20	1.10
7	2.20	1.90	0.70
8	3.10	2.90	0.60
9	4.80	4.60	0.40
10	3.80	3.70	0.00
11	1.20	1.00	0.00

 # Mean of ten observations

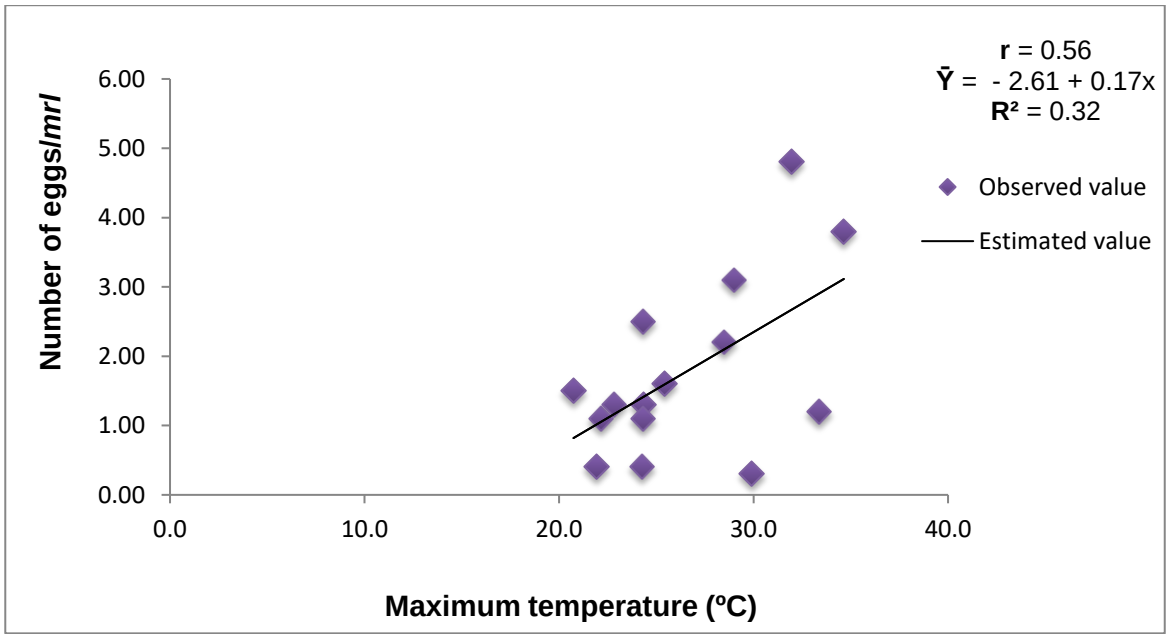

Fig. 2. Regression of maximum temperature (ºC) on number of eggs of gram pod borer in chickpea

Our result fully agreed with findings of Shah and Shahzad [12] as reported that maximum temperature exhibited significantly positive correlation, morning RH showed significantly negative correlation and evening RH exhibited negatively non-significant correlation with eggs number. Jagdish and Agnihotri [13] reported that maximum temperature exhibited significantly positive correlation, minimum temperature had exhibited positively correlated with eggs number but statistically found to be non-significant, evening RH exhibited negatively non-significant correlation, rainfall exhibited negatively non-significant correlation and sunshine had exhibited non-significant positive correlation with egg population. Tekam *et al.* [11] also reported that maximum temperature and evaporation had exhibited significantly positive while, minimum

temperature exhibited positive correlation with eggs number but statistically found to be non-significant. Further, evening RH and rainfall exhibited negatively non-significant correlation while, sunshine had exhibited positive non-significant correlation with the number of eggs.

3.3 Larval Population of *H. armigera*

The population of gram pod borer larvae were ranged between 0.00 - 4.60 larvae/*mrl* during *Rabi* season presented in Table 1 and Fig. 1. The incidence of larval population with 0.20 larvae/*mrl* first appeared on vegetative stage of chickpea crop at 50th SW (i.e. 10th to 16th December). The population of larvae slightly increased upto next four weeks and reached its first peak (2.30 larvae/*mrl*) at 3rd SW (i.e. 15th to 21st January). After that, the larval population slightly declined with 1.10 and 0.90 larvae/*mrl*) during 4th SW (i.e. 22nd to 28th January) and 5th SW (i.e. 29th January to 4th February), respectively. Later on larval population slightly increased and resumed its second peak (4.60 larvae/*mrl*) at 9th SW (i.e. 26th February to 4th March). Then larval population slightly declined with the maturity of crop.

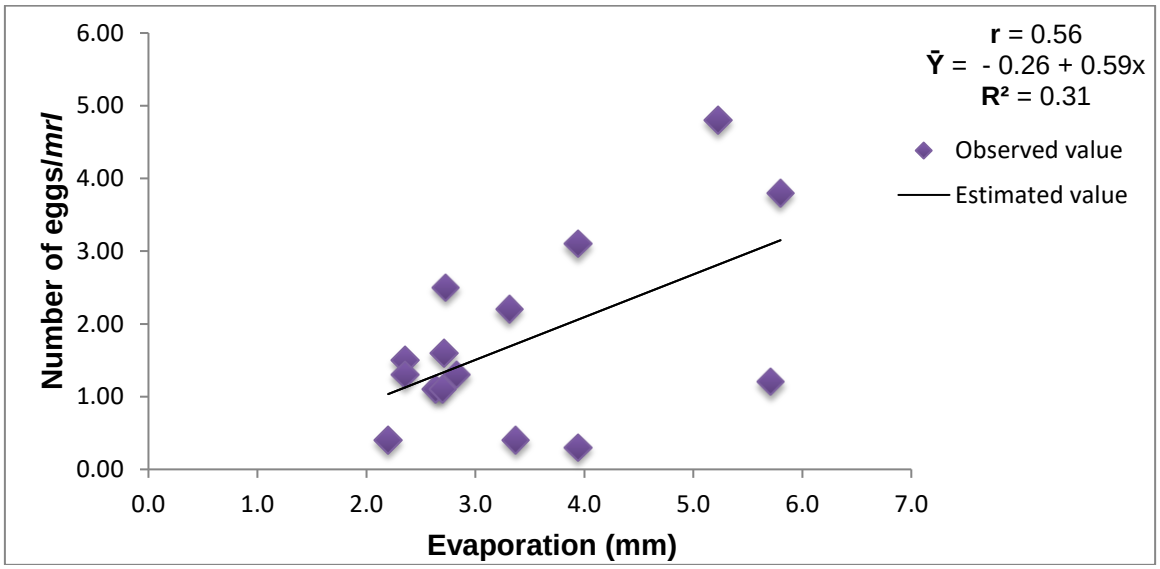

Fig. 3. Regression of evaporation (mm) on number of eggs of gram pod borer in chickpea

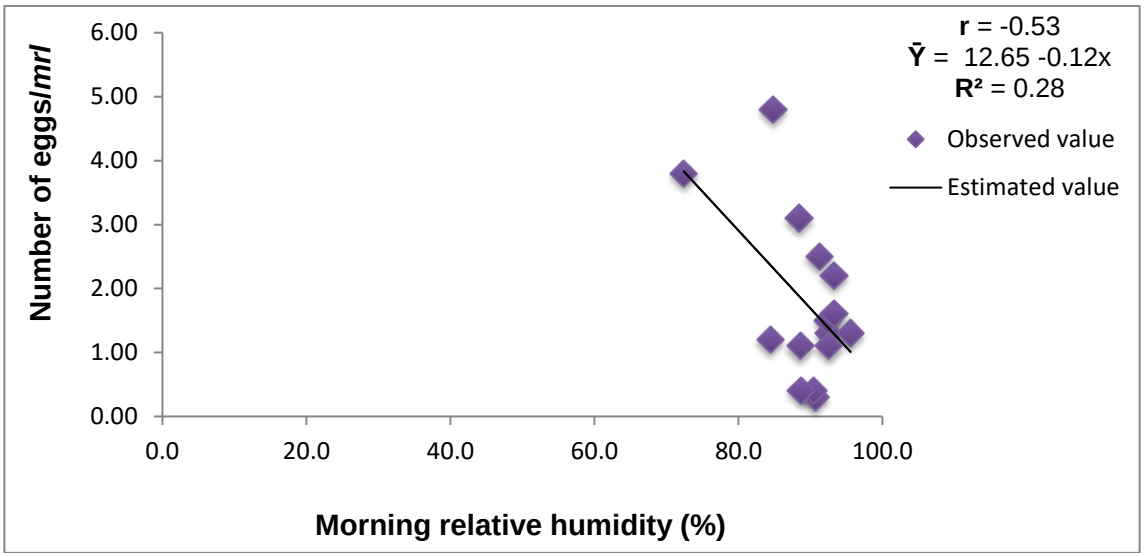

Fig. 4. Regression of morning relative humidity (%) on number of eggs of gram pod borer in chickpea

Table 2. Correlation (r) and regression coefficient (byx) of egg and larval population of *H. armigera* and their larval parasitoid on chickpea with weather parameters

Weather parameter	Eggs population (*H. armigera*)		Larval population (*H. armigera*)		Larval parasitoids (*C. chlorideae*)	
	r	***byx***	***r***	***byx***	***r***	***Byx***
Maximum temperature (ºC)	0.56*	0.17	0.57*	0.17	-0.53*	-0.06
Minimum temperature (ºC)	0.21^{NS}	-	0.21^{NS}	-	-0.56*	-0.09
Morning RH (%)	-0.53*	-0.12	-0.55*	-0.13	0.53*	0.05
Evening RH (%)	-0.51^{NS}	-	-0.51^{NS}	-	0.31^{NS}	-
Sunshine (hrs)	0.45^{NS}	-	0.45^{NS}	-	-0.05^{NS}	-
Rainfall (mm)	-0.35^{NS}	-	-0.34^{NS}	-	-0.31^{NS}	-
Evaporation (mm)	0.56*	0.59	0.57*	0.61	-0.59*	-0.26

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

The first incidence of larval population of gram pod borer on chickpea was also evident from the reports of Yadav *et al.* [14] and Kaneria *et al*. [15] as they also reported that incidence of larval population of gram pod borer on chickpea was started 2nd week of December (50th SW). Similarly, Patel *et al.* [16] partially supported and reported that the incidence of gram pod borer was started from the 2nd week of November which remained till 4th week of February with its peak activity was recorded during 1st and 2nd week of December. Contrarily, Gautam *et al*. [17] and Kumar *et al*. [18] recorded the incidence of gram pod borer population first time during 46th SW while, Sardar *et al.* [19] recorded its incidence first time during 47th SW on chickpea crop. Munni *et al.* [20] Kumar and Srivastava [21] also recorded two peaks of larval population of gram pod borer on chickpea.

3.4 Correlation between Larval Population of *H. armigera* and Weather Factors

The result of correlation studies in Table 2 revealed that larval population exhibited significantly positive correlation with maximum temperature and evaporation (r = 0.57 and r = 0.57, respectively). The regression equations being as $\bar{Y} = -2.93 + 0.17x$ ($R^2 = 0.32$) and $\bar{Y} = -0.55 + 0.61x$ ($R^2 = 0.32$). From the above equations it may be expressed that with every unit increase in maximum temperature and evaporation there were an increase of 0.17 and 0.61 larval population/*mrl* (Fig. 5 and 6, respectively). Minimum temperature and sunshine was exhibited non-significant positive correlation with influence of larval population. Further, morning RH exhibited significant and negative correlation (r= -0.55) with larval population. The regression equations being as $\bar{Y} = 13.10 - 0.13x$ ($R^2 = 0.30$). From this equation it may be expressed that with every unit increase in morning RH there was a decrease of 0.13 larval population/*mrl* (Fig.7). While, evening RH and rainfall expressed negative correlation with larval population but statistically it was found to be non-significant.

The present findings are the full agreement with those of Yadav *et al.* [14] Kumar and Srivastava [21] Spoorthi *et al.* [22] Bahadur *et al.* [23] Singh *et al.* [24] Kumar *et al*. [18] and Waseem and Thakur [25] as they reported that maximum temperature exhibited significantly positive and minimum temperature expressed non-significant positive correlation with the influence of larval population of gram pod borer. Similarly, Meena and Bhatia [26] Sagar *et al.* [27] Bala [28] and Sharma *et al.* [29] also reported that maximum temperature exhibited significantly positive correlation with the influence of larval population of gram pod borer. Further, Meena and Bhatia [26] Bahadur *et al.* [23] and Waseem and Thakur [25] also reported that morning RH had exhibited significant negative correlation with larval population of gram pod borer.

3.5 Population of Larval Parasitoid (*Campoletis chlorideae*)

The data presented in Table 1 and Fig. 1 revealed that the population of larval parasitoid (*C. chlorideae*) was ranged between 0.00-1.90 parasitoid/*mrl* during *Rabi* season. The incidence of parasitoid population first started to appear on vegetative stage of chickpea crop at 51st SW (i.e. 17th to 23rd December) (0.20 parasitoid/*mrl*). The population of parasitoid increased in the following weeks and reached its first peak (1.90

parasitoid/*mrl*) at 3rd SW (i.e. 15th to 21st January). After that the parasitoid population gradually declined 0.90 parasitoid/*mrl* and 0.80 parasitoid/*mrl* at 4th SW (i.e. 22nd to 28th January) and 5th SW (i.e. 29th January to 4th February), respectively and again resumed its second peak (1.1 parasitoid/*mrl*) during 6th SW (i.e. 5th to 11th February). Later on this trend slightly declined toward the maturity of crop. The present findings are in full conformity with those of Devi *et al.* [30] and Kaur *et al*. [31] as they found the percentage of parasitism ranged from 0.18 to 23.81% and 0.02 to 1.50 cocoons/*mrl,* respectively. Similarly, Bisane *et al*. [32] also observed that the occurrence of *C. chlorideae* firstly observed at 51st SW until 3rd SW and caused 8.11 to 11.54% parasitisation in chickpea. Further, Singh *et al.* [24] indicated that larval parasitization by *C. chlorideae* was first observed in 3rd week of December (*i.e*., 51st SW) this result is in close conformity with the present finding.

3.6 Correlation between Larval Parasitoid (*C. chlorideae*) and Weather Factors

The result of correlation studies revealed that larval parasitoid population showed significantly positive correlation with morning RH (r= 0.53) (Table 2). The regression equations being as $\bar{Y}$ = -3.92 + 0.05x (R^2 = 0.28). From this equation it may be expressed that with every unit increase in morning RH there was an increase of 0.05 parasitoid population/*mrl* (Fig.8). While, evening RH exhibited positive correlation (r = 0.31 respectively) with the influence of larval parasitoid population but statistically found to be non-significant. Further, maximum temperature, minimum temperature and evaporation

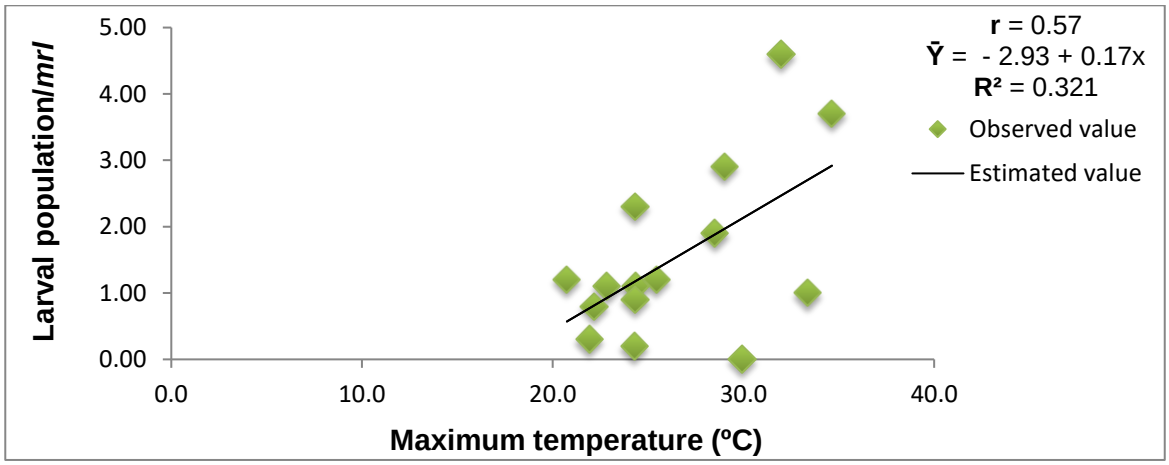

Fig. 5. Regression of maximum temperature (ºC) on larval population of gram pod borer infesting chickpea

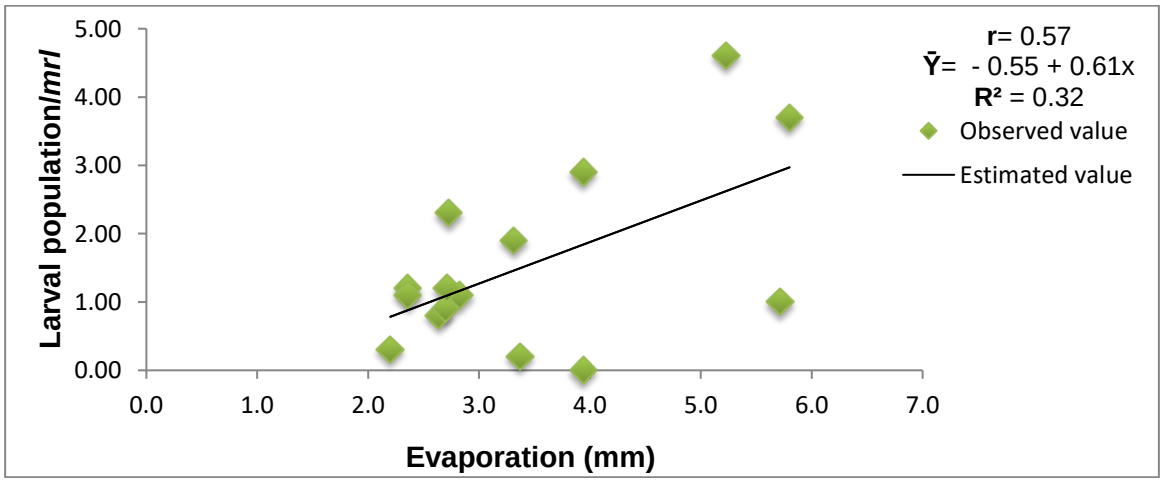

Fig. 6. Regression of evaporation (mm) on larval population of gram pod borer infesting chickpea

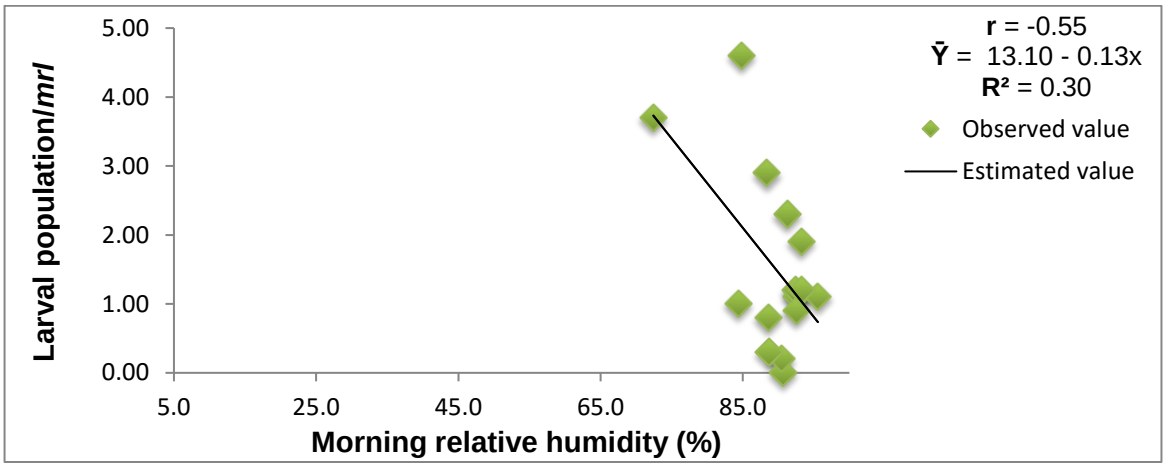

Fig. 7. Regression of morning relative humidity (%) on larval population of gram pod borer infesting chickpea

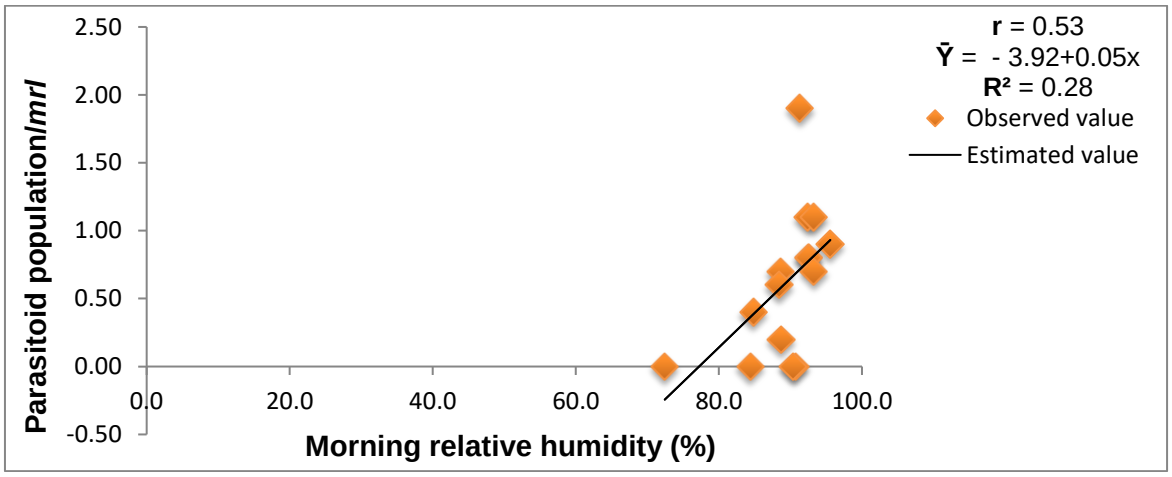

Fig. 8. Regression of morning relative humidity (%) on larval parasitoid population of gram pod borer in chickpea

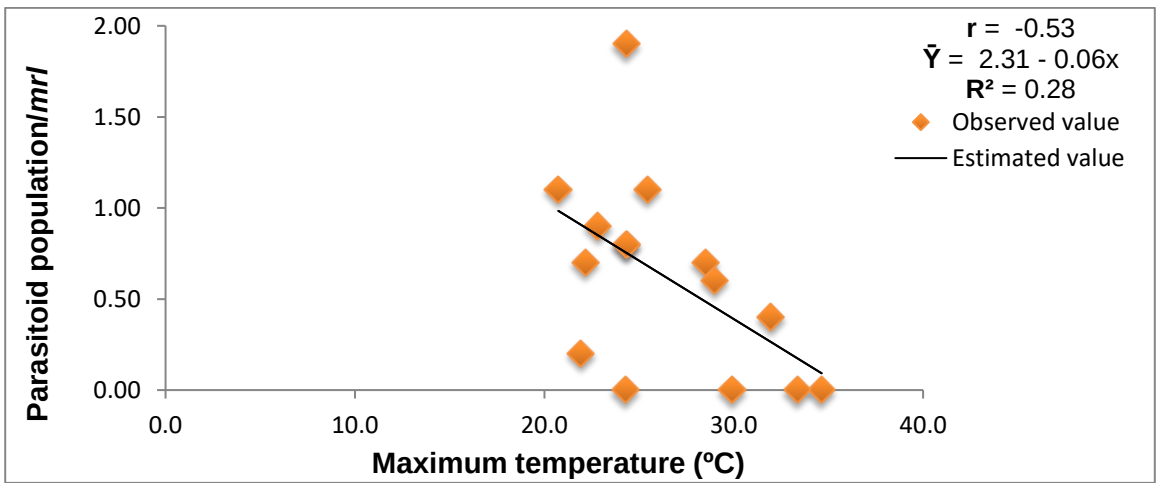

Fig. 9. Regression of maximum temperature (ºC) on larval parasitoid population of gram pod borer in chickpea

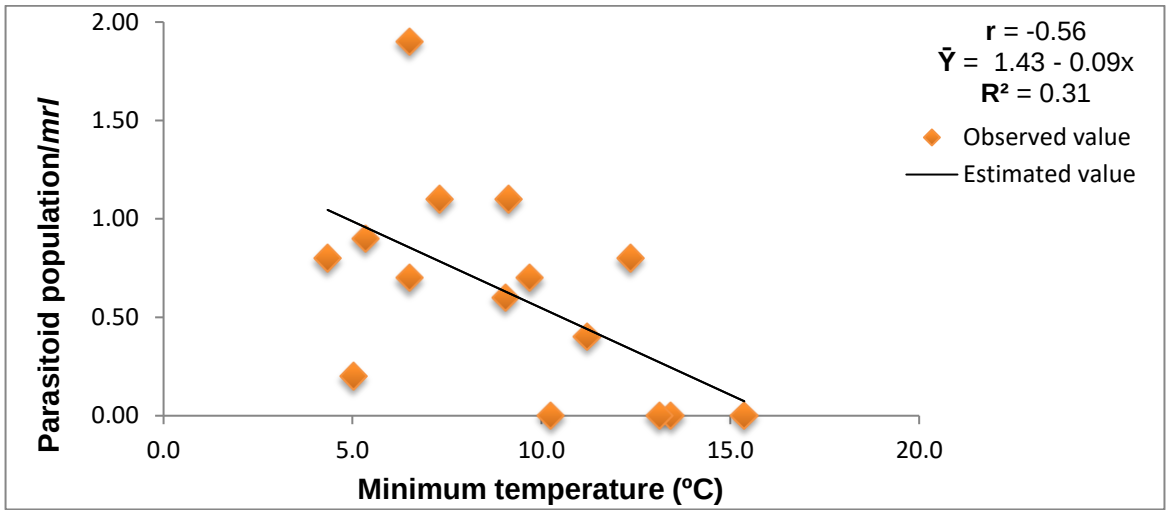

Fig. 10. Regression of minimum temperature (ºC) on larval parasitoid population of gram pod borer in chickpea

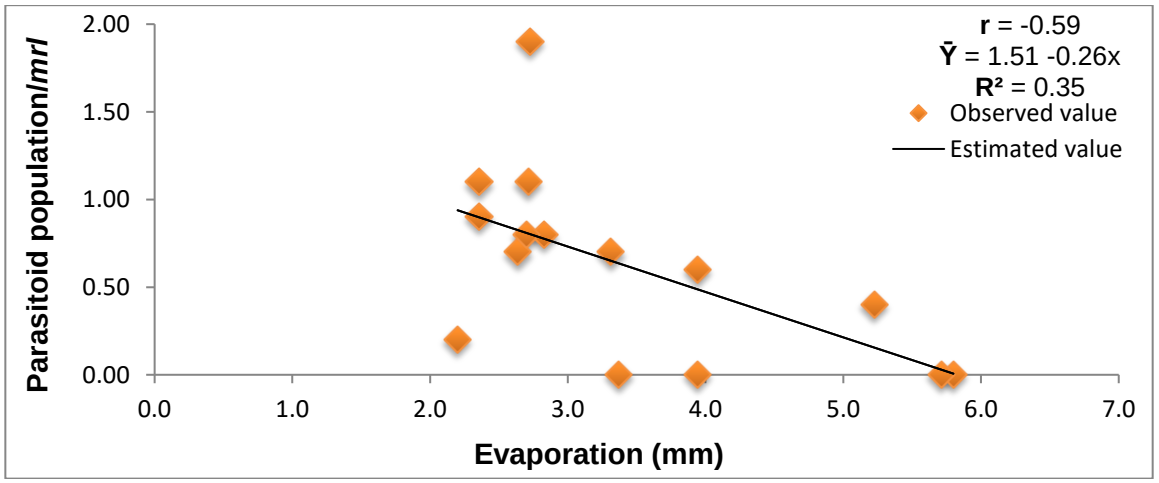

Fig. 11. Regression of evaporation (mm) on larval parasitoid population of gram pod borer in chickpea

exhibited significant and negative correlation (r = -0.53, r = -0.56 and r = -0.59, respectively) with larval parasitoid population. The regression equations being as $\bar{Y}$ = 2.31 - 0.06x (R^2 = 0.28), $\bar{Y}$ = 1.43 - 0.09x (R^2= 0.31) and $\bar{Y}$ = 1.51 - 0.26x (R^2 = 0.35). From this equation it may be expressed that with every unit increase in maximum temperature, minimum temperature and evaporation there was a decrease of 0.06, 0.09 and 0.26 larval parasitoid population/*mrl* (Fig. 9, 10 and 11, respectively). While, sunshine and rainfall exhibited non-significant negative correlation (r = -0.05 and r = -0.31, respectively) with parasitoid population.

Similar findings was also reported by Bhagat *et al*. [33] and Divija and Agnihotri [34] as they computed that maximum temperature and minimum temperature exhibited significantly negative correlation with the influence of parasitoid population (*C. chlorideae*) and morning relative humidity had exhibited significantly positive correlation with parasitoid population. Similarly, Munni *et al.* [20] reported that *C. chlorideae* exhibited reciprocal relationship with weather parameters and suppressed the larval population of gram pod borer in chickpea crop [35].

4. CONCLUSION

It was concluded that the number of eggs and the larval population of gram pod borer was first observed on vegetative stages and was available

till the maturity of crop with two peak points first peak at 3rd SW and second peak at 9th SW, respectively. The result of correlation studies revealed that both eggs number and larval populations was found significant positive correlation with maximum temperature and evaporation. While, both the number of eggs and the larval populations were found significantly negative correlation with morning RH. The parasitoid population first appeared at vegetative stage of the crop with two peak points i.e., first at 3rd SW and second at 6th SW. The result of correlation studies revealed that the parasitoid population found significant positive correlation with morning RH, whereas it was exhibited significant negative correlation with maximum and minimum temperature and evaporation, respectively.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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