CHAPTER V
DISCUSSION

The jute hairy caterpillar, *Spilosoma obliqua* Walker, is one of the major pests of jute in Assam. In view of the seriousness of the problem and as no detail information on the biology and other aspects of this pest is available from Assam, the present investigation had, therefore, been conducted to study the biology and to evaluate the efficacy of some insecticides against this pest. The salient findings of these investigations are discussed below:

5.1. BIOLOGY

In the present investigations, the egg incubation period varied greatly in different generations, the longest being in the case of fifth generation, when the mean maximum temperature was 26.38 and 29.02 °C during 1999-2000 and 2000-2001 respectively (Table 2 and 3). Almost similar observations were made by Singh (1962) and Singh and Singh (1995 a). Patel (1940) and Das (1948) recorded the incubation period as 6 days. According to Tiwari et al. (1988), it varied from 6.0 to 7.2 days. Barua (1970) and Hussain (1972) reported the incubation period to vary from 3 to 7 days and 5 to 9 days, respectively, on jute in Assam. Bhattacharyya et al. (1995) observed it as 4 to 8 days. These confirm the incubation period recorded in the present investigations except in the fifth generation.

The egg viability (Table 2 and 3) was observed to be increased with the fall of temperature during March in both the years studied. These findings were almost in conformity with that of Singh and Singh (1995 a), according to whom, the viability varied from 83.52 to 99.33 per cent in different generations. Singh (1962)
reported nearly cent per cent egg viability. According to Hussain (1972), it ranged from 80.39 to 90.09 per cent. Deshmukh et al. (1982) recorded 95 to 100 per cent egg viability on castor. The present investigations are, more or less, in line with those of earlier workers. In the present investigation, the hatching of eggs usually took place during early morning hours as observed by Singh and Singh (1995a).

In the present study, it was observed that the larvae of *S. obliqua* undergoes 6 larval instars as observed by Prasad and Chand (1980 a), Kalita (1992), Singh and Sehgal (1992), Singh and Singh (1995 a) and Bhattacharyya et al. (1995). The duration of different larval instars were also recorded generation wise in the present investigation.

During the course of the present study, it was observed that the larval durations were different in different generations (Table 4 and 5). The shortest larval period being recorded in the third and fourth generations during 1999-2000 and first to fourth generations during 2000-2001, when the average maximum temperature ranged from 31.97 to 32.34 °C and 31.67 to 32.10 °C respectively (Table 4 and 5). The larval period was longest in the fifth generation during both the years studied, when the average maximum temperatures were 27.46° and 26.49 °C during 1999-2000 and 2000-2001 respectively. It was evident from the present investigation that the temperature around 32 °C helped the insect to complete larval development in shortest possible time, whereas, the temperature below 28 °C prolonged larval period. According to Singh and Singh (1995 a), the temperature around 30 °C shortened larval period on sunflower in Punjab. Dahale et al. (1988) recorded the average larval period as 23.50 days. According to Nath and Singh (1996), it was 24.72 days. The present observations are, more or less, in line with the earlier
workers but were at variance with those reported by Pandey et al. (1968) and Ara et al. (1989) on jute from Kanpur and Bangladesh respectively. According to Singh and Sehgal (1992) and Bhattacharyya et al. (1995), the larval period varied from 30 to 42 days and 13 to 32 days, respectively, depending upon hosts and weather conditions. Barua (1970) and Hussain (1972) recorded the larval period to vary from 19 to 28 and 18 to 28 days, respectively, on jute in Assam. According to Kalita (1992), the average larval period ranged from 18.9 to 26.7 days, depending upon season. These slight variations may be due to different climatic conditions of the experimental site.

In the present investigations, the maximum larval survival was observed in the first to third generations and first to fifth generations during 1999-2000 and 2000-2001, respectively, when the average maximum temperatures varied from 31.20 to 32.40 °C and 26.49 to 32.10 °C, respectively. The larval survival was minimum in the case of sixth generations in both the years, when the average maximum temperatures were 29.77 and 30.10 °C during 1999-2000 and 2000-2001 respectively (Table 4 and 5). Singh and Singh (1995 a) observed minimum larval survival (40 per cent) during May and maximum (95 per cent) during October, when the average temperatures were 31.8 and 27.2 °C respectively. These variations may be due to different host plants used for the study and the differences in climatic conditions. According to Pandey et al. (1968) and Prasad and Chand (1980 b), the larval survival was 90 per cent on jute and sunflower. Dahale et al. (1988) reported the mean larval survival as 88 per cent on sunflower. In the present studies also the larval survivals during the active season were 86 and 78 per cent during 1999-2000 and 2000-2001 respectively.
The pre-pupal period (Table 4 and 5) as observed in the present investigation was also different in different generations, the longest being recorded in the fifth generation in October – December during both the years studied. These findings was almost in agreement with the findings of Singh and Singh (1995a), according to whom, it varied from 1 to 7 days, the longest (5 to 7 days) being in the month of November – January in Punjab. According to Singh and Sachan (1987), the pre-pupal period varied from 1 to 1.5 days on sugarbeet. Tiwari et al. (1988) recorded it as 1.8 to 2.0 days, whereas, Nath and Singh (1996) recorded this period as 1.76 days on groundnut. Kalita (1992) recorded the pre-pupal period to vary from 2 to 3 days on jute. In the present studies also the pre-pupal period varied from 1 to 2 days during active season. The present findings in respect of pre-pupal period are at variance with those reported by Singh and Sehgal (1992) who reported it to vary from 4 to 7 days on different hosts in Delhi. The probable reason for these variations may be due to different host plants used for the study and the differences in climatic conditions.

In the present investigations, the longest pupal period was recorded in the case of the fifth generation, shortest being in the first generation during both the years studied (Table 6 and 7). Barua (1970) and Hussain (1972) reported that the pupal period to vary from 9 to 13 and 6 to 13 days, respectively, on jute during active season in Assam. Pandey et al. (1968) recorded pupal period as 8 to 10 days on jute. According to Nath and Singh (1996), it was 11.46 days on groundnut. In the present studies also the pupal period varied from 8 to 12 days during active season. The prolongation of pupal period as observed during cooler months confirms the earlier findings of Singh (1962) and Singh and Singh (1995 a), according to whom,
it ranged from 10 to 105 days and 10 to 74 days respectively, depending upon season.

The pupal survival (Table 6 and 7), as recorded in the present investigations was also different in different generations. Deshmukh et al. (1982) recorded the pupal survival to vary from 47 to 90 per cent on castor. According to Singh and Sachan (1987), it varied from 45 to 75 per cent on different sugarbeet varieties. Singh and Singh (1995 a) recorded the survivability of pupae to vary from 40 to 94.7 per cent on sunflower. The present observations are, more or less, in line with the earlier workers. In the present findings, the lowest pupal survival was observed at lower temperature during December – March, which are at variance with the observations made by Singh and Singh (1995 a) on sunflower in Punjab. The reason for these variations could be attributed to the different host plants used for the study and the prevailing environmental conditions of the experimental site.

In the present studies the emergence of adults was noticed during night time and maximum emergence was observed during evening and early morning hours as observed by Singh and Singh (1995a). The mating behaviour of *S. obliqua* as observed in the present study was almost similar with the observation made by Barua (1970), Hussain (1972) and Singh and Singh (1995a) in Assam and Punjab respectively. In the present investigations, the pre-mating and mating period were also recorded generation wise (Table 8 and 9). Siddiqi (1985) reported the pre-mating and mating period as 17.54 and 11.15 hours respectively. According to Singh and Singh (1995 a), they varied from 15.25 to 17.00 hours and 8.5 to 12.50 hours respectively. The present observations are, more or less, in line with the earlier workers. However, the present findings are at variance with the observations made
by Barua (1970) and Kalita (1992), according to whom, the period of mating varied from 3 hours 13 minutes to 8 hours 4 minutes and 3.5 to 7.4 hours respectively. These variations may be due to differences in climatic conditions. The pre-oviposition, oviposition and post-oviposition period as recorded in the present study were presented in Table 8 and 9. Barua (1970) recorded the average pre-oviposition and oviposition period as 38 hours 55 minutes and 11 hours 27 minutes respectively. According to Tiwari et al. (1988), it varied from 1.4 to 3.0, 1.4 to 3.2 and 0.4 to 1.2 days respectively. Singh and Singh (1995 a) recorded the pre-oviposition, oviposition and post-oviposition period to vary from 1.5 to 3.0, 2.0 to 3.3 and 1.0 to 3.0 days respectively. Patel (1940) recorded the oviposition period of *S. obliqua* to vary from 3.0 to 4.0 days in West Bengal. These variations may be attributed to the different host plants used for the study and the differences in climatic conditions.

The present investigations revealed that under the laboratory confinement, the average fecundity varied from 621.90 to 1191.60 and 624.40 to 1054.80 eggs during 1999-2000 and 2000-2001 respectively (Table 8 and 9). Patel (1940) observed the fecundity to vary from 400 to 1000 eggs in West Bengal. According to Barua (1970), it varied from 224 to 1217 eggs, whereas, Pandey et al. (1968) reported the average fecundity as 610.6 eggs. Ara et al. (1989) observed the fecundity as 795 to 978 eggs in Bangladesh. According to Hussain (1972), it varied from 301 to 515 eggs, whereas, Kalita (1992) recorded the average fecundity as 533 eggs. These present studies are, more or less, in line with the earlier workers. The present findings were found to be contradictory with that of Singh and Singh (1995 a), according to whom, the egg laying capacity varied from 1089 to 1849 eggs in Punjab. This variation may be due to variations in climatic conditions of the
experimental site. The oviposition behaviour of *S. obliqua* were found to be almost similar with the observation made by Barua (1970) and Singh and Singh (1995a) in Assam and Punjab respectively.

In the present investigation, the sex-ratio was in favour of males (Table 10). Similar observation was also made by Singh and Singh (1995a) in Punjab. According to Pandey *et al.* (1968), the sex-ratio of *S. obliqua* was 1.00 O : 2.00 O. Prasad and Chand (1980b) recorded it as 1.00 O : 5.00 O on sunflower. Deshmukh *et al.* (1982) reported it to vary from 0.72 O : 1.00 O to 1.33 O : 1.00 O on different food plants. The probable reason for this variation could be attributed to the variations in the prevailing environmental conditions and the host plants used for the study.

The present investigations revealed that the mated adults lived longer than unmated adults irrespective of their sexes. Similar observation was also made by Singh and Singh (1995a) in Punjab. It was also observed in the present study that the female lived longer as compared to male one. Singh and Singh (1995a) also reported that the longevity of the mated female was more than that of the male. In the present investigations, the longevity was recorded for both mated and unmated adults (Table 8 and 9). Pandey *et al.* (1968) recorded the longevity of male and female as 3.0 and 5.0 days respectively. Lal and Mukharji (1978) and Deshmukh *et al.* (1982) reported it to vary from 3.0 to 5.0 days and 4.0 to 12.0 days, respectively, depending upon food and temperature. Siddiqi (1985) recorded the longevity as 6.0 to 14.0 days, whereas, Dhaliwal (1988) recorded it to vary from 1.0 to 4.0 days. According to Singh and Singh (1995a), the longevity of male and female varied from 2.5 to 6.5 days and 2.48 to 5.85 days, respectively, in the case of unmated
adults, whereas, in the case of mated adults, it varied from 2.2 to 7.66 and 4.2 to 8.66 days respectively in Punjab. These variations in adult longevity may be attributed to different food plants used for the study and the prevailing environmental conditions as observed by Deshmukh et al. (1982).

The duration of life cycle from the time of the first egg deposition to the adult emergence varied from generation to generation (Table 11 and 12). In the present investigation, it was observed that the *S. obliqua* completed 6 overlapping generations in a year. Similar observations were also made by Lefroy (1906) and Singh and Singh (1995 a). According to Singh (1962), there were 3 generations of this pest on sunflower in Punjab. It was also observed in the present study that the longest generation period was recorded at low temperature (Table 11 and 12) during both the years studied, which confirms the earlier observation made by Singh and Singh (1995 a). Andrews (1915) reported the duration of life cycle as 40 days in Bengal. According to Singh (1970) and Bhattacharyya et al. (1995) it varied from 35 to 49 days and 34 to 47 days respectively. Hussain (1972) recorded it as 34 to 50 days in Assam. In the present investigation, the generation period as recorded from first to fourth generation were, more or less, similar with the earlier workers. The generation period as recorded during the sixth generation was almost in conformity with that of Woodhouse (1913) and Nath and Singh (1996), according to whom, the period was 75 and 53.06 days, respectively.

Most of the morphological characters of egg, larva, pupa and adult *S. obliqua*, as observed in the present study were found to be in conformity with those observed by Singh and Singh (1995 a). Regarding the egg size (Table 13) differences were observed from the observation made by Singh (1962), Dahale et al.
(1988) and Singh and Singh (1995a), according to whom, the egg size was $0.82 \times 0.73$ mm, $0.57$ mm and $0.57$ mm respectively. The weight of 100 eggs (Table 14) as recorded in the present study were found to be in contrary with those of Barua (1970), according to whom, it was $50$ mg. These differences in size and weight may be due to nutritional effect of the host plants and the prevailing environmental conditions. Regarding the general body measurement of the larvae (Table 13), slight differences were observed from the observation made by Dahale et al. (1988), according to whom, the body length of larvae to vary from $2.05$ to $43.76$ mm and $1.86$ to $34.90$ mm in different instars on berseem and sunflower respectively. According to Singh and Singh (1995a), it varied from $1.83$ to $42.17$ mm on sunflower in Punjab. The present findings in respect of larval size (Table 13) and weight (Table 14) were found to be in contrary with the observations made by Ara et al. (1989) on jute in Bangladesh. These differences in body size and weight might be due to nutritional deficiencies, nutritional imbalance of the host plants and the prevailing environmental conditions as observed by House (1969) and Barney and Rock (1975) on other insects. In the present investigation, the average size of male and female pupae were $15.87 \times 6.04$ mm and $18.89 \times 7.07$ mm respectively (Table 13). According to Dahale et al. (1988), the male and female pupae measured $1.647 \times 0.641$ cm and $1.916 \times 0.788$ cm respectively on sunflower. Singh and Singh (1995a) recorded it as $1.64 \times 0.65$ cm and $1.99 \times 0.81$ cm in the case of male and female pupae respectively, which supported the present findings. Regarding the pupal weight (Table 14), differences were observed from the observations made by Dahale et al. (1988) and Singh and Singh (1995a), according to whom, the male and female pupae weighed $0.3459$ and $0.5965$ g and $0.3611$ and $0.5885$ gm respectively.
According to Prasad and Chand (1980b), the average weight of pupae was 0.8315 g. These differences might be due to nutritional effect of the host plants and the prevailing environmental conditions. The sexual dimorphism of *S. obliqua* (Fig. 1.) as observed in the present study were found to be almost similar with those observed by Rathore and Verma (1977), Goel and Kumar (1983) and Singh (1992), according to whom, the genital opening of male and female pupae were present on the 9th and 8th abdominal sternite respectively.

The present investigations revealed that the adult females were larger in size as compared to male ones (Table 13). Similar observations were made by Barua (1970), Singh and Singh (1995a) and Bhattacharyya et al. (1995). Regarding the type of antennae, the present study was in conformity with those observed by Rathore and Verma (1977) and Singh and Singh (1995a), who reported that antennae in the case of males were bipectinate and serrate in the case of females. According to Barua (1970), the antennal pectinations are prominent in male moth than the female one. In the present observation, slight variations were observed in adults size from the observation made by Singh (1962), Singh and Singh (1995a) and Bhattacharyya et al. (1995). These variations might be due to nutritional effect of the host plants and the prevailing climatic conditions.

The findings of the present investigations on the biology of *S. obliqua* have already been published (Sarma and Kalita, 2000).

5.2. DEVELOPMENT OF *S. OBLIQUA* ON DIFFERENT HOSTS

In the present observations, it was observed that the *S. obliqua* undergoes 6 larval instar completed in 23.50 to 24.85 and 24.20 to 24.30 days during 1999 and 2000, respectively, on sesamum, brinjal and jute (Table 15 and 16). Andrews (1915)
reported the larval period as 21 days in Bengal. According to Dahale et al. (1988), it took 23.5 days to complete larval development on sunflower in Maharashtra. Nath and Singh (1996) recorded the larval period as 24.72 days. The present findings are almost in conformity with the observation made by earlier workers. The present findings were at variance to those observed by Pandey et al. (1968), according to whom, the larval period was 19 days and 17 to 18 days on jute and sesamum respectively. The reason for these variations could be attributed to the prevailing environmental conditions of the study area.

The larval survival as recorded in the present study on all the three hosts (Table 15 and 16) were found to be almost in conformity with the observations made by Singh and Sehgal (1992), according to whom, it was 78.05, 80.00 and 80.20 per cent on pea, sunflower and lentil respectively. Pandey et al. (1968) recorded 90 and 95 per cent larval survival on jute and sesamum respectively. According to Singh and Singh (1995 a), it varied from 40 to 90 per cent on sunflower. The pre-pupal period as observed in the present study varied from 1 to 2 days on these three hosts as observed by Singh and Singh (1995 a) on sunflower during active season. The pupal period as recorded in the present observations (Table 15 and 16) were almost similar with the observation made by Pandey et al. (1968), according to whom, it varied from 7 to 9 days and 8 to 10 days on jute and sesamum respectively. According to Singh and Sehgal (1992), it was 10 and 10.66 days on lentil and linseed respectively. Regarding the pupal survivability, the present findings (Table 15 and 16) were almost in conformity with the observations made by Singh and Sehgal (1992), who recorded 55.56 per cent pupal survival on radish in Delhi. According to Singh and Singh (1995 a), it was 66.7 per cent on sunflower in Punjab.
The pupal weight recorded in the present study (Table 15 and 16) were almost similar with the findings of Ara et al. (1989), who reported that the weight of male and female pupae varied from 0.197 to 0.258 and 0.265 to 0.333 g respectively on jute in Bangladesh. Pandey et al. (1968) recorded the average pupal weight as 0.347 and 0.385 g on jute and sesameum respectively. The fecundity as recorded on all these three hosts in the present observations (Table 15 and 16) confirms the earlier observations made by Pandey et al. (1968) and Dahale et al. (1988). The present findings in respect of incubation period (Table 15 and 16) were found to be at variance with those of Pandey et al. (1968), who reported it as 3 and 2 days on jute and sesameum respectively. According to Mathur (1962), it was 3 to 4 days. These variations might be due to variation in environmental conditions and host plants used for the study. Regarding the sex-ratio, the present observation were in conformity with the findings of Singh and Singh (1995 a), but at variance with those observed by Pandey et al. (1968), according to whom, the sex-ratio was in favour of females.

5.3. ALTERNATE HOSTS

Altogether 50 plant species were recorded as alternate hosts of S. obliqua in Assam (Table 22), out of which 6 plant species were recorded as host for the first time. Except the newly recorded host plants, the other host plants were also reported by different workers from different places of India and abroad which are enlisted in the review chapter. In the present study, it was also observed that on Momordica dioica, the larvae of S. obliqua could not survive beyond 3 days as observed by Lal and Mukharji (1978) and Singh and Singh (1995 a) on Kachnar.
5.4. NATURE AND EXTENT OF DAMAGE

The larvae just after hatching caused injury by scrapping the lower surface of the leaves gregariously and thereby skeletonised the same. Such attacked leaves showed meshed appearances which could be detected from a distance (Plate 17). In later instar, they fed voraciously on foliage and finally consumed the whole shoots of the plants in severe infestation (Plate 19). Similar observations were also made by Das (1948) on jute and Singh and Singh (1993 a) on sunflower. In the present investigation, it was also observed that the mature leaves were more preferred than the immature one, which confirms the earlier observations made by Das (1948) and Ara et al. (1989).

In the present study it was observed that the consumption of jute leaves were more during 5th and 6th instar. Similar observations were also made by Singh and Singh (1993 a) on sunflower in Punjab. In contrary to the present study, Ara et al. (1989) reported that the food intake increased from 4th instar onward on jute in Bangladesh. The probable reason for this variation could be attributed to the prevailing environmental conditions of the study area. The present investigation revealed that the total leaf area eaten by a larva in its whole life was 201.33±10.05 cm² and 258.02±11.18 cm² on immature and mature leaves respectively (Table 17) as against 195.75 to 252.15 cm² and 289.78 to 398.87 cm² on immature and mature leaves, respectively, as reported by Ara et al. (1989). According to Singh and Singh (1993 a), a single larva consumed, on an average, 284.50 cm² sunflower leaves in its whole life in Punjab. These differences in leaf area consumption might be due to different host plants used for the study and the prevailing environmental conditions.

This part have already been published (Sarma and Kalita, 2001).
5.5. **SEASONAL INCIDENCE OF *S. OBLIQUA***

A critical review of the results of the present investigation revealed that the larvae of *S. obliqua* remained active in the field throughout the jute season, i.e., from May to August as indicated by its incidence (Table 18 to 21). The incidence of larvae, was, however, noticed on JRO 524 and JRO 632 cultivars during first or second week of May and fourth or fifth week of May, respectively, in both Nalbari and Darrang districts during 1999 and 2000. The larval population was very rare in the field during first week of June 1999 in both the cultivars irrespective of the places of study. Their population again started increasing and the peak incidence was, however, recorded during second or third week of June 1999 in both the cultivars irrespective of the places of study (Table 18 and 20). During the year 2000, the peak population was observed in fourth week of May on both the cultivars in Nalbari district, and in Darrang district, the peak was recorded on the first week of July on JRO 524 and fourth week of July on JRO 632 cultivars (Table 21 and 19). The larval population, thereafter, declined but remained on JRO 632 cultivar up to harvesting time of the crop. According to Singh (1962), the adults of *S. obliqua* emerged by the end of February or in early March and the caterpillars appeared in the second week of March in Punjab. Sethi *et al.* (1979) reported that the peak population (1350 nos./plant) of this insect was noticed during third week of March on sunflower at Delhi. According to Singh and Singh (1993 b), this pest was active in the first week of August, when the average temperature and relative humidity were 29.6°C and 80.9 per cent respectively. They recorded the peak population (2300 nos./50 plants) during third week of May, when the average temperature and
relative humidity were 30.6 °C and 48.8 per cent respectively. Bhatia et al. (1995) reported that, on cole crops, the time of peak incidence varied between second to fourth week of December, after which the population declined. The probable reason for these variations in the appearances of the pest and its peak incidence could be attributed to the variations in the physical factors of the environment prevailing in different localities and different host plants used for the study.

During the course of present investigation, an attempt was made to ascertain the influences of the various weather factors (temperature, relative humidity and total rainfall) on the incidence of this pest. It was revealed that temperature showed positive correlation, whereas, the relative humidity and rainfall were negatively correlated with the larval population of this pest, thereby indicating that the weather factors exerted significant influence on the build up of this pest. These findings were quite in agreement with those of Malik and Parihar (1996), according to whom, the maximum and minimum temperature were positively correlated, while relative humidity was a negative factor for the population build-up of Diacrisia obliqua on turnip in Uttar Pradesh. Sethi et al. (1979) observed in Delhi that unseasonal rains during February followed by gradual rise in temperature under fairly high humidity and longer sunshine duration provided conducive conditions for the population build-up of this pest on sunflower.

5.6. NATURAL ENEMIES

In the present study, 3 species of larval parasitoids such as Apanteles obliquae, Meteorus sp. and Blepharella lateralis and 2 species of unidentified Dipteran pupal parasitoids were found parasitising S. obliqua in the field. It was also observed in the present study that the parasitisation by A. obliquae ranged form 9.24
to 18.42 and 5.91 to 21.59 per cent during 1999 and 2000 respectively. Lall (1960) and Shetgar et al. (1990) reported 5.27 to 19.50 and 15.12 per cent parasitization by *A. obliquae* in Bihar and Madhya Pradesh respectively. Battu and Ramakrishnan (1989) recorded its parasitization to vary from 1.1 to 32.9 per cent in Delhi. The present observation, are more or less, in line with the earlier workers. The parasitization up to 6.06 per cent by *Meteorus* sp. was reported by Kalita and Borah (1993) in Assam as against 5.10 to 29.17 and 4.65 to 11.01 per cent during 1999 and 2000 respectively in the present observation. Singh and Singh (1995 b) reported 38.92 per cent parasitisation by *Meteorus* sp. along with *Glyptapanteles obliquae* and *Carcelia* sp. in Punjab. The parasitization by *B. laterallis* as recorded in the present study varied from 3.13 to 4.35 and 2.30 to 10.16 per cent during 1999 and 2000 respectively. Kumar and Yadav (1987 a) reported this parasitoid on the larvae of *S. obliqua* in Bihar. Kalita and Borah (1993) observed 1.75 per cent parasitization by *B. laterallis* in Assam.

The parasitisation by unidentified Dipteran pupal parasitoid (Plate 25) ranged from 18.67 to 22.22 and 15.25 to 23.97 per cent during 1999 and 2000 respectively, whereas, the parasitisation varied from 7.14 to 14.06 and 8.25 to 14.51 per cent in the case of other Dipteran pupal parasitoid (Plate 26) during 1999 and 2000 respectively. The parasitisation by *Carcelia* sp., a larval-pupal parasitoid was 6.0 and 28.7 per cent as recorded by Battu and Dhaliwal (1976 a) and Battu and Ramakrishnan (1989) respectively. Kumar et al. (1990) also reported *Exorista sorbillans*, a larval-pupal parasitoid of *S. obliqua* on mulberry.

The overall parasitisation by all these parasitoids as recorded in the present studies were 13.72 and 11.74 per cent during 1999 and 2000 respectively. According
to Singh and Singh (1995 b), the overall parasitisation by different parasitoids to *S. obliqua* was 34.80 per cent on sunflower in Punjab during 1990-91. In addition to these parasitoids, some predators were also recorded in the field.

5.7. FIELD EVALUATION OF EFFICACY OF SOME INSECTICIDES ON THE LARVAL POPULATION OF *S. OBLIQUA* ON JUTE

5.7.1 Knockdown effect of the insecticides in the laboratory

It was evident from the present investigations (Table 24) that cypermethrin and deltamethrin showed good initial mortality of the larval population of *S. obliqua* 1 day after spraying during both the years studied, however, these were found at par with fenvalerate and endosulfan during the studied year 2000. The second observation after 2 days of spraying during 1999 still indicated an increased percentage larval mortality in all the above mentioned insecticidal treatments except fenvalerate, but during the studied year 2000, only deltamethrin gave good results by giving 97.5 per cent larval mortality followed by cypermethrin and endosulfan. In the third observation at 3 days after spraying deltamethrin, cypermethrin and endosulfan gave cent per cent larval mortality during 1999, while during the studied year 2000, cypermethrin and deltamethrin gave cent per cent mortality of the larvae of *S. obliqua* followed by endosulfan (94.17 per cent) and fenvalerate (92.50 per cent).

From all these observations it is quite apparent that deltamethrin and cypermethrin were the most effective insecticides, closely followed by endosulfan and fenvalerate, which gave quick knockdown effect of *S. obliqua* larvae in the laboratory.
Goel and Kumar (1991) reported that deltamethrin was the most potent insecticide followed by cypermethrin against this pest in the laboratory. According to Singh and Jakhmola (1984) cypermethrin and fenvalerate gave cent per cent mortality of *Acherontia catalaunalis* larvae 72 hours after spraying on sesamum. Singh and Grewal (1982) recorded the quick knockdown effect of endosulfan and quinalphos against *Diacrisia obliqua* larvae. According to Biswas et al. (1995), cypermethrin and fenvalerate were more toxic chemicals against 7 days old larvae of *S. obliqua* in the laboratory. Nagia et al. (1990 a) reported that in the laboratory studies, cypermethrin, deltamethrin and fenvalerate were also found to be effective against this pest on castor. Singh et al. (1978) reported that quinalphos and endosulfan at 0.05 per cent concentration provided higher initial mortality of *S. obliqua* larvae. The present observations are, more or less, in line with the earlier workers.

5.7.2. **Residual effect of the insecticides in the field**

In the present investigations, it was observed that deltamethrin, cypermethrin, fenvalerate and endosulfan showed a good initial reduction of larval population of *S. obliqua* 5 days after spraying during both the years studied (Table 25). The second observation after 10 days of spraying still indicated its residual effect as evident from the lowest numbers of pest population in these treatments as compared to control, whereas, during the studied year 1999, all these insecticides were found at par with dimethoate, phosphamidon and multineem. In the third observation at 15 days after spraying, all the synthetic pyrethroids and endosulfan showed good residual effect by keeping the pest population much lower in comparison to control.
It is evident from all these observations that deltamethrin, cypermethrin, fenvalerate and endosulfan were the most potent insecticides against this pest and were effective up to 15 days of spray in the field. Goel and Kumar (1991) recorded the deltamethrin as the most effective insecticide followed by cypermethrin against *S. obliqua* larvae up to 15 days of spray on sesame crop. According to Singh *et al.* (1996), both cypermethrin and deltamethrin proved effective for the control of *S. obliqua* as well as increased the yield of sesame at Ludhiana. Nagia *et al.* (1989) reported that spraying of 0.05 per cent cypermethrin, deltamethrin and fenvalerate showed antifeedant properties to the larvae of this insect infesting mustard and castor plants. According to Kumar and Mehto (1996), the spraying of 0.07 per cent endosulfan minimizes the damage caused by this pest as well as increased the yield of urd in Bihar. Singh *et al.* (1978) observed that quinalphos and endosulfan provided longer persistence of toxicity against *S. obliqua*. The effectiveness of endosulfan was also reported by Nath and Singh (1996) on groundnut. The present observations are almost in conformity with those of earlier workers.