Original Research Article

Population dynamics of gram pod borer (*Helicoverpa armigera* Hubner) and its larval parasitoid (*Campoletis chlorideae*) on chickpea

Abstract

The present investigation was carried out to study the population dynamics of gram pod borer (*H. armigera* Hubner) and its larval parasitoid (*Campoletis chlorideae*) 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*) was 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 was 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 egg and larval populations was found significant positive correlation with maximum temperature and evaporation. While, both of these egg and larval populations was found significant negative correlation with morning RH. The larval parasitoid population (*C. chlorideae*) was 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.

Key words: *Helicoverpa armigera*, *Campoletis chlorideae*, population dynamics, chickpea.

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INTRODUCTION

Chickpea (*Cicer arietinum* L.) is a legume crop of Fabaceae family which is grown across the world. It is also known as Bengal gram, Chana, Garbanzo, etc, is one of the most important pulse crop of India and it considered as 'King of pulses' and 'the poor man's meat' (Bhatt and Patel, 2001). Chickpea has one of the highest nutritional compositions among any dry edible legume contains 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 is helpful for lowering blood cholesterol (Haq *et al*., 2007 and Pittaway *et al*., 2008).

India is the largest producer of chickpea in the world sharing 65% area and 70% of total global production. India ranks first in area and production of chickpea while it is remain behind from several countries in terms of productivity because of poor adoption of plant protection technology by the farmers (Samriti *et al.,* 2020).In India, the total area of chickpea was occupied during 2020-21 in 9.85 million ha with production and productivity of 11.99 million tones and 1217 kg/ha, respectively (Anonymous, 2022).The major chickpea producing states are Madhya Pradesh, Uttar Pradesh, Rajasthan, Maharashtra, Gujarat, Andhra Pradesh and Karnataka which are sharing over 95% area. In Madhya Pradesh, chickpea was cultivated in 2.10 million ha area with the production and productivity of 3.13 million tones and 1488 kg/ha, respectively (Anonymous, 2022).

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 (Bhagwat *et al.*, 1995). Chickpea is infested by nearly 60 different types insect pests among which gram pod borer (*Helicoverpa armigera* Hubner), cutworm (*Agrotis ipsilon* Hufnagel), termite (*Odontotermes obesus* Rambur) and black bean aphid (*Aphis fabae* Scopoli) are the major importance pests (Acharjee and Sharma, 2013 and Chandrashekar *et al.* 2014). Of them, gram pod borer, *H. armigera* is one of the devastating key pests causing severe yield loss and infesting several crops such as cereals, pulses, cotton, vegetables and fruit crops as well as wild hosts too. *H. armigera* is distributed throughout the India and account for 50 to 60% losses in grain yield (Balikai *et al*., 2001). Its larval population builds up apparently influenced by various weather factors. Moreover, their populations are greatly fluctuating by their natural enemy's especially larval parasitoid (*Campoletis chlorideae*). Hence, keeping the above facts in view 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.

MATERIALS AND METHODS

A field experiment was conducted to study the population dynamics of gram pod borer (*Helicoverpa armigera* Hubner) and its parasitoid (*Campoletis chlorideae*) 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 number of eggs and 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 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 (1967).

RESULTS AND DISCUSSION

Egg population of gram pod borer (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 egg population (0.30 eggs/*mrl*) was first appeared on vegetative stage of chickpea crop at 49^{th} SW (i.e. 3^{rd} to 9^{th} December). The population of egg was increased in succeeding weeks and reached its first peak (2.50 eggs/*mrl*) at 3^{rd} SW (i.e. 15^{th} to 21^{st} January). After that, the egg population was slightly declined (1.30 eggs/*mrl*) at 4^{th} SW (i.e. 22^{nd} to 28^{th} January) and (1.10 egg/*mrl*) at 5^{th} SW (i.e. 29^{th} January to 4^{th} February). After that egg population was again slightly increased in succeeding weeks and reached its second peak (4.80 eggs/*mrl*) at 9^{th} SW (i.e. 26^{th} February to 4^{th} March). Later on egg population was slightly declined as the crop reached toward the maturity stage. The present findings are corroborated with the findings of Dindor *et al.* (2020) as they reported that the egg population of gram pod borer first appeared from 49^{th} SW. The two peak incidence was observed in the finding of Tekam *et al*. (2018) indicating a close conformity to present finding.

Correlation between egg population of gram pod borer and weather factors

Correlation studies revealed that egg population was 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 this 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 egg population/*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 of egg population 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 population/*mrl* (Fig. 4). The present findings are the full agreement with findings of Shah and Shahzad (2005), as reported that maximum temperature exhibited significantly positive correlation, morning RH showed significantly negative correlation and evening RH exhibited negatively non-significant correlation with egg population. Jagdish and Agnihotri (2015) as reported that maximum temperature exhibited significantly positive correlation, minimum temperature had exhibited positively correlated with egg population 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.* (2018) also reported that maximum temperature exhibited significantly positive correlation, minimum temperature had exhibited positively correlated with egg population but statistically found to be non-significant, evening RH exhibited negatively non-significant correlation, rainfall exhibited negatively non-significant correlation, sunshine had exhibited non-significant positive correlation, evaporation exhibited significantly positive correlation with egg population.

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Larval population of gram pod borer (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* was 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). Later on larval population was slightly declined with the maturity of crop. The first incidence of larval population of gram pod borer on chickpea was also evident from the reports of Yadav *et al.* (2016) and Kaneria *et al*. (2018) 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.* (2015) 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*. (2018) and Kumar *et al*. (2019) recorded the incidence of gram pod borer population first time during 46th SW while, Sardar *et al.* (2018) recorded its incidence first time during 47th SW on chickpea crop. Munni *et al.* (2013), Kumar and Srivastava (2017) and Kaneria *et al.* (2018) as they recorded two peaks of larval population of gram pod borer on chickpea.

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Correlation between larval population of H. armigera and weather factors

The result of correlation studies in Table 2 revealed that larval population was 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 was an increase of 0.17 and 0.61 larval population/*mrl* (Fig. 5 and 6, respectively). While, minimum temperature and sunshine exhibited non-significant positive correlation with the 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 the findings of Yadav *et al.* (2016), Kumar and Srivastava (2017), Spoorthi *et al.* (2017), Bahadur *et al.* (2018), Singh *et al.* (2018), Kumar *et al*. (2019) and Waseem and Thakur (2019) 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 (2014), Sagar *et al.* (2017), Bala (2020) and Sharma *et al.* (2020) also reported that maximum temperature exhibited significantly positive correlation with the influence of larval population of gram pod borer. Further, Meena and Bhatia (2014), Bahadur *et al.* (2018) and Waseem and Thakur (2019) as they reported that morning RH had exhibited significant negative correlation with larval population of gram pod borer. Contrarily, Patel *et al.* (2015) reported that larval population of *H. armigera* was significantly negative correlation with evaporation.

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Population of larval parasitoid (Campoletis chlorideae)

The data presented in Table 1 and Fig. 1revealed that the population of larval parasitoid (*C. chlorideae*) were 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 51^{st} SW (i.e. 17^{th} to 23^{rd} December) (0.20 parasitoid/*mrl*). The population of parasitoid increased in succeeding weeks and reached its first peak (1.90 parasitoid/*mrl*) at 3^{rd} SW (i.e. 15^{th} to 21^{st} January). After that the parasitoid population was gradually declined 0.90 parasitoid/*mrl* and 0.80 parasitoid/*mrl* at 4^{th} SW (i.e. 22^{nd} to 28^{th} January) and 5^{th} SW (i.e. 29^{th} January to 4^{th} February), respectively and again resumed its second peak (1.1 parasitoid/*mrl*) during 6^{th} SW (i.e. 5^{th} to 11^{th} February). Later on this trend was slightly declined toward the maturity of crop. Present findings are full conformity with the findings of Devi *et al.* (2002) and Kaur *et al*. (2004) 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*. (2008) also observed that the occurrence of *C. chlorideae* firstly observed at 51^{st} SW until 3^{rd} SW and caused 8.11 to 11.54% parasitisation in chickpea. Further, Singh *et al.* (2018) indicated that larval parasitization by *C. chlorideae* was first observed in 3^{rd} week of December (*i.e*., 51^{st} SW) this result is close conformity with the present finding.

Correlation between larval parasitoid (C. chlorideae) and weather factors

The result of correlation studies revealed that larval parasitoid population was 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 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 larval population. Similar findings was also reported by Bhagat *et al*. (2020) and Divija and Agnihotri (2021) 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.* (2013) reported that *C. chlorideae* exhibited reciprocal relationship with weather parameters and suppressed the larval population of gram pod borer in chickpea crop.

CONCLUSION

It was concluded that the egg and 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 egg and larval populations was found significant positive correlation with maximum temperature and evaporation. While, both of these egg and larval populations was found significant negative correlation with morning RH. The parasitoid population was first appeared at vegetative stage of the crop with two peak points 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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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	**Egg population /*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

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

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

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

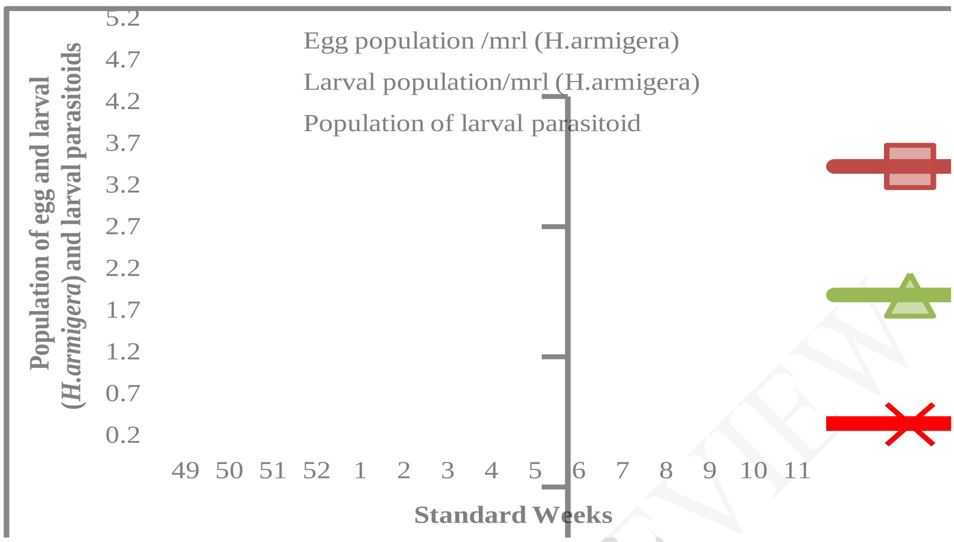

Fig. 1: Occurrence of egg and larval population (*H. armigera*) and larval parasitoid (*C. chlorideae*) on chickpea during *Rabi* 2020-21

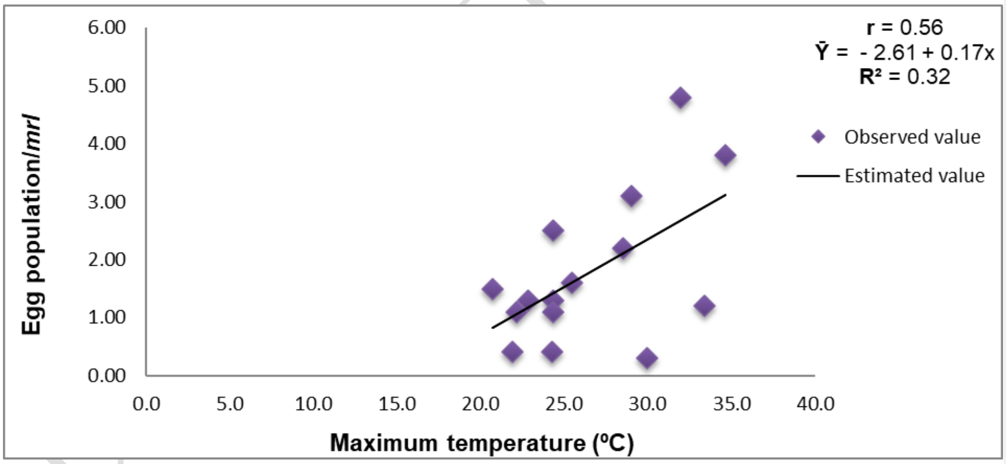

Fig. 2: Regression of maximum temperature (ºC) on egg population of gram pod borer on chickpea

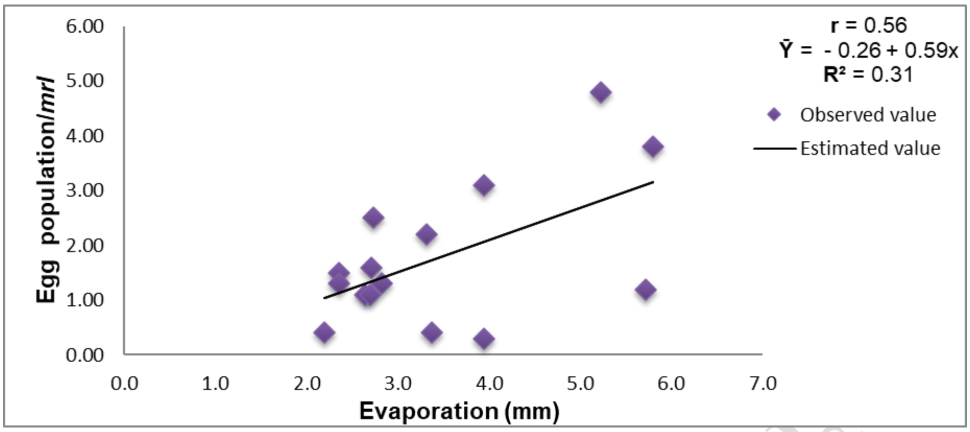

Fig. 3: Regression of evaporation (mm) on egg population of gram pod borer on chickpea

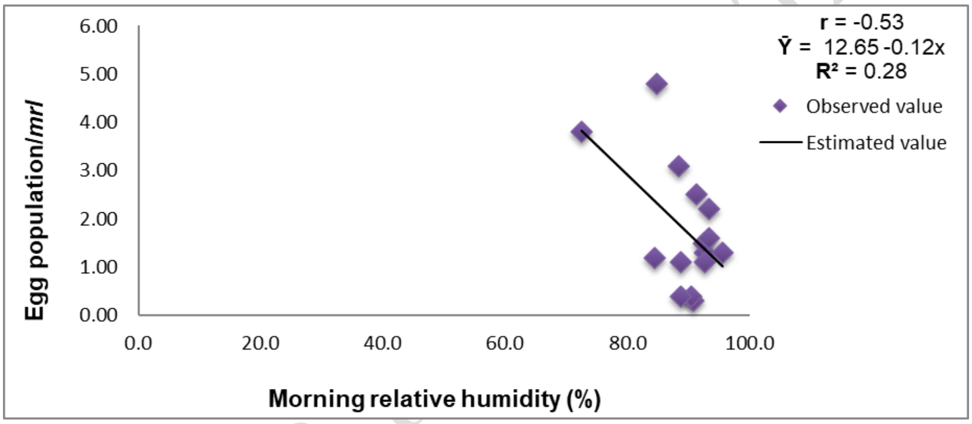

Fig. 4: Regression of morning relative humidity (%) on egg population of gram pod borer on chickpea

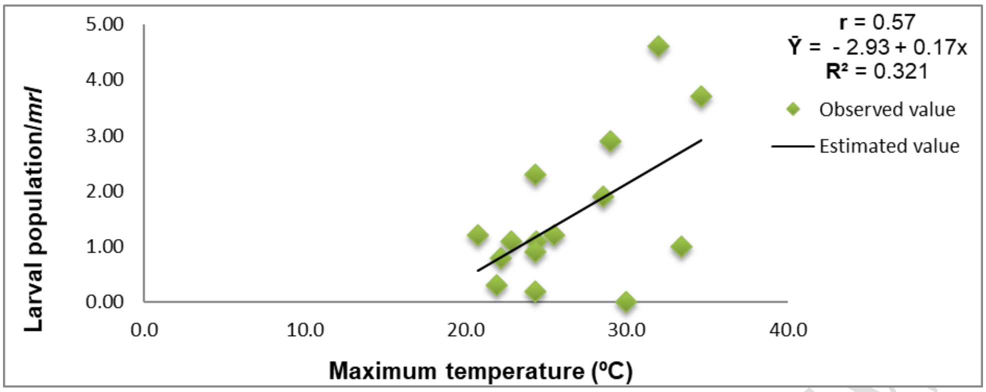

Fig. 5: Regression of maximum temperature (ºC) on larval population of gram pod borer infesting chickpea

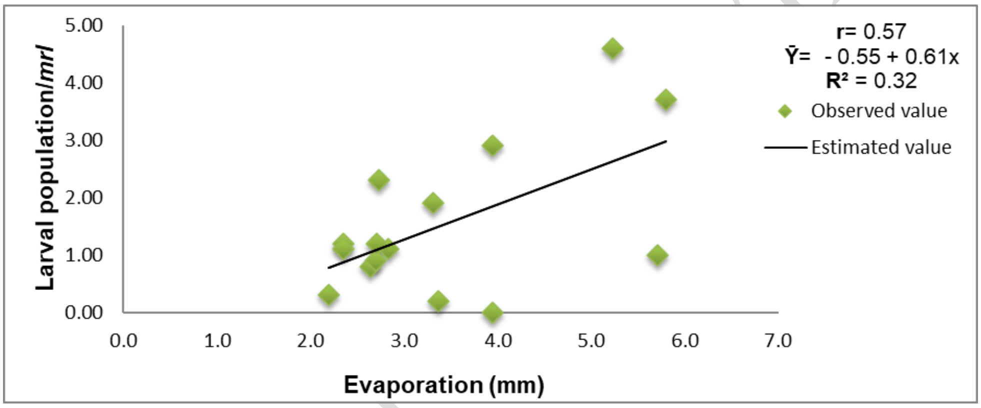

Fig. 6: Regression of evaporation (mm) on larval population of gram pod borer infesting chickpea

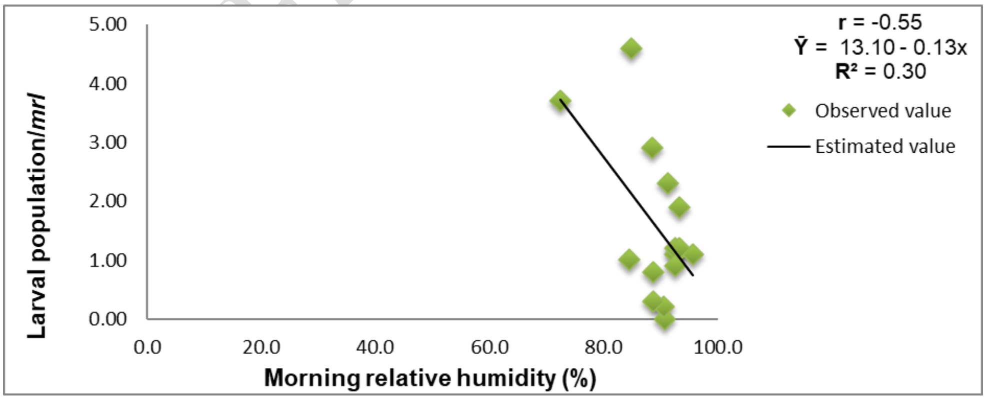

Fig. 7: Regression of morning relative humidity (%) on larval population of gram pod borer infesting chickpea

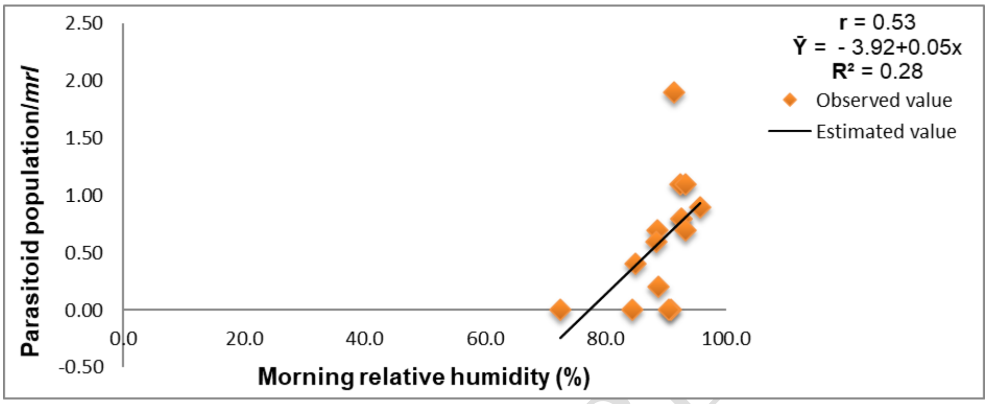

Fig. 8: Regression of morning relative humidity (%) on larval parasitoid population of gram pod borer on chickpea

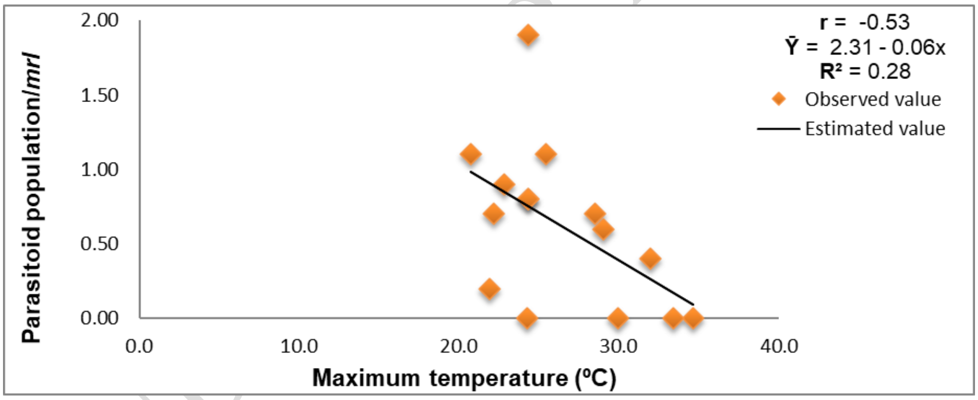

Fig. 9: Regression of maximum temperature (ºC) on larval parasitoid population of gram pod borer on chickpea

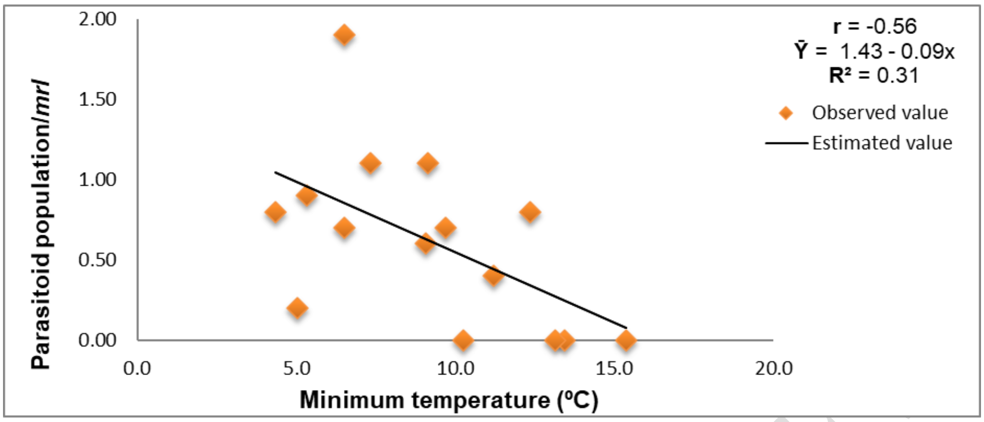

Fig. 10: Regression of minimum temperature (ºC) on larval parasitoid population of gram pod borer on chickpea

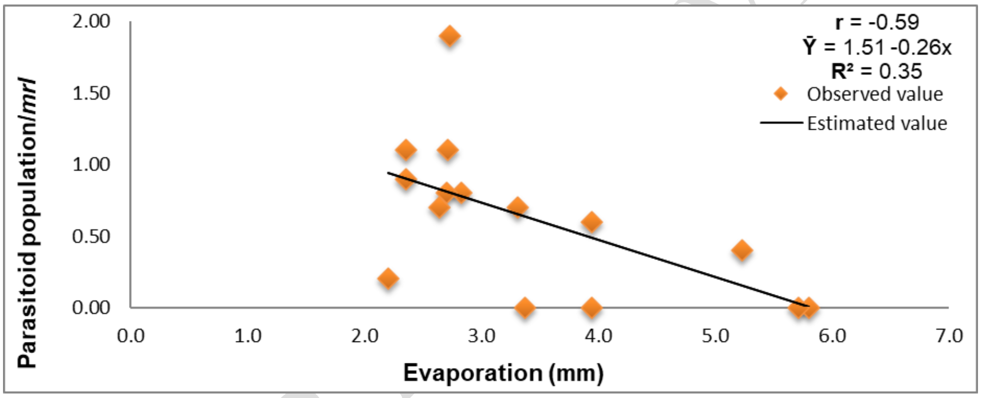

Fig. 11: Regression of evaporation (mm) on larval parasitoid population of gram pod borer on chickpea