**Life table study of fruit borer, (*Helicoverpa armigera*) on chilli.**

**ABSTRACT**

The total period required to complete life cycle from eggs to emergence of adult varied from 33 to 44 days with an average of 38.5 ± 7.78 days, whereas the generation from eggs to death of male and female i.e. total life cycle was found to be completed within 39 to 52 days with an average of 45.5 ± 9.19 days and 40 to 53 days with an average of 46.5 ± 9.19 days, respectively. In total life cycle days required for hatching of egg took about 3 to 4 days with an average of 3.5 days, total larval period took about 17 to 23 days with an average of 20 days, pre-pupal period took 1 to 2 days with an average of 1.5 days, pupal period took about 12 to 15 days with an average of 13.5 days, pre-oviposition period took 2 to 5 days with an average of 2 to 5 days with an average of 3.5 days, oviposition period took 5 to 7 days with an average of 6 days, post- oviposition period took 1 to 2 days with an average of 1.5 days. Adult longevity of male and female varied for few days without food and with food. Male with food survived for about 6 to 8 days with an average of 7 days whereas female moth survived for about 7 to 9 days. Male moth without food survived for about 1 to 2 days with average of 1.5 days and female moth survived for about 1 to 3 days with an average of about 2 days. Total life cycle of male moth with food was 39 to 52 days with average of 45.5 days and total life cycle of female moth with food was between 40 to 53 days with average of 46.5 days.

**INTRODUCTION**

Chilli is one of the most important spices that is grown in India. Chilli is originated from South and Central America in (1700 BC). Chilli is introduced to India for the first time from Brazil by Portuguese during the end of fifteenth century. Its cultivation became popular from 17th century and since then it has acquired importance as a marked spice and vegetable crop which became an important ingredient in many cuisines.

 Throughout tropical and warm temperature of world, chilli (*Capsicum annuum* L.) is known for being one of the necessary crops cultivated as ‘vegetable and commercial spice crop’. This spice crop is of great importance favoured for its fruit as it is used in green as well as ripe and dried form. Chilli peppers are used for their sensory quality of strong smell and taste, flavour and colour which confirms them as one of the most liked spices in many parts of the world. In curry, chilli is pre-owned as paste, powder, broken or whole form. The chilli pepper pods are used either resh or manufactured form like chilli powder, oleoresin, capsanthin, chilli oil, chilli paste and chilli sauce.

Chilli is a part of human’s diet and are enriched with vitamins, especially vitamin ‘A’ and ‘C’ and minerals. Beside regular use of chilli such as vegetables, spices, flavouring, sauces and pickles, it is also being used in medicinal, cosmetics and beverage purpose (Tiwari *et al.,)*. “Green chilli per 100 gm of edible portion has a moisture content of 85.7 gm, protein 2.9 gm, fat 0.6 gm and minerals 1.0 gm (Das 2001). The strength of red colour of chilli is mainly due to the existence of two pigment namely “capsanthin and its isomer capsorubin”. Pungency is due to capsaicin which also control anti-cancerous properties. This is the main element for preparation of medication for heart disease and pain relief. Chilli is important anti-oxidant and anti-inflammatory agents.

The genus and family to which chilli comes from are *Capsicum* and Solanaceae. Mainly five species of *Capsicum spp.* are cultivated which includes “*C. annuum, C. baccatum, C. chinense, C. frutesence,* and *C. pubescens.” C. annum* L. is the most broadly cultivated species all over the world for its pungent (Chilli syn. Hot pepper) and non-pungent (Sweet pepper) fruits. Chilli is an herbaceous, annual crop, having a basal and terminal gathering of leaves. It is observed that in some chilli variety the leaves have reticulate venation and absence of basal meristem. The blossoms are bisexual type. The flowers are actinomorphic.

India is the 2nd largest producer of chilli in the world and at present about one-fourth of world’s chilli is produced in India. World’s hottest chilli (Bhut Jolokia) is cultivated in hilly terrains of Assam in a small town named Tezpur, India. In India, chilli is grown in 634-to-921-thousand-hectare area with production of 364 to 895 thousand tonnes with an average yield of 574 to 957 kg per hectare (Anonymous, 2024). This crop is grown in almost all parts of India with Andhra Pradesh having the maximum acre of agricultural land followed by Telangana, Karnataka, West Bengal, Gujarat and Maharashtra.

Chhattisgarh has an area of 41,359 ha under chilli crop with production of 2,80,312 MT (Anonymous 2023). Chilli is grown in all parts of Chhattisgarh in all seasons. Since it is grown throughout the year, there is transmission of insect pest from sowing to harvest and from one season to another season. Seasonal abundance study on the wide spread and new emergent insect pests, in relation to change in abiotic and biotic factors and their control on the population fluctuation of harmful insect pests like thrips (*Scirtothrips dorsalis)*, aphid (*Aphis* gossypii), whitefly (*Bemisia tabacii*), fruit borer (*Helicoverpa armigera*) and tobacco caterpillar (*Spodoptera litura*). Among the different insect pest of chilli crop thrips, *S. dorsalis* is the important one which can cause 50 to 90 percent yield loss (Borah, 1987). Patel and Gupta (1998) also reported the losses caused by the thrips 60.5 to 74.3 percent. “Reddy and Reddy (1999)” reported “that the losses caused by the fruit borers is to the extent of 90 percent. The yield of green chilli is also affected by aphid, jassid, whitefly and mite under field conditions (Anonymous, 1979). “The damage due to mites and thrips together” had been estimated to the tune of 50 percent (Kandasamy *et al*., 1990). Fruit borer has a life cycle of four stages egg, larvae, pupa, adult. They have an average life cycle of 1-2 months. Minimum average day of eggs is 5-6 days, average days of around 18 days, and average days of pupa in life cycle is 7-34 days.

**MATERIAL AND METHODS**

The biology of fruit borer, *Helicoverpa armigera* on chilli was studied in the laboratory condition, Department of Entomology College of Agriculture, Raipur from January to March 2024. A brief account of techniques used in the present study is described below:

The initial culture of pest was obtained by collecting eggs form instructional farm of College of Agriculture, Raipur, C.G during the month of January 2024. After hatching the individual larvae were reared in the glass jars to avoid cannibalism. Fresh bud’s tender leaves and apical shoot were provided daily as a food for 1st and 2nd instar larvae. Further, tender and leaves were provided daily as food for third to sixth instar till pupation. Freshly formed pupae were kept individually in small sized plastic jar containing dry soil, the top of which was covered with muslin cloth and secured firmly with rubber band. The freshly emerged male and female adult were confined individually into the glass jar. The cotton swab soaked in 10 per cent honey solution was kept suspected in the jar was wrapped with black coloured paper to observe egg laying. The top of the jar was covered with muslin cloth and secured firmly with rubber band. Dates of pre-oviposition, oviposition and post oviposition period were recorded.

**Pre-oviposition period**

The period required for the emergence of female moth from pupa to the beginning of egg laying was recorded for ten females. On the basis, average pre-oviposition period was worked out.

**Oviposition period**

To work out the oviposition period, dates of first and last egg laid by female moth was recorded. The period between those two dates was considered as oviposition period was recorded for ten females and mean oviposition period was worked out.

**Post-oviposition period**

The period of end of oviposition by female. On this basis average post oviposition period was worked out.

**Site of oviposition**

Microscopic observations on the site of oviposition under captivity were made while working out the oviposition period. The paper surface, glass jar surface cotton swab surface and muslin cloth were observed critically for the eggs.

 **Fecundity**

To study the fecundity, total number of eggs laid by each female during its life span were counted. Such ten females were observed and mean fecundity was worked out.

**Incubation period**

To study the incubation period, the number of days from egg laid till the hatching of egg was recorded as incubation period. A set of hundred eggs was kept under observation.

**Pre-pupal period**

 The period required for full development of larvae as indicated by cessation of feeding till complete formation of pupa was recorded for ten larvae and average pre-pupal period was worked out and data are presented.

**Pupal period**

To record pupal period, ten freshly formed pupae were kept under observation in plastic jars till emergence of adult and on this basis the average pupal period was worked out. The mean length and breadth of pupa were also recorded by using “millimetre scale” on the basis of measurements taken for ten pupae.

**Adult longevity**

Newly emerged adults were separated on the basis of their sexes and released in a separate glass jar and cotton swab soaked in 10% honey solution was kept suspended in the jar as food for moth. To record the longevity of adult moths without food, ten newly emerged male and female moths were released in another jar without 10% honey solution. The top of all the jars were covered with muslin cloth and secured firmly with rubber band. The longevity of ten males and females was recorded by observing the duration between emergence and the death of adult. The data thus obtained were used to calculate average longevity of male and female moths with food as well as without food.

**Life cycle**

The total period for the completion of life cycle was worked out based on the duration of egg**,** larval, pre-pupal, pupal and adult stage.

**Results and discussion**

The results obtained are presented and discussed here under:

**Pre-oviposition, oviposition and post-oviposition period**

The pre-oviposition, oviposition and post-oviposition period were recorded and the result are presented in table 1.

**Table 1: Pre-oviposition, oviposition and post oviposition period of *Helicoverpa armigera* on chilli.**

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | Pre-oviposition | Oviposition  | Post-oviposition |
| 1 | 4 | 6 | 1 |
| 2 | 2 | 6 | 1 |
| 3 | 3 | 7 | 2 |
| 4 | 3 | 5 | 2 |
| 5 | 4 | 6 | 2 |
| 6 | 2 | 7 | 1 |
| 7 | 5 | 5 | 1 |
| 8 | 3 | 5 | 2 |
| 9 | 2 | 6 | 1 |
| 10 | 5 | 6 | 1 |
| Range | 2-5 | 5-7 | 1-2 |
| Mean | 3.3 | 5.9 | 1.4 |
| S. D± | 1.16 | 0.74 | 0.52 |

It was revealed that the pre-oviposition period varied from 2 to 5 days with an average of 3.3 ± 1.16 days. The oviposition varied from 5 to 7 days with an average of 5.9 ± 0.74 days. The post-oviposition period was observed only for 1 to 2 days with mean of 1.4 ± 0.52 days. These observations are in conformity with the findings of Baikar and Naik revealed that pre-oviposition period varied from 2 to 4 days with an average of 3.1 ± to 0.74 days. The oviposition period ranged between 5 to 6 days with an average 5.5 ± 0.53 days. The post-oviposition period was recorded only for 1 to 2 days with a mean of 1.3 ± 0.48 days. Bhatt and Patel (2001) observations are also in conformity with the findings of Bhatt and Patel (2001), who reported that the pre-oviposition, oviposition and post-oviposition periods were 2.85, 7.5 and 1.10 days, respectively on chickpea. Pandey and Kumar (2007) also reported that pre-oviposition, oviposition and post-oviposition period lasted for 3.12 ± 0.66, 9.8 ± 0.54 and 1.22 ± 0.36, respectively on chickpea. Sharma *et al.* (2011) also reported that pre-oviposition, oviposition and post-oviposition periods were 2.15 – 3.21, 5.25 – 6.60 and 1.12 – 1.33 days, respectively.

**Eggs**

In the laboratory were oviposition occurred the eggs were covered with yellowish brown hairs and the hairs seen earlier as present on the abdomen of the adult females were not seen after oviposition confirming that the female had dropped the abdominal hairs after oviposition to cover the laid egg mass. On removal of the hairy mass, it was seen that the eggs were laid one over the other in three layers. Eggs were spherical in shape and yellowish creamy in colour.

 The present findings regarding eggs of *Helicoverapa armigera* are in conformity with Rao and Abraham (2008), who reported that newly laid eggs of *Helicoverpa armigera* were white and before hatching, their colour turned yellowish to brownish. Ali *et al*., (2009) also reported that the size of eggs varied from 0.42 mm to 0.60 mm in length and 0.40 mm to 0.55 mm in breadth.

**Hatching percentage**

The data regarding hatching percentage is presented in table 2. It was evident from the data that the hatching period ranged from 2 to 4 days and hatching percentage ranged from 80 to 100 with an average of 90 ± 6.67 days.

**Table 2: Incubation period and hatching percentage of *Helicoverpa armigera* on chilli.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.no | No. of eggs observed | No. of eggs hatched (Days) | Total eggs hatched | Hatching percentage |
| 1 | 2 | 3 | 4 |
| 1 | 10 | - | - | 4 | 5 | 9 | 90 |
| 2 | 10 | - | - | 4 | 5 | 9 | 90 |
| 3 | 10 | - | 3 | 6 | - | 9 | 90 |
| 4 | 10 | - | - | 4 | 4 | 8 | 80 |
| 5 | 10 | - | 2 | 6 | 1 | 9 | 90 |
| 6 | 10 | - | - | 3 | 5 | 8 | 80 |
| 7 | 10 | - | - | 5 | 4 | 9 | 90 |
| 8 | 10 | - | 4 | 4 | 1 | 9 | 90 |
| 9 | 10 | - | - | 4 | 6 | 10 | 100 |
| 10 | 10 | - | - | 5 | 5 | 10 | 100 |
| Range | 8-10 | 80-100 |
| Mean | 9 | 90 |
| S. D± | 0.67 | 6.67 |

**4.4.4 Larval development**

During present studies it was observed that there were six instars of larva. The observations on larval instars and larval period are given in table 3. The development period of larvae ranged from 19-22 days with an average of 20.3 ± 1.07 days. During this period, larvae moulted six times. The instar wise description of larvae is presented here under.

 The present observations are in accordance with Baikar and Naik, who reported that larval period of 21.8 days on chilli. Ali *et al.,* (2009) reported the larval period of 16.96 days on chickpea.

**First instar larvae**

 The first instar lasted for 2-3 days with mean of 2.5 ± 0.53 days table 3. Newly hatched larvae were tiny, active and yellowish white to reddish brown with dark brown to black head capsule.

**Second instar larvae**

The second instar larvae lasted for 2-3 days. The mean of larvae that lasted for 2-3 days is 2.8 with a standard deviation of ±0.42 showed in table 3.

**Third instar larvae**

The third instar larvae lasted for 3-4 days. The mean of larvae that lasted for 3-4 days is 3.6 with a standard deviation of ±0.52 showed in table 3.

**Fourth instar larvae**

 The fourth instar larvae lasted for 3-4 days. The mean of larvae that lasted for 3-4 days is 3.4 with a standard deviation of ±0.52 showed in table 3.

**Fifth instar larvae**

The fifth instar larvae lasted for 3-4 days. The mean of larvae that lasted for 3-4 days is 3.5 with a standard deviation of ± 0.53 showed in table 3.

**Sixth instar larvae**

The sixth instar larvae lasted for 4-5 days. The mean of larvae that lasted for 4-5 days with a standard deviation of ± 0.52 showed in table 3.

The total duration of larval ranged from 19-22 days with a mean of 20.4 and a standard deviation of ±1.07 showed in table 3.

**Table 3: Larval development of *Helicoverpa armigera* on chilli.**

|  |  |  |
| --- | --- | --- |
| **S.no** | **Duration of larval instars (days)** | **Total larval period** |
|  | I | II | III | IV | V | VI |  |
| 1 | 2 | 3 | 3 | 3 | 4 | 5 | 20 |
| 2 | 3 | 3 | 4 | 4 | 3 | 4 | 21 |
| 3 | 3 | 2 | 4 | 3 | 3 | 4 | 19 |
| 4 | 2 | 3 | 3 | 3 | 4 | 5 | 20 |
| 5 | 2 | 3 | 3 | 4 | 4 | 5 | 21 |
| 6 | 2 | 3 | 4 | 3 | 3 | 4 | 19 |
| 7 | 3 | 2 | 4 | 3 | 4 | 4 | 20 |
| 8 | 2 | 3 | 3 | 3 | 4 | 5 | 20 |
| 9 | 3 | 3 | 4 | 4 | 3 | 5 | 22 |
| 10 | 3 | 3 | 4 | 4 | 3 | 5 | 22 |
| Range | 2-3 | 2-3 | 3-4 | 3-4 | 3-4 | 4-5 | 19-22 |
| Mean | 2.5 | 2.8 | 3.6 | 3.4 | 3.5 | 4.6 | 20.4 |
| S.D± | 0.53 | 0.42 | 0.52 | 0.52 | 0.53 | 0.52 | 1.07 |

**4.4.5 Life table of fruit borer *Helicoverpa armigera*.**

**4.4.5.1 Egg period**

Egg period lasted for an average of minimum of 3 days and a maximum of 4 days with a mean of 3.5 days and standard deviation of ± 0.71 table 4.

**4.4.5.2 Larval period**

An average larval period of 1st instar larvae ranged for about 2 to 3 days with a mean value of 2.5 with a standard deviation of ± 0.71 showed in table 4.

 The second instar larvae lasted for 2-3 days. The mean of larvae ranged for about 2-3 days is 2.8 with a standard deviation of ±0.42 showed in table 4.

 The third instar larvae lasted for 3-4 days. The mean of larvae ranged for about 3-4 days is 3.6 with a standard deviation of ±0.52 showed in table 4.

 The fourth instar larvae lasted for 3-4 days. The mean of larvae ranged for about 3-4 days is 3.4 with a standard deviation of ±0.52 showed in table 4.

 The fifth instar larvae lasted for 3-4 days. The mean of larvae ranged for about 3-4 days is 3.5 with a standard deviation of ± 0.53 showed in table 4.

 The sixth instar larvae lasted for 4-5 days. The mean of larvae ranged for about 4-5 days with a standard deviation of ± 0.52 showed in table 4.

 The pre pupal period ranged for about 1 to 2 days with an average of 1.5 and standard deviation of ± 0.71 showed in table 4.

 Pupal period ranged for about 12 to 15 days with a mean value of 13.5 and standard deviation ± 2.12 showed in table 4.

 Life cycle form egg to adult emergence ranged with a minimum value of 33 days and maximum of 44 with mean value of 38.5 days and standard deviation of ± 7.78 showed in table 4.

**4.4.5.3 Oviposition period**

 Pre-oviposition period lasted for minimum of 2 days and a maximum of 5 days with an average mean of 3.5 and standard deviation of ± 2.12 showed in table 4.

 Oviposition period lasted for a minimum of 5 and a maximum of 7 days with an average mean of 6 and standard deviation of ± 1.41 showed in table 4.

 Post-oviposition period lasted for minimum of 1 days and a maximum of 2 days with an average mean of 1.5 and standard deviation of ± 0.71 showed in table 4.

**4.4.5.4 Adult longevity**

The adult longevity was studied for both the sexes with and without food and observation presented in table 4. It was noticed that the male moth was short lived. They lived without food for 1 to 2 days with an average of 1.5 ± 0.71 days, while females lived without food for 1 to 3 days with an average of 2 ± 1.41 days. However, when fed with 10% honey solution, the male adult longevity increased and ranged from 6 to 8 days with an average of 7 ±1.41 days, while female adult longevity increased up to 7 to 9 days with an average of 8 ±1.41 days showed in table 4.

**4.4.5.5 Adults**

The adult moth of *H. armigera* was stout bodied with broad thorax. The forewings had a series of dots on the margins. However, the hind wings were with a broad dark-brown border at the apical end. They had yellowish margins and strongly marked veins. There was distinguished colour pattern between male and female moths. Males were greenish-grey in colour, whereas females were orange-brown in colour with tuft of hair on the tip of abdomen. Almost similar description of adult moth has been given in by Ali *et al.* (2009) and A. A. Baikar and K. V. Naik (2016).

**4.4.5.6 Total life table**

The observations pertaining to life table are presented in table 4. The total period required to complete life cycle from eggs to emergence of adult varied from 33 to 44 days with an average of 38.5 ± 7.78 days, whereas the generation from eggs to death of male and female i.e. total life cycle was found to be completed within 39 to 52 days with an average of 45.5 ± 9.19 days and 40 to 53 days with an average of 46.5 ± 9.19 days, respectively showed in table 4.

**Table 4: Life table of *Helicoverpa armigera***

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.no | Particulars | Duration | Mean | Standard deviation |
|  |  | Minimum | Maximum |
| 1 | Egg period | 3 | 4 | 3.5 | 0.71 |
| 2 | Larval period |  |  |  |  |
|  | 1st instar | 2 | 3 | 2.5 | 0.71 |
|  | 2nd instar | 2 | 3 | 2.5 | 0.71 |
|  | 3rd instar | 3 | 4 | 3.5 | 0.71 |
|  | 4th instar | 3 | 4 | 3.5 | 0.71 |
|  | 5th instar | 3 | 4 | 3.5 | 0.71 |
|  | 6th instar | 4 | 5 | 4.5 | 0.71 |
|  | Total larval period | 17 | 23 | 20 | 4.24 |
| 3 | Pre-pupal period | 1 | 2 | 1.5 | 0.71 |
| 4 | Pupal period | 12 | 15 | 13.5 | 2.12 |
| 5 | Life cycle (egg to adult emergence) | 33 | 44 | 38.5 | 7.78 |
| 6 | pre- oviposition period | 2 | 5 | 3.5 | 2.12 |
|  | Oviposition period | 5 | 7 | 6 | 1.41 |
|  | Post-oviposition period | 1 | 2 | 1.5 | 0.71 |
| 7 | Adult longevity |  |  |  |  |
|  | Male (with food) | 6 | 8 | 7 | 1.41 |
|  | Female (with food) | 7 | 9 | 8 | 1.41 |
|  | Male (without food) | 1 | 2 | 1.5 | 0.71 |
|  | Female (without food) | 1 | 3 | 2 | 1.41 |
| 8 | Total life cycle |  |  |  |  |
|  | Male (with food) | 39 | 52 | 45.5 | 9.19 |
|  | Female (with food) | 40 | 53 | 46.5 | 9.19 |

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