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Population Fluctuations with Reference to Different Developmental Stages of *Helicoverpa armigera* (Lepidoptera: Noctuidae) on Chickpea and Their Relationship with the Environment

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ABSTRACT

Studies were conducted to monitor the seasonal changes in the population of *Helicoverpa armigera* pod borer pest of chickpea. Data revealed that the pest population was low during 49^{th} to 6^{th} standard weeks but increased from 7^{th} standard week onwards and declined again during 14^{th} standard week. A positive correlation existed between the eggs, larval instars and overall density of *H. armigera* and the average maximum and minimum temperatures. However, a negative correlation existed between the eggs, larval instars and overall density of *H. armigera* and the average morning percent relative humidity. The eggs, larval instar and overall density of this pest held no relationship with evening percent relative humidity.

Key Words: Population; Eggs; Larval instars; *Heliothis armigera;* Gram; Relative Humidity; Temperature

INTRODUCTION

Gram pod borer, *Helicoverpa armigera* (Hubner) plays a detrimental role in the destruction of chickpea crop which is the world's third most important pulse crop (Rheenen & Van Rheenen, 1991), grown in the semi-arid tropics around the world (Jodha & Rao, 1987). The countries affected by the devastating attack of *H. armigera* on chickpea include India, Pakistan, Turkey, Mexico, Iran, Australia and Ethiopia (FAO, 1994). *H. armigera* often causes substantial damage to the crop at the pod formation stage (Lal *et al*., 1985; Naresh & Malik, 1986; Deka *et al*., 1987).

The moths begin ovipositing on chickpea at the seedling stage but this behavior is checked by the adverse climatic and geographical conditions (Tahhan *et al*., 1982; Lal, 1996). *H. armigera* starts devouring the young shoots, leaves and pods whatever available soon after hatching. A large number of entomologists studied the population fluctuations of *H. armigera* on ckickpea (Dakwale & Singh, 1980; Deka *et al*., 1989; Prasad *et al*., 1989; Patnaik & Senapati, 1996; Khurana, 1997; Patel & Koshiya, 1997, 1999) and observed population peaks in different months of the year. The population peaks generally corresponds to the full bloom and pod formation stage of chickpea (Deka *et al*., 1987; Lal, 1996; Patel & Koshiya, 1999). Many other factors including temperature and humidity (Yadava *et al*., 1991; Yadava & Lal, 1988), rainfall (Tripathi & Sharma, 1985), predators (Thakur *et al*., 1995; Gunathilagaraj, 1996) and parasitoids (Bhatnagar, 1980; Srinivas & Jayaraj, 1989; Thakur *et al*., 1995) can also affect *H. armigera* population.

The extent of damage inflicted by *H. armigera* to chickpea depends not only on the number of larvae but also on its developmental stages (Tripathi & Sharma, 1984). No study has so far reported population fluctuations with reference to eggs and larval instar densities under field conditions. Therefore, the aim of this study was to describe the population dynamics of *H. armigera* in terms of eggs and larval instars. The role of environmental factors affecting these variations has also been described.

MATERIALS AND METHODS

The present study was carried out at the experimental fields of Ayub Agricultural Research Institute, Faisalabad during Rabi season 2001-02. Chickpea variety cv-90395 was sown during mid November with row to row distance of 45 cm and plot size of 100.8 m^2.

Observations were recorded weekly throughout the growing season of the crop by counting the number of eggs and different larval instars of *H. armigera* on randomly selected twenty plants while walking diagonally across the field. The identification criteria for different larval instars were based on the color pattern and size which was modified after Mathews and Tunstall (1994). The first instar larvae were usually yellowish white and the second being yellowish. Third and forth instar larvae were yellowish green or greenish yellow with slight and dominant streaks respectively on the body while fifth and sixth were green in color. The effect of maximum and minimum temperatures and average morning and evening RH (%) was also related with the population fluctuations at different development stages of *H. armigera* by using software SPSS 10.0, SPSS® Inc., Chicago, USA.

RESULTS

Population fluctuations. *H. armigera* made its first appearance in the 49th standard week on chickpea crop and its overall population kept on increasing until it reached 8 larvae per 20 plants during 1st standard week (Fig. 1). Its population started to decline afterwards and reached 2 individuals per 20 plants during the 5th and 6th standard weeks. The population started to rise again and its second peak (109 individuals per 20 plants) was observed in the 13th standard week and began to decline again in the following week (93 pests per 20 plants).

Eggs of *H. armigera* were first noticed in the 3rd standard week. However, a consistent appearance of eggs was observed from 7th standard week onward (Fig. 2). During this period, minimum number of eggs (2 eggs per 20 plants) was observed during the 9th standard week and maximum numbers of eggs (26 eggs per 20 plants) were seen during 13th standard week. The fluctuations in the population density of *H. armigera* in terms of 1st instar larvae showed a very similar pattern to that of its overall population pattern (Fig. 1) except that none of the 1st instar larvae were confronted during 5th and 6th standard weeks. Contrary to 1st instar larvae, none of the 2nd instar larvae was found during the 49th to 51st, and 5th and 6th standard weeks. Very low density of 2nd instar larval was noticed during 52nd and 1st to 4th standard weeks. Their consistent appearance was noted from 7th standard week and onward and reaching maximum number (19 larvae per 20 plants) during the 14th standard week. The population density of the 3rd instar larvae showed much more fluctuations compared to other larval instar densities. Steady appearance of 3rd instar larvae was noticed from 8th standard week and onward, reaching maximum (15 larvae per 20 plants) during the 14th standard week. The 4th instar larvae did not appear from 49th up to 4th standard week. The increasing trend in the population density of 4th instar larvae was observed from 9th standard week and onward with maximum density (12 larvae per 20 plants) during the 14th standard week. The 5th instar larvae were not observed from 49th up to 6th standard week. However, they appeared from 7th standard week and remained consistent through rest of the crop season. Lowest population density (1 larva per 20 plants) of 5th instar larvae was noted during the 8th standard week and peaking (6 larvae per 20 plants) during 13th standard week. The 6th instar larvae first appeared during the 8th standard week, but became consistent from 10th standard week and onward.

Data revealed that the relative numerical importance of larval instars was in decreasing order from the1st instar to the 6th instar *i.e.* 32, 18, 14, 9, 5 and 4%, respectively while the relative importance of eggs was comparable to that of 2nd instar (Fig. 3).

Correlation studies. There was a significant positive correlation among the eggs, larval instars and overall density of *H. armigera* and the average maximum and minimum temperatures (Table I). A negative correlation was observed between the eggs, larval instars and overall density of *H. armigera* and the average morning relative humidity, while no correlation was observed between the eggs, larval instars and overall density of *H. armigera* and the average evening relative humidity.

Fig. 1. Overall population density of gram pod borer (*Helicoverpa armigera*) on chickpea observed during Rabi Season 2001-02

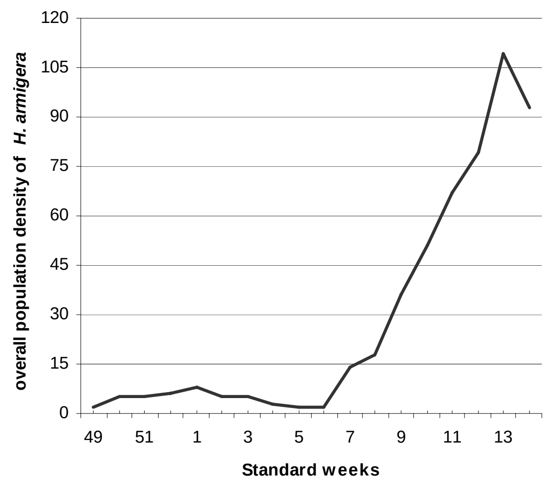


Fig. 2. Population fluctuations in the eggs and larval instars density of gram pod borer (*Helicoverpa armigera*) on chickpea observed during Rabi Season 2001-02

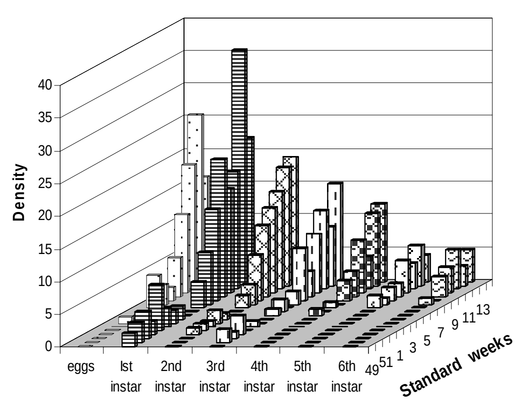
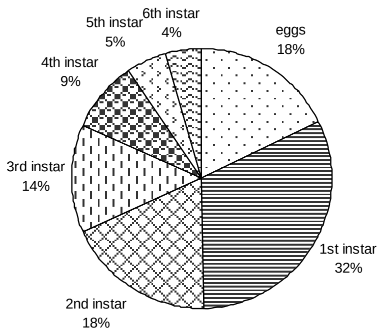


Fig. 3. Relative numerical importance (% ages) of different developmental stages of *Helicoverpa armigera* on Chickpea during Rabi Season 2001-02



DISCUSSION

The results revealed that the chickpea cultivar-90395 was quiet vulnerable to the attack of *H. armigera* larvae when compared to the other chickpea variety (Deka *et al.*, 1987); the former (cv-90395) was attacked very early and offered less resistance compared to the latter. Other possible reason for this vulnerability may be that it was a late sown cultivar (Chaudary & Sachan, 1995; Prasad & Sing, 1997; Borah, 1998).

In addition, variation in the environmental and geographical conditions can also be considered as main factors in the incidence of this pest (Tahhan *et al*., 1982; Lal, 1996). The present field was irrigated and in such fields larval density of *H. armigera* is always greater than in non-irrigated ones (Qadeer & Singh, 1989).

After their first appearance, the pest started to increase slowly (Yadava & Lal, 1988; Lal, 1996) but when the temperature became lower in January and February, it declined. The minimum number of the early instar larvae of *H. armigera* during winter months was due to the fact that the early instar larvae had less tolerance to the prevailing cool temperature, and hence resulted in their retarded growth and greater mortality (Olla & Saini, 2000). As the early instar larvae were unable to grow properly and survive, there was complete absence of late instar larvae in December and January (Fig. 1). The population of *H. armigera* flourished during second half of February and outbreak situations were found throughout March (Lal, 1996), probably owing to the optimum temperature and abundant food in the form of pods. This is in accordance with other studies which state that the peaks of *H. armigera* larval population generally corresponds to appropriate climatic conditions (Dakwale & Singh, 1980) or full bloom and pod formation stage of the crop (Deka *et al.*, 1987; Lal, 1996; Patel & Koshiya, 1999). Contrary to this, Saini and Juglan (1998) observed that only a few larvae were present at the pod formation stage.

The correlations between the larval population density of *H. armigera* and mean temperature and relative humidity ranges observed during the course of present study were in agreement to that noticed in other studies (Mehto *et al*., 1985; Yadava *et al*., 1991). According to these studies the mean temperature had significant positive correlation with population density of *H. armigera* while mean relative humidity had significantly negative correlation with the *H. armigera* larval population (Table I). Patnaik and Senapati (1996) however, found a negative correlation between mean temperature ranges and larval incidence.

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REFERENCES

Bhatnagar, V.S., 1980. A report on research on *Heliothis* complex at ICRISAT (India), 1974–79. *Int. Crops Res. Instt. for the Semi–Arid Tropics*, pp. 23. India

Borah, R.K., 1998. Influence of sowing dates on the infestation of *Helicoverpa armigera* and grain yield of chickpea in the hill zone of Assam. *Indian J. Entomol*., 60: 416–7

Chaudhary, R.R.P. and R.B. Sachan, 1995. Comparative efficacy and economics of some insecticides against gram pod borer *Helicoverpa armigera* (Hubner) in chickpea in western plain of Uttar Pradesh. *Bhartiya Krishi Anusandhan Patrika*, 10: 159–64

Table I. Correlation coefficient between the eggs, larval instars and overall density of gram pod borer (*Helicoverpa armigera*) and average maximum and minimum temperature and average morning and evening relative humidity in the study area during Rabi Season 2001-02

	Average maximum temperature (°C)	Average minimum temperature (°C)	Average morning relative humidity (%)	Average evening relative humidity (%)
Eggs	0.8681 *	0.8252 *	-0.7907 *	-0.4588 $^{N.S}$
1st instar	0.7617 *	0.8039 *	-0.6951 *	-0.2794 $^{N.S}$
2nd instar	0.8538 *	0.8806 *	-0.8150 *	-0.3765 $^{N.S}$
3rd instar	0.8173 *	0.8580 *	-0.7905 *	-0.3176 $^{N.S}$
4th instar	0.8093 *	0.8075 *	-0.8346 *	-0.4362 $^{N.S}$
5th instar	0.8345 *	0.8006 *	-0.7492 *	-0.4412 $^{N.S}$
6th instar	0.8623 *	0.8589 *	-0.7432 *	-0.3746 $^{N.S}$
overall	0.8632 *	0.8737 *	-0.8077 *	-0.3888 $^{N.S}$

1. * = Correlation is significant at 0.05 level 2. $^{N.S}$ = Correlation is insignificant at 0.05 level

Dakwale, R.N. and R. Singh, 1980. Logistic growth curve in *Heliothis armigera* population. *Geobios*, 7: 57–60

Deka, N.K., D. Prasad, and P. Chand, 1987. Succession and incidence of insect pests in chickpea, *Cicer arietinum* L. *Giornale Italiano di Entomol.*, 3: 421–8

Deka, N.K., D. Prasad and P. Chand, 1989. Plant growth, *Heliothis* incidence and grain yield of chickpea as affected by date of sowing. *J. Res. Birsa Agric. Univ.*, 1: 161–8

FAO, 1994. *Production Year Book*. Food and Agriculture Organization of the United Nations, Rome, Italy

Gunathilagaraj, K., 1996 Management of *Helicoverpa armigera* in chickpea with *Acridotheres tristis*. *Madras Agric. J.*, 83: 72–3

Jodha, N.S. and K.V.S. Rao, 1987. Chickpea: world importance and distribution. *In:* Saxena, M.C. and K.B. Sing, (eds.) *The Chickpea*, pp. 1–10. Wallington, CAB Intern., UK

Khurana, A.D., 1997. Seasonal activity and chemical control of *Helicoverpa armigera* (Hubner) on chickpea. *J. Insect Sci.*, 10: 48–51

Lal, O.P., 1996. An outbreak of pod borer, *H. armigera* (Hubner) on chickpea in Eastern Uttar Pradesh, India. *J. Entomo. Res.*, 20: 179–81

Lal, S.S., C.P. Yadava and C.A.R. Dias, 1985. Assessment of crop losses in chickpea caused by *H. armigera*. *FAO Pl. Protect. Bull.*, 33: 27–35

Mathews, G.A. and J.P. Tunstall, 1994. "*Insect Pests of Cotton*" CAB Intern. Publishers, Cambridge University, UK

Mehto, D.N., K.M. Singh and R.N. Singh, 1985. Incidence of insect pests in chickpea *Cicer arietinum* Linn. *Indian J. Entomol.*, 47: 117–36

Naresh, J.S. and V.S. Malik, 1986. Observations on the insect pests of chickpea (*Cicer arietinum* L.) in Haryana. *Bull. Entomol.*, 27: 75–7

Olla, G.S. and R.K. Saini, 2000. Survival of *Heliothis armigera* (Hubner) larvae on chickpea through winter months in the field in Northern India. *J. Entomol. Res.*, 24: 383–6

Patel, C.C. and D.J. Koshiya, 1997. Seasonal abundance of American bollworm, *Helicoverpa armigera* on different crop hosts at Junagadh (Gujarat). *Indian J. Entomol.*, 59: 396–401

Patel, C.C. and D.J. Koshiya, 1999. Population dynamics of gram pod borer, *Helicoverpa armigera* (Hubner) Hardwick on cotton, pigeon pea and chickpea. *Gujarat Agric. Univ. Res. J.*, 24: 62–7

Patnaik, H.P. and B. Senapati, 1996. Trends in *Helicoverpa* egg, larval and adult population changes in the chickpea environment of Orissa. *Indian J. Pl. Protect.*, 24: 18–23

Patnaik, H.P., B. Senapati, L.K. Rath, R. Mohapatra and S. Mohapatra, 1995. The role of natality in population fluctuations of the gram–caterpillar, *Helicoverpa armigera* (Hubner) on chickpeas. *ACIAR Food Legume Newsl.*, 22: 10–1

Prasad, C.S. and V.P. Singh, 1997. Impact of variety, sowing date and control measures on incidence of pod borer, *Helicoverpa armigera* (Hub.) and yield of chickpea. *Ann. Pl. Protect. Sci.*, 5: 26–8

Prasad, D., P. Chand, N.K. Deka and R. Prasad, 1989. Population dynamics of *Heliothis armigera* (Hub.) on chickpea. *Giornale Italiano di Entomol.*, 4: 223–8

Qadeer, G.A. and Y.P. Singh, 1989. Some observations on outbreak of gram pod–borer on gram during Rabi 1987–88 in Haryana. *Pl. Prot. Bull.*, 41: 1–2

Rheenen, H.A.V and H.A. Van Rheenen, 1991. Chickpea breeding, progress and prospects. *Pl. Breeding Abst.*, 61: 997–1009

Saini, R.K. and R.S. Juglan, 1998. Incidence of *Helicoverpa armigera* (Hubner) in chickpea during different months. *Ann. Agric. Biol. Res.*, 3: 101–3

Srinivas, P.R. and S. Jayaraj, 1989. Record of natural enemies of *Heliothis armigera* from Coimbatore district, Tamil Nadu. *J. Biol. Control.*, 3: 71–2

Tahhan, O., S. Sithanantham, G. Hariri and W. Reed, 1982. *Heliothis* species infesting chickpeas in northern Syria. *Int. Chickpea Newsl.*, 6: 21

Thakur, J.N, J.P. Singh, O.P. Verma and M.C. Diwakar, 1995. Bioecological studies on gram pod borers *Heliothis* species under Jammu conditions. *J. Adv. Zool.*, 16: 118–22

Tripathi, S.R. and S.K. Sharma, 1985. Population dynamics of *Heliothis armigera* (Hubner) (Lepidoptera Noctuidae) on gram in the Terai belt of N. E. Uttar Pradesh. *Giornale Italiano di Entomol.*, 2: 347–53

Yadava, C.P. and S.S. Lal, 1988. Relationship between certain abiotic and biotic factors and the occurrence of gram pod borer, *Heliothis armigera* (Hbn.) on chickpea. *Entomon*, 13: 3–4

Yadava, C.P., S.S. Lal, R. Ahmad and J.N. Sachan, 1991. Influence of abiotic factors on relative abundance of podborers of chickpea (*Cicer arietinum*). *Indian J. Agric. Sci.*, 61: 512–5

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