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Full Length Research Paper

Studies of occurrence of pod borer *Heliothis viriplaca* in relation to the phenology of chickpea in rain-fed chickpea fields in Kermanshah region of Iran

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In order to determine the seasonal occurrence of *Heliothis viriplaca* as well as the best timing of sprays in relation to the phenology of chickpea, light-traps and monitoring methods were applied. All experiments were conducted in two research stations (Mahidasht and Sararood) in 2003 and 2004. The results of adult moths caught by light-traps showed that this pest has only one generation per year and the maximum adult population density appears in the field from end May until early June. The results show that the population density of *H. viriplaca* was 95% while population density of *Helicoverpa armigera* and *Helicoverpa peltigera* were 2 and 3%, respectively. A comparison of the flight peak, the peak of pod borer oviposition, peak of activity of larvae populations and the phenology of plant showed that a period of 13 to 15 days after the flight peak of *H. viriplaca* was most appropriate for chemical control. This time period coincided with 50% of plant flowering. The field experiments showed that fully grown larvae of *H. viriplaca* were parasitized by the *Habrobracon hebetor*, but in this time, most of the larvae had bored the pod of chickpea so this parasitic wasp is likely not to be an adequate agent for pest control.

Key words: Pod borer, *Heliothis viriplaca*, phenology, light trap.

INTRODUCTION

Chickpea *Cicer arietinum* L. is the third most important grain legume crop in the world (Romeis et al., 2004), and it is important as food, feed and fodder (Singh, 1997). In Iran, the climate of this plant producing area is mainly cool and cold semi-arid with a high variability in rainfall (Soltani et al., 1999). Although relative to other pulses, chickpea has remarkably few insect pest problems (Williams et al., 1991), however some of this pest such as *Heliothis* larvae do cause extensive damage and control method need to be developed. The legume pod borer *Heliothis viriplaca* Huf. is the major insect pest of chickpeas in Iran. In some years, the damage of this pest is so severe that chickpea yield was reduced to about 90% (Kahrarian, 2009).This pest is distributed in Middle East, Central England through Europe to Altai Mountains to Morocco and Algeria (Kravchenco et al., 2005), and in the eastern Mediterranean countries such as Turkey and Syria (Weigand, 1996). Early instar larvae (usually I and II instar) of this pest initially feed on parenchymal tissue of leaves and reproductive organs (flower and blossoms), while, late instar larvae (usually III, IV and V instars) bored pods and feed on the seeds.

In the old sources of Iran, this pest is mostly mistaken with similar species such as *Helicoverpa armigera*. Behdad (1989) expressed two to three generation for this pest, but Jozeian (2002), and Mahjob and kaviani (2002), suggested one generation in Ilam and kermanshah provinces, respectively. Other experiment showed that *H.viriplaca* has only one generation in Syria, Turkey (Saxena et al., 1996) and Israel (Kravchenco et al., 2005). Knowing the exact time of using pesticides is one of the most important conditions for use of pesticides. Unfortunately, in many cases, spraying time is inappropriate. A large number of entomologists studied the population fluctuations of *H. armigera* on ckickpea (Deka et al., 1989; Prasad et al., 1989; Patnaik and Senapati, 1996; Khurana, 1997; Patel and Koshiya, 1997, 1999) but research on population fluctuation of *H.*

viriplaca is limited. The aim of this study was to determine the seasonal occurrence of this pest as well as the best timing of sprays in relation to the phenology of chickpea. In addition, number of generation of this pest in western Iran using photo trap and monitoring methods was also recorded.

MATERIALS AND METHODS

Seasonal occurrence of *H. viriplaca* and host plant phenology

Recorded different stages of plant growth

In order to get more accurate information from chickpea phenology and compare it with the various developmental stages of pest, peas were planted in an area of 2000 m^3 of lands, in two research stations; Mahidasht and Sararood belonged to Pest and Diseases Research Center of Kermanshah, Iran (34°N, 46°79 E; 1352 m and 34°23 N, 47°8 E; 1351 m elevation, respectively). After growing peas, different growth stages were studied in these two fields. The following information were noted; 1) emergency stage; 2) flowering stage; 3) 50% of flowering stage; 4) beginning of pod formation; 5) 50% of pod formation stage.

Randomly assigned, 50 pea plants were chosen, at each visit. Number of flowers to bloom, were counted. This method continued until the 50% flower became to blossom. Also, 50 pea plants were selected from each visit after pod formation and the number of pods than the flowers was counted. This method continued until 50% of the flowers became pod.

Determination of the seasonal occurrence of H.viriplaca

To study the population fluctuations of adult moths, and providing accurate information from the time of emergence, and adult moths flying peak, light traps with fluorescent lamps were placed in two research stations; Sararood and Mahidasht. Based on the approximate date of emergence of adult moths, light traps were placed in both areas, almost two weeks before appearing on adult insects. Adult moths caught by light traps, were counted every day, and were noted in separate forms. In addition, the containers containing pesticide were replaced every two weeks. Due to numerous problems, in the second year, light trap were installed, only at Sararood Research Station, and data collection was done only in this area.

Determination of the egg density and distribution

In order to obtain distribution of eggs and laying rate of this pest, pea fields were monitored, twice weekly. 100 plants were selected randomly, from each field and the number of eggs was counted. Each selected plant was divided into three parts, high, middle and end of pea plants. In each visit, front and under surface of 50% leaves per plant were counted and the number of eggs was notes, if egg was seen.

Larvae counting

After chickpea emergence, field visits were made once every three days. As and when *H. viriplaca* larvae appeared, fields were visited once every week. For this purpose, 100 plants from each field were selected randomly, and larvae in each plant were counted. Larvae were grouped by size into three types; small (instar I and II), moderate (instar III and IV) and large (V instar larvae and prepupa).

Population density in other species of pod borer

In addition to *H. viriplaca*, other species that had been caught by light traps were identified each day. With this method, the population of these species was identified.

Possibility of natural enemies

To record the population of emerging parasitoid adults, larvae were collected from insecticide free fields and kept under laboratory conditions (25±2°C and relatively humidity 70±5%).

RESULTS

The results of adult moth catches with light traps in Mahidasht research station showed that the adult first appeared in late April 2003. The peak incidence was recorded during May 15 to 22. Later, the population reduced and was nil during the end of May until 26 June (Figure 1). Results obtained from adult moths caught by light traps in two years in the research station Sararood, showed that the first adult moths were caught in late April. Maximum adult population density appeared in the field from May 20 to 27, and May 10 to 17, in 2003 and 2004, respectively (Figure 1) and finally reached zero. Both sexes were caught by the light trap. On the other hand, females mating were attracted to the light traps.

Counting egg density and egg distribution

Results of egg counts are shown in Figure 2. Results show that females of *H. viriplaca*, laid from early May (average, 14 days after adult flight peak) and the average laying ended in early June. Usually, the eggs were placed in a batch of four to ten, in the back of the leaves. Most of these eggs were trailed in the third top of chickpea.

Larvae counting

Results from counting larvae, showed that the first small larvae of these pests, were seen from early May (May 5), and after this, the population of small larvae, increased, so in late May (25 until 30 May 2004), it reached the highest density. At this time, medium and large larvae were found in low densities (Figure 3).

Record different growth stages of chickpea

Results related to the recorded different growth stages of pea plants are expressed in Tables 1, 2 and 3. The results show that, in the first year, at Mahidasht research station, 50% of flower formation in pea plants, was at

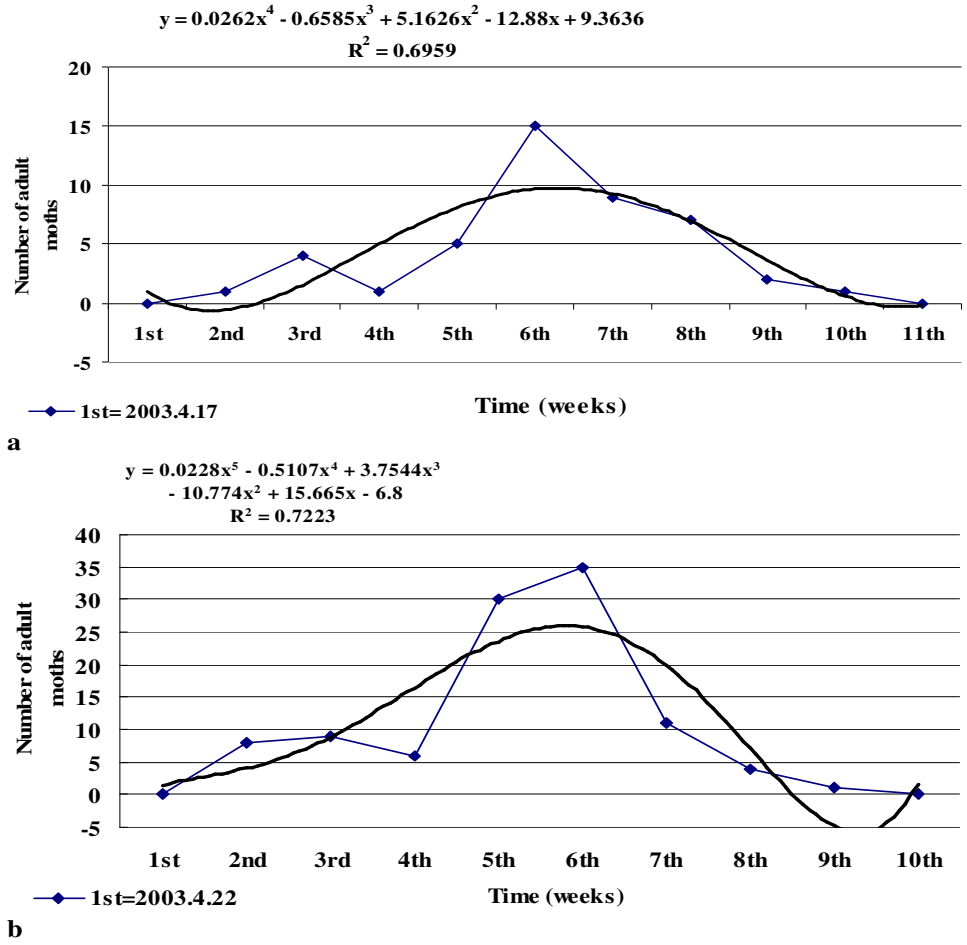
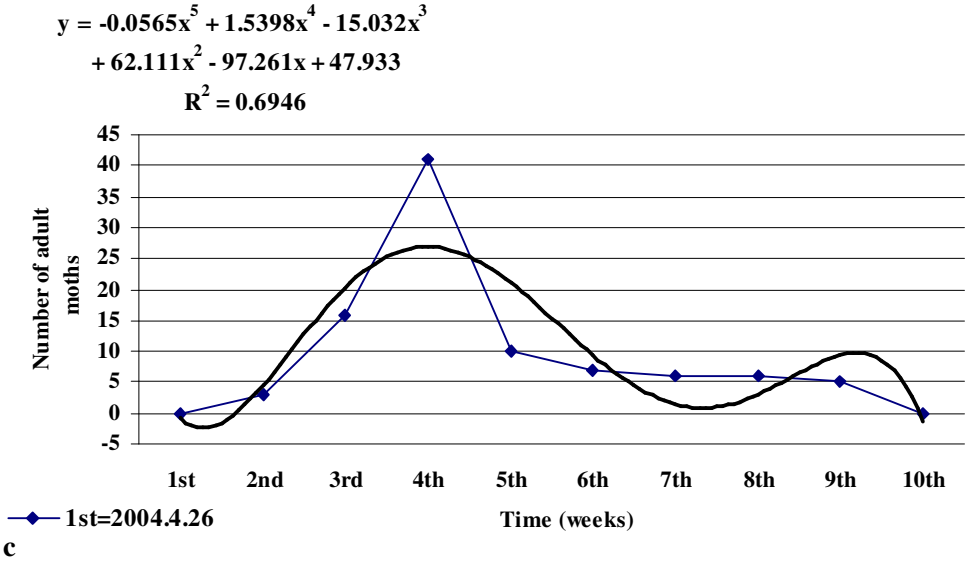


Figure 1. Illustration of adult moths of *H. viriplaca* caught by light trap. a) Mahidasht research station in 2003; b) Sararood research station in 2003; c) Sararood research station in 2004.



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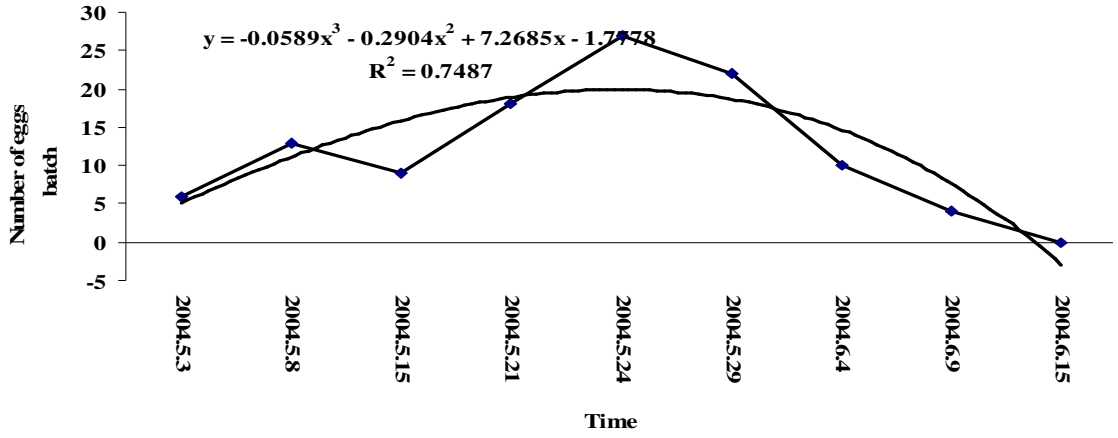

Figure 2. Counted eggs batch of *Heliothis viriplaca* in Sararood research station in 2004.

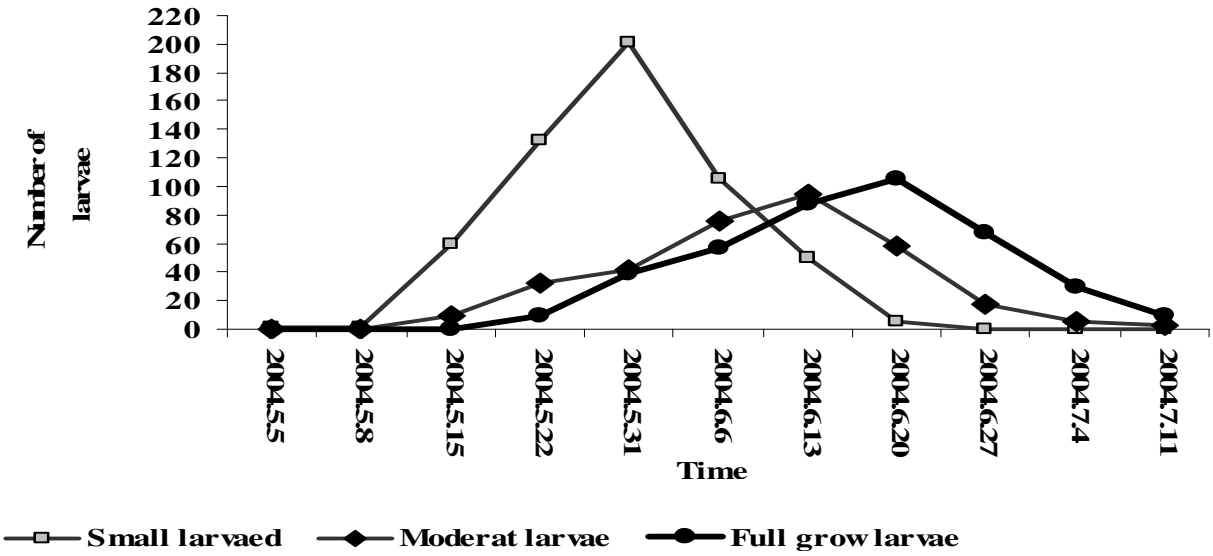

Figure 3. Illustration of counted larvae of *H. viriplaca* in Sararood research station in 2004.

early June (June 4) and 50% of pea pods formation, was at mid-June (June 11) while in Sararood Research Station, 50% of flower formation, in 2003 and 2004 were on June 11, and May 31, respectively, and 50% of pods formation in 2003 and 2004, were on June 15, and June 5, respectively (Figure 4).

Comparison of flight peak of *H. viriplaca* with different stage of growth in chickpea

Comparison of flight peak of *H.viriplaca*, with different stages of growth in pea plants showed that, in Mahydsht Research Station, 50% of flower formation in pea plants was concurrent with 13 days after flight peak of *H.viriplaca*,. In Srarood research station, 50% flowering stage during the two years (2003 and 2004), were concurrent with 15 and 14 days after flight peak of this pest, respectively. The results show that, 14 to15 days after flight peak of *H. viriplaca* coincided with 50% of chickpea flowering (Figure 5).

Comparison of the peak population density of small larvae of *H. viriplaca* with different stage of growth in chickpea

Results related to recorded peak population density of small larvae (instar I and II) with different stage of growth in chickpea show that peak population density of small

Table 1. Different growth stages of chickpea in Mahidasht research station in 2003.

Stage growth of chickpea	Date
Planting	2003.3.21
Emergency stage	2003.4.6
Early of flowering	2003.5.25
50% 0f flowering	2003.6.4
Early of podding	2003.6.4
50% 0f podding	2003.6.11

Table 2. Different growth stage of chickpea in Sararood research station in 2003 at 2003**.**

Stage growth of chickpea	Date
Planting	2003.3.20
Emergency stage	2003.4.5
Early of flowering	2003.5.25
50% 0f flowering	2003.6.11
Early of podding	2003.6.10
50% 0f podding	2003.6.15

Table 3. Different growth stage of chickpea in Sararood research station in 2004.

Stage growth of chickpea	Date
Planting	2004.3.16
Emergency stage	2004.3.29
Early of flowering	2004.5.21
50% 0f flowering	2004.5.31
Early of podding	2004.5.30
50% 0f podding	2004.6.5

larvae (instar I and II) was simultaneous with 50% of flowering in pea plants (Figure 6).

Determination of the best time of chemical control

According to the results obtained from the light trap placed in Mahydsht research station, and records from different growth stages of chickpea in this region, it was found that there was 13 days gap between the flight peak of *H.viriplaca*, and 50% of flowering in pea plants. However, in the research station Sararood, during two consecutive years, the results show that there were 15 and 14 days interval between the flight peak of *H.viriplaca*, and 50% of flowering in pea plants, respectively. On the other hand, the results of larvae counted, showed that about 14 days after adult flight peak of *H.viriplaca* is the peak population density of small larvae (instar I and II). Considering that the peak population density of small larvae, is the best time for the chemical control with this pest, so it can be stated that approximately 14 days after peak flight, is the best time

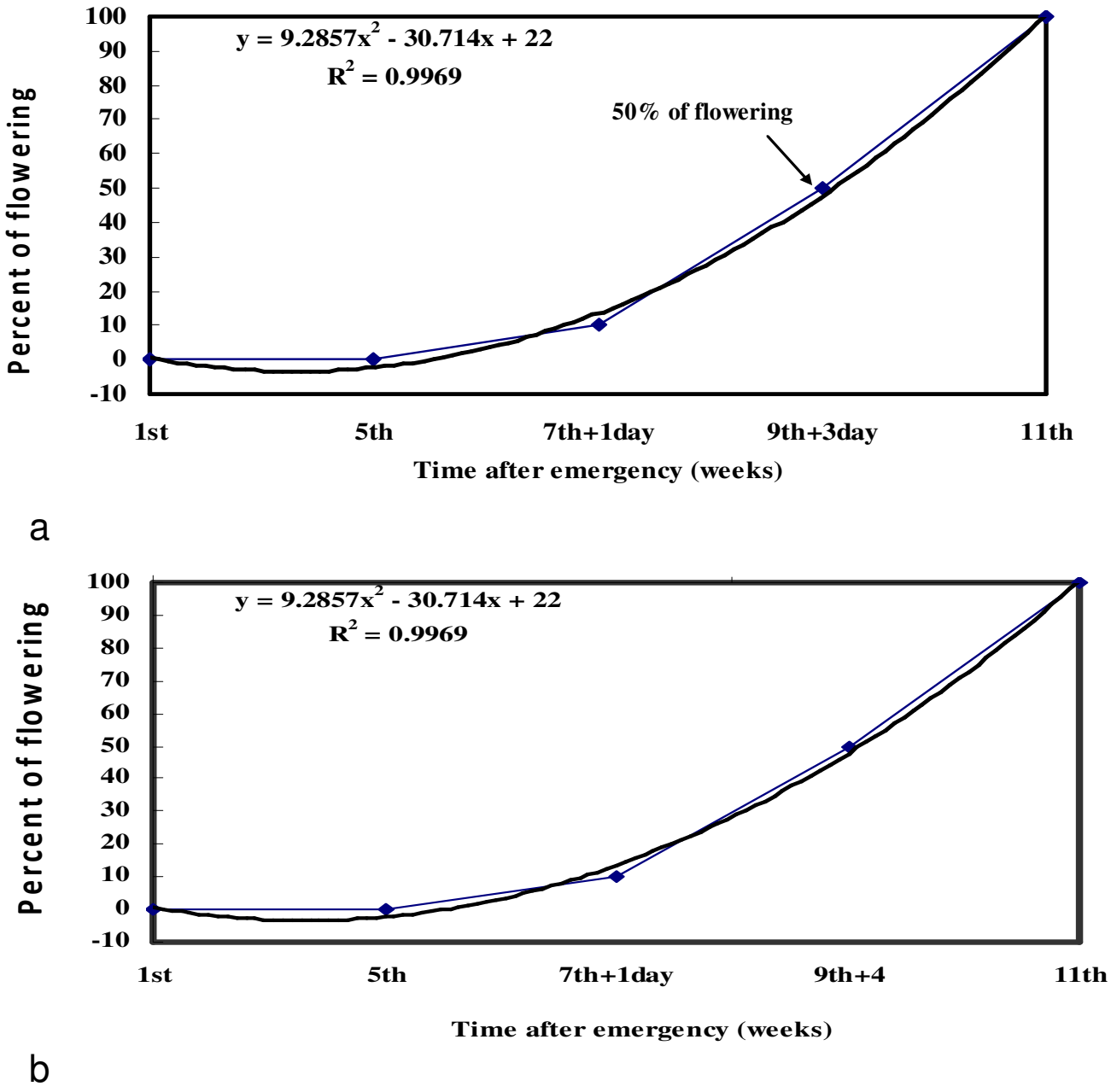

Figure 4. Different growth stage in chickpea. a) Mahidasht research station in 2003; b) Sararood research station in 2003; c) Sararood research station in 2004.

for the chemical control against larvae *H.viriplaca*, and this time is simultaneous with 50% of flowering in pea plants (Figure 7).

Population density in other species of pod borer

Study of other species pod borer showed that in addition to *H. viriplaca*, there were also species (*H.armigera* and *H. peltigera*) at both regional Mahydsht and Sararood. But both *H.armigera* and *H. peltigera* were found with a relationally low population density and were included in 2 to 3% of the total population of pod borer moths taken by light traps, respectively.

Results from natural enemies

Results from larva sampled from insecticide free fields, showed that some of the larvae of this pest were severely, parasited by parasitc wasp *Habrobracon hebetor* (Braconidae). Results reveal that fully grown

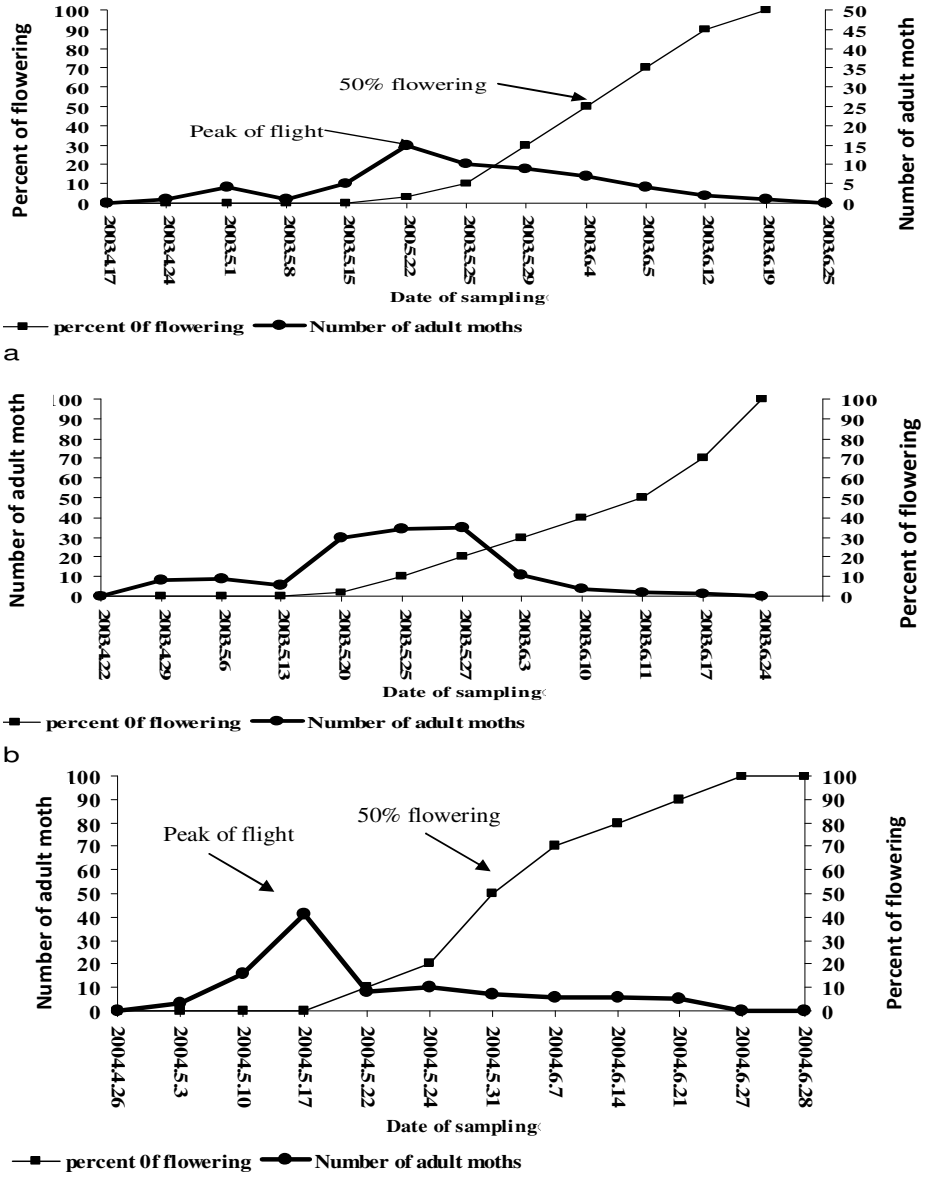

Figure 5. Comparison of peak of flight of *H. viriplaca* with 50% flowering of chickpea. a) Mahidasht research station in 2003; b) Sararood research station in 2003; c Sararood research station in 2004.

larvae of *H. viriplaca* were parasitized by the parasitic wasp *H. hebetor* inside the pods by *H. hebetor.* The first parasitic larvae were observed from mid-January and thereafter, the parasite rate was greatly increased over time, so that in early July, many of the larvae were approximately parasites of by wasp (Table 4).

DISCUSSION

Results obtained from the number of *H.viriplaca* taken by light trap, show that this pest has only one flight peak. This peak usually occurs in late June to July and then, the populations of adult moth taken by the light trap were low, so its reached zero around late September. These results indicate that the considered pests, has only one generation in Kermanshah province and western Iran. Kahrarian et al. (2010) showed that under laboratory conditions, this pest has one generation per year with obligate diapause. Moreover, this result is in accordance with Kravchenco et al. (2005) and Saxena et al. (1996). A comparison of the flight peak, the peak of pod borer oviposition, peak of activity of larvae populations and the phenology of plant showed that a period of 13 to 15 days

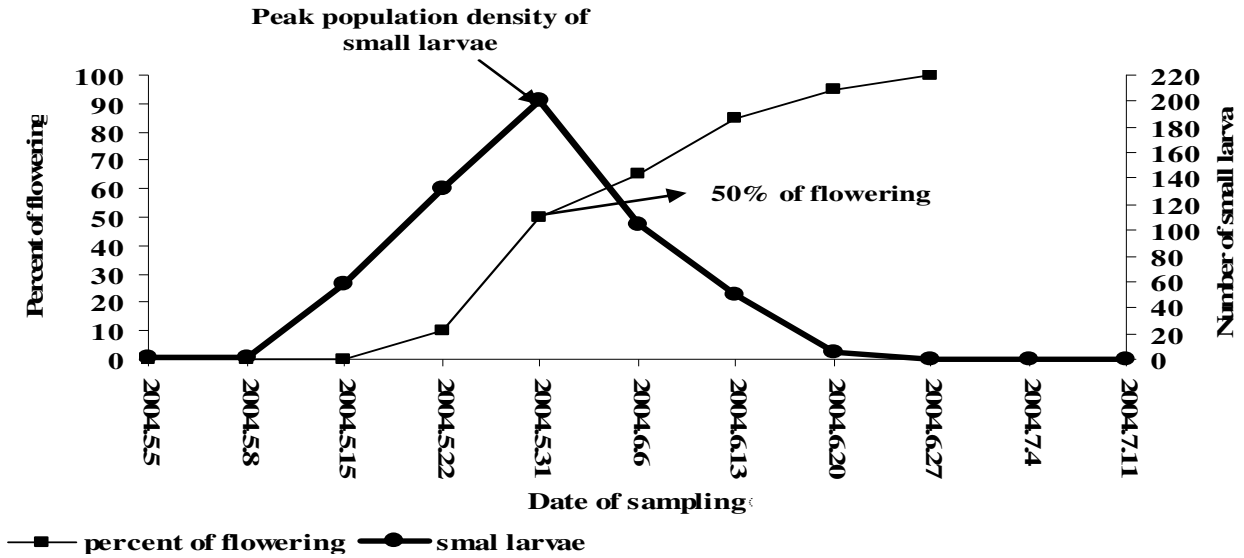

Figure 6. Comparison the peak population density of small larvae of *Heliothis viriplaca* with different stage of growth in chickpea.

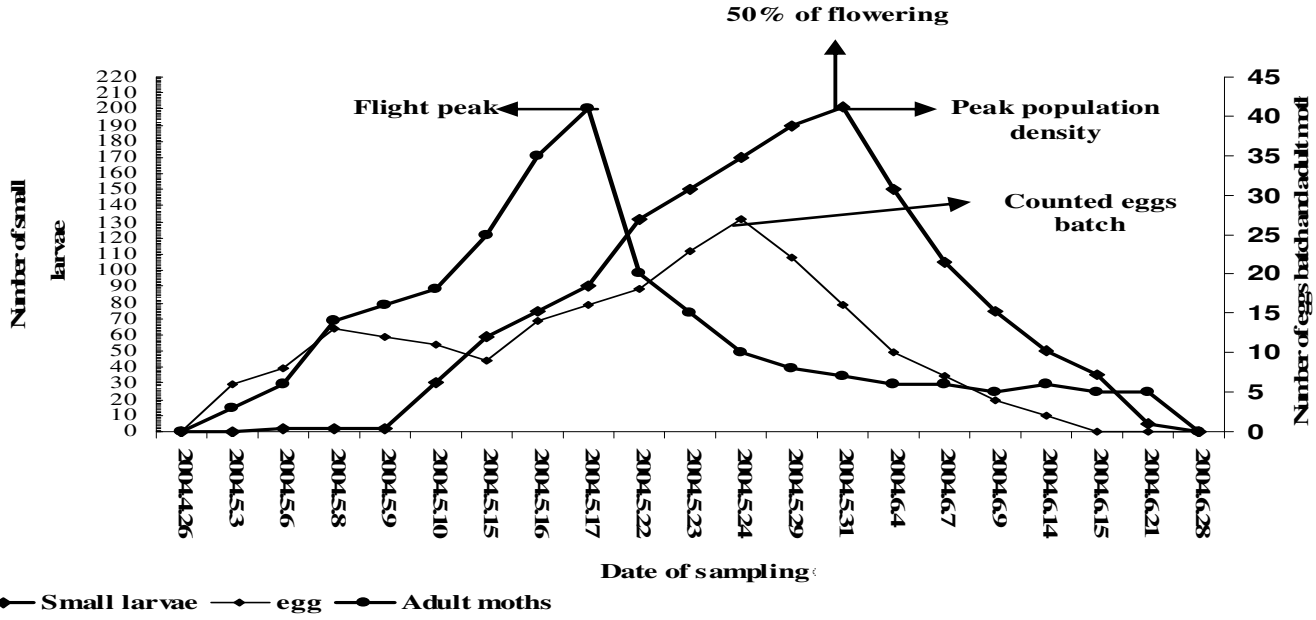

Figure 7. Comparison of flight peak, peak population density of small larvae and counted eggs batch of *Heliothis viriplaca* with 50% flowering of chickpea.

after the flight peak of *H. viriplaca* was most appropriate for chemical control. This time period coincided with 50% of plant flowering. Sequeira et al. (2001) reported chickpea attractiveness to oviposition of *Helicoverpa* moths from as early as 14 days after planting and throughout the growth period. At first, we observed *H. hebetor* species in Kermanshah region; but not recorded. The field studies showed that the population of parasitic wasp *H. hebetor* increased significantly at the end of the season. Unfortunately, fully grown larvae of *H. viriplaca* were parasitized by the parasitic wasp *H. hebetor* in the end of the season, but by that time most of larvae bored the chickpea pod. This parasitic wasp is therefore not an adequate agent of pest control. In contrast, *H. armigera* is multi generational. Consequently, the larvae of second generation of this pest are most parasites of *H.hebetor*. Therefore, the over wintering pupa, will be the less for the next year. This could be one reason that these species

Table 4. Number of larvae of *H. viriplaca* parasite by *Habrobracon hebetor*.

Date	Number of larva	Number of parasitic larva	Percent of parasitic larva (%)
2004.6.7	100	1	1
2004.6.9	100	3	3
2004.6.17	20	8	40
2004.6.28	28	27*	96.43

* Larvae collected from 2600 pod of pea.

had less population density in Kermanshah province in the pea fields. In similar research, ICARDA (1982) indicated that *H. viriplaca* moths were more abundant than *H. armigera* or *H. peltigera* in the southwest Asia during April to June 1981 (Hariri, 1982).

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