CHAPTER - VI

SUMMARY AND CONCLUSION

Studies on gram pod borer, Heliothis armigera (Hb.), were undertaken at College of Agriculture, Raipur. It included the (i) Study on bionomics of gram pod borer on different hosts and (ii) Evaluation of the economic threshold level of gram pod borer. Bionomics included, Egg period, their size and viability, larval period, larval length and larval weight, and applicability of Dyar's law, Pupal period, size and weight, total developmental period longevity of male and female adult, their size, sex-ratio, pre-oviposition, oviposition and post oviposition periods, and fecundity of H. armigera (Hb.). Qualitative and quantitative study included larval survival, pupal survival, adult survival, ovipositional host preference, and different indices.

Field investigations were undertaken to find out (1) effect of defoliation on chick-pea yield, (2) economic threshold level for Heliothis and (3) Varietal preference of Heliothis armigera.

Shortest egg period of 3.13 ± 0.52 days in the first generation was recorded on Chick pea which was significantly pre-dominant than that on artificial diet and
remaining hosts. Longest duration of hatching (4.13 ± 0.74 days) was observed on linseed, similar trend of egg-period was also noticed during second generation. Different tested hosts have not shown their effect on size of the eggs. A significantly poor viability as compared to chick-pea was observed on rose, linseed and amaranthus.

Larval duration of the first instar was the shortest on artificial diet and longest on amaranthus during the both generations. The shortest duration of second instar caterpillar in both the generations was obtained on linseed and artificial diet, the corresponding values in respect to longest duration of second instar were recorded on cauliflower and rose, respectively. In first and second generations shortest larval period of third instar caterpillar was noticed on chick-pea and artificial diet. Chrysanthemum, gave the longest larval duration of third instar in both the generations. Fourth instar larvae lasted shortest duration on chick-pea in both the generations but amaranthus and chrysanthemum gave longest larval period during first and second generations, respectively. Chick-pea and artificial diet gave shortest fifth instar period during the first and second generations, but cotton and chrysanthemum were shown longest, fifth instar duration in first and second generations, respectively. In both the generations, chrysanthemum and rose gave shortest and
longest larval period of sixth instar larvae. Duration of seventh instar was statistically similar for all the hosts. Eighth instar was found only on chrysanthemum during the first generation only.

Total larval period lasted shortest on artificial diet in both the generations i.e. 17.33 ± 0.82 and 13.86 ± 0.74 days. Chrysanthemum fed larvae had the longest larval duration during both the generations being 24.06 ± 1.49 and 19.86 ± 1.36 days.

Larval length during the first instar varied between 1.85 ± 0.09 (chick-pea) and 1.77 ± 0.11 mm (linseed), while during the second generation it deviated from 2.16 ± 0.12 (artificial diet) to 1.66 ± 0.11 mm (chrysanthemum) from second instar to sixth instar. Maximum larval length was observed on artificial diet in both the generations, while the shortest larvae were obtained on chrysanthemum in both the generations, up to sixth instar. In case of seventh instar the longest larvae obtained when they fed on linseed in both the generations (29.74 ± 0.87 and 30.22 ± 1.31 mm) shortest larvae of seventh instar in the first generation were recorded on chrysanthemum (23.18 ± 1.56 mm) but in second generation corresponding value was 28.22 ± 2.42 mm on amaranthus.
Eight instar of *Heliothis* larvae was only recorded on chrysanthemum with 28.93 ± 1.44 mm larval length.

When recording larval weight, artificial diet resulted with heaviest larvae from first instar to sixth instar. Lightest larvae of first instar in first and second generations were recorded on chrysanthemum and linseed respectively. In both the generations minimum larval weight of second and fourth instars were observed on amaranthus, while during the third instar minimum larval weight in the first and second generations were noticed on chrysanthemum and amaranthus, respectively.

Chrysanthemum fed larvae had minimum body weight from fifth instar to seventh instar in both the generations, but maximum larval weight of seventh instar in both the generations was obtained on linseed. Only chrysanthemum fed larvae moulted seven times and shown 273.53 ± 13.80 mg body weight.

Part of study was undertaken to verify applicability of Dyar's law and moultwise growth ratio of head capsule were found to be 1.76, 1.72, 1.88 and 1.58 mm and overall growth ratio was 1.74 mm.

In respect to pre-pupal period, pupal period, pupal size and pupal weight artificial diet shown its pre-eminence
over all the test host, the values for these parameters were found to be 2.60 ± 0.74 days, 14.47 ± 0.52 days, 19.7 ± 0.23 × 5.89 ± 0.17 mm and 297.0 ± 3.86 mg in first generation and 2.40 ± 0.57 days, 13.93 ± 0.80 days, 19.91 ± 0.11 × 5.94 ± 0.12 mm and 300.03 ± 2.15 mg were recorded in the second generation. Similarly, least preferred host was chrysanthemum, which gave 4.27 ± 0.46 days, 19.13 ± 0.99 days, 16.69 ± 1.00 × 3.85 ± 0.35 mm and 253.8 ± 14.13 mg values in the first generation but in second generation were figured 4.07 ± 0.80 days, 19.20 ± 0.94 days, 18.23 ± 0.38 × 4.42 ± 0.32 mm respectively.

Total developmental period in both the generations were recorded on artificial diet (37.80 and 33.45 days) while on chrysanthemum prolonged developmental period upto 51.46 and 46.80 days in first and second generations.

Significantly longest life of male and female alata during the both generation was observed on artificial diet, chrysanthemum gave shortest longevity of male and female in each generation. Size of male and female alata in two generation had greater value on chick-pea but larvae reared on chrysanthemum gave significantly smallest male and female in first and second generations.

In first generation female dominance over male was noticed on cotton (1.0:1.14) but in second generation it
was found to be on artificial diet and cauliflower (1:1.50).

Influence of different hosts in respect to the pre-oviposition and post-oviposition period in both the generations was found to be non-significant. However significantly longer oviposition period during the first and second generations was recorded on artificial diet (4.2 ± 0.45 days) and chick-pea (4.6 ± 0.55 days). The shortest period of egg laying in both the generations was recorded on chrysanthemum which was 2.6 ± 0.55 days.

Highest and lowest numbers of eggs in two generations were laid by those female alata which emerged from chick-pea and chrysanthemum, respectively. The fecundity on chick-pea was 368.4 ± 47.29 and 387.0 ± 51.29 eggs. On chrysanthemum corresponding values were 183.8 ± 102.16 and 188.4 ± 104.77 eggs recorded in first and second generations respectively. Trend obtained for per cent viability was the same as in case of fecundity. In both the generations the per cent viability was found to be 87.02 and 89.36 per cent chick-pea and 70.29 and 75.16 per cent recorded on chrysanthemum.

Overall artificial diet gave higher larval survival in both the generation and it was lowest on chrysanthemum in first generation while on amaranthus during the second generation. Higher pre-pupal, pupal and adult survival in
both the generations were obtained on artificial diet whereas corresponding values on chrysanthemum was observed minimum.

Female alata which was emerged from artificial diet, chick-pea, cotton, berseem, cauliflower, rose, linseed, amaranthus and chrysanthemum laid maximum 77.66 ± 6.66, 82.0 ± 25.51, 79.66 ± 12.01, 62.33 ± 11.59, 66.66 ± 10.01, 72.00 ± 8.88, 38.00 ± 11.78, 32.00 ± 21.79 and 39.33 ± 24.00 eggs on chick-pea, cotton, berseem, cauliflower, rose, linseed, amaranthus and chrysanthemum, respectively.

Growth index values 4.62 and 6.01 were calculated for artificial diet in first and second generation, respectively. Chrysanthemum (1.66) and amaranthus (2.73) have resulted with poor potential for growth index. Similarly higher and lower values of larval index, pupal index, larval pupal index, adult index, oviposition index and survival index in both the generations were obtained on chick-pea and chrysanthemum, respectively.

Effect of defoliation on chick-pea yield was negligible. In case of zero per cent defoliation grain yield was 1953.6 kg/ha while in 70.00 per cent defoliation, caused by ten larvae per ten plant gave 1879.5 kg/ha yield.

Positive linear relationship was observed between
larval density and pod damage \( (Y = 2.33 + 2.45 \times x) \). Pod damage caused by 3, 4 and 5 larvae per ten plant did not differ significantly however it was found to be better than that recorded with larval density of 6 larvae per ten plant. Similarly grain yield negatively correlated with larval density \( (Y = 61.86 - 0.82 \times x) \).

Grain yield recorded with four larval density was less than that of zero larval density however grain yield of four larval density were found to be at par with larval density of three and five larvae.

There was linear relationship between per cent pod damage and grain yield per ten plants and no significant reduction in yield till the larval density reached up to four larvae per ten plants, but no sooner the larval density reached five per ten plants, four larvae per ten plants was considered as economic threshold level for chick-pea at this level cost benefit ratio also was 1:1.39.

Maximum and minimum per cent pod damage (9.75) and 5.91 per cent were recorded on cultures JG 74 and GL 1002, respectively. Cultures ICCC-37, GL 1002, BDNG-9-3 and Annegiri-1 were shown 7.40, 5.91, 6.75 and 6.53 per cent pod damage but grain yield kg/ha varied from 300 to 663 kg/ha. Grain yield of culture JG 74, Annegiri-1, GL 1002, BDNG-9-3, and ICCC-37 were found to be 370, 531, 334, 454 and 526
kg/ha respectively.

From the above summarized study following conclusion can be drawn,

1. Different hosts did not significantly affect the size of eggs, however chick-pea gave significantly shortest egg period and large number of fertile eggs. Later two parameters were poorest on chrysanthemum.

2. Larval duration, length and weight were clearly influenced by hosts, but all these parameters were found to be at par with each other, on artificial diet and chick-pea. In respect to larval development, chrysanthemum was found to be most inferior host.

3. Dyar's law has its applicability on this test insect.

4. All the observations were recorded on transformation stage shown pre-eminence of artificial diet, but followed by chick-pea.

5. Total developmental period in both the generations was shortest on artificial diet followed by chick-pea and longest on chrysanthemum.

6. Artificial diet gave longer period of survival to male and female alata and chick-pea supplied better nutrition for larger body size. Female dominance was noticed on cotton,
pre and post oviposition periods were not significantly different. On different hosts however, significantly higher fecundity and per cent viability were observed on chick-pea.

7. In respect to larval, pre pupal and pupal and adult survival artificial diet and chrysanthemum maintained their status as most and least preferred hosts.

8. Artificial diet gave poorer choice for oviposition, but chick-pea and cotton were placed in first and second position in cross ovipositional study.

9. Growth index was higher on artificial diet but in remaining indices chick-pea proved its significance.

10. Larval density at vegetative stage of chick-pea could not affect the grain yield statistically. Four Heliothis larvae per one meter row length or per ten plants of chick-pea said to be economic threshold level.

11. Culture JO 74 sustain higher per cent pod damage but highest yield (kg/ha) was recorded on culture PDG-93-84.