CHAPTER-F

BIOCONTROL

Biological control is the use of living organisms to control pests (animals or plants). A natural enemy such as parasite, predator or disease causing organism is introduced into the environment of the pest or if already present it is encouraged to become more effective maintaining the number of pest organism below the level of economic damage to plants or danger to human health. Of the several methods of pest control to enhance production, biological approach is considered to be relatively less expensive and free from harmful side effect to our environment. Hence, biocontrol agents are ecofriendly and control the pest population upto good extent without causing pollution hazards. During present course of investigation following predators, pathogens and parasitoids are observed:-

(1) PREDATORS: - Generally these occur in nature along with along with pest population and decrease the pest population upto some extent. During present course of investigation following predators have been recorded which have good potential for the control of Eusarcocoris capitatus population in nature. However, four predators, namely Harpector marginatus, formacid ant, Praying mantis and Araneus species of spider of some have been observed.

A. Harpector marginatus Fabr. (Heteroptera: Reduviidae) (Plate - 34 A): - This Heteropteran bug has been observed feeding on both the nymphs and adults of E. capitatus. It is a red coloured active bug which holds the nymph or adult by its powerful fore legs to pierce the prey body by maxillary and mandibular stylets using powerful protractor and
retractor muscles. It, then, inserts some proteolytic and lysing enzymes through saliva with the help of powerful salivary pump. The host is paralyzed, after that, the bug sucks the body fluid or dissolves substances by powerful cibarial pump.

_H. marginatus_ is a potential predatory bug found in North Western Uttar Pradesh in good number in the agriculture field area as well as forest area. It shows warning mimicry in nature. It is recorded in those areas, where the bug population was high. However, it was not observed where population of bug was low or establishment of bug was in progress on Tulsi, _Ocimum sanctum_ plants.

Bug population feed on _E. capitatus_ in nature during March to October when the population of _E. capitatus_ reaches on peak. Simultaneously, the bug population also increases many times. The bug has alarming red colour, high adaptation and capability for unfavorable condition and it can live up to 2 months in starved condition at room temperature and R.H. The bug is polyphagous and has a wide range of prey. It is also observed that showing cannibalism in absence of the other prey. Powerful individual attacks the weaker member of its own species and suck its body content. Thus, this predator, _H. marginatus_, decreases, population of _E. capitatus_ up to some extent.

**B. Ants (Hymenoptera: Formicidae):** - Three species of ants were recorded feeding on the eggs, and younger nymphs of _E. capitatus_. These are _Camponotus compresis_, _Solenopsis geminata_ and _Myrmecocystus_ species (Figs. - 38, 39 and Plate - 35). These ant species don’t feed on the elder alive nymphs (III\textsuperscript{rd}, IV\textsuperscript{th} and V\textsuperscript{th} stage) and adults (male and female) of _E. capitatus_. Maximum numbers of these ants occur in soil near by the root of the plants or on the _O. sanctum_ plants. Already dead nymph and
adult of *E. capitatus* are also devoured by the ants. In those areas, where the population of these ants was high, no eggs and early stage of nymphs were observed on the plant.

**C. Praying mantis (Hierodula species)** (Plate - 34 B) has been observed feeding on the nympha1 instars and adults of *E. capitatus* on the inflorescence of Tulsi at two occasions on field planted plants.

**D. Arachnids** belonging to the family Argyopidae, genus *Araneus* have also been observed feeding on *E. capitatus* (Plate - 34 C). These Arachnids can be observed in the field in a good number. *Araneus* feeds on both nymphs as well as on adults of *E. capitatus*. Besides this genus, a number of other non-identified polyphagous species of *Arachnids* also feed on these bugs.

**2) PATHOGENS:** - Compared with parasitoids and predators, classical biological control programs targeting arthropod pest have used pathogens very little. Besides predator, two species of fungus have been observed infecting the nymphs as well as adults during rainy seasons. *Aspergillus* species is common, saprophytic fungus (Plate - 36) and second species of fungus is not identified. It bears thick whitish mycelium emerging out on the body of insect all around (Plate - 37 A and B). Fungus infected bug generally died and after the death of insect mycelium of this fungus were found growing rapidly and multiplying.

**3) PARASITOIDS:** - One hymenopterans parasitoid *Trissolcus* species (Fig. - 40 and Plate - 37 C) belong into family Braconidae has been observed parasitizing the eggs during April to October months while population of the bug is on the peak. Parasitized eggs appear black in colour (Plate - 37 D). Percentage of parasitization ranges 2 - 20% in field.
(4) **PREDATORY POTENTIAL:** - For knowing predatory potential two predators were selected namely *Harpector marginatus* and *Hierodula* species of *Praying mantis* (Plate - 34 A and B). In laboratory experiments were conducted during peak population of the bugs and predators. A population of bug (*E. capitatus*) was maintained in laboratory on caged potted plants of *O. sanctum*. Similarly, predator stages (adults and nymphs of *H. marginatus*) were also reared in lab on the diet of *E. capitatus*. Feeding potential of the *H. marginatus* was investigated in lab as well as in field conditions. Some hurricane glass lantern chimneys were taken in laboratory and each chimney was covered by fine muslin cloth at top and base was placed in a petridish. A wet cotton swab was kept in each chimney to maintain proper R.H. In these chimneys 1<sup>st</sup>, 2<sup>nd</sup>, 3<sup>rd</sup>, 4<sup>th</sup>, 5<sup>th</sup> instar nymphs and adults of *H. marginatus* were introduced separately (one in each chimney). These were kept starved for 24 hours. After that in each chimney 4 number of every stage of nymphs and adults of *E. capitatus* were supplied along with food material. After 24 hours, number of dead nymphs and adults of *E. capitatus* were counted in each chimney and noted. This experiment was repeated several times and observations were recorded in table - 40. The data of the table - 40 clearly reveal that 1<sup>st</sup> nymphal instar of *H. marginatus* consumed average 3 nymphs per day and preferred for food 1<sup>st</sup> and 2<sup>nd</sup> nymphal stage of *E. capitatus*. 2<sup>nd</sup> nymph consumed average 4 nymphs per day and mostly preferred 2<sup>nd</sup> and 3<sup>rd</sup> nymphal stage of *E. capitatus*. 3<sup>rd</sup> nymphal instar killed average 6 nymphs per day and mostly preferred 1<sup>st</sup> and 2<sup>nd</sup> nymphal stage of *E. capitatus*. 4<sup>th</sup> instar killed average 7 nymphs per day and mostly preferred 3<sup>rd</sup> nymphal stage of *E. capitatus*. In the same duration, fifth instar consumed average 9 nymphs and preferred all five nymphal stage and some adults of *E. capitatus*. Male and female consumed average 10 and 12 bugs (*E.
capitatus) respectively per day and also preferred all five nymphaal stage and adults of E. capitatus. Data of the table - 40 also depict that 1st to 4th nymphs of predator killed average 10 to 25% nymphs of E. capitatus per day while Vth instar and adults of H. marginatus utilized average 32 to 42.85% nymphs as well as adults of E. capitatus as food.

In another experiment to note the predatory potential, of the Praying mantis, its adults (Hierodula species) were brought in lab and maintained in wooden wire gauze cages. A cotton swab was kept inside the cage to maintain proper R.H. Nymphs and adults of E. capitatus were supplied to them as food. Feeding potential of the mantis was investigated only in laboratory. In laboratory experiment five hurricane glass lantern chimneys were used. Each chimney was placed in a petridish and covered at top by fine muslin cloth. A wet cotton swab was kept in each chimney to maintain proper R.H. In each chimney 24 hrs. starved one Praying mantis was introduced separately. Then, in each such chimney 25 (10 adults + 15 nymphs) bugs of E. capitatus were supplied along with food material. After 24 hours, number of dead nymphs and adults of E. capitatus were counted separately in each chimney and noted. The experiments were repeated several times during 2007-2009 and observations were recorded in table - 41. The data of the aforesaid table clearly depict that each adult Praying mantis consumed minimum 7 (2 adults + 5 nymphs) bugs of E. capitatus and maximum 16 (5 adults + 11 nymphs) bugs with an average of 12 (4 adults + 8 nymphs) bugs of E. capitatus within 24 hrs. Thus, the killing capacity per day ranged minimum 28% and maximum 64% with an average of 48%. Mantis population feed on E. capitatus in nature during July to October when the population of E. capitatus reaches on peak.
(5) PARASITIZATION PERCENTAGE: - It was determined in field as well as in laboratory rearing:-

A. Field parasitization percentage: - Eggs of *E. capitatus* were collected at regular interval from the field laid on *O. sanctum* inflorescence. During peak period of their occurrence observations were maid for three consecutive years 2007-2009 and data are recorded in table - 42. The data of this table reveals that in field parasitization percentage varied from 2 to 20% with an average of 14% by *Trissolcus* species. This parasitization percentage was observed influenced by the site of collection, R.H. and temperature.

B. In laboratory: - Rearing of *Trissolcus* species of parasitoid was carried in plastic jars and hurricane glass lantern chimneys. These were covered by fine muslin cloth and necessary R.H. was maintained by keeping a cotton swab dipped in water inside them. 30% honey solution was kept in petridish inside jars as well as in chimney as food for *Trissolcus*. About 50 *Trissolcus* were kept each in a chimney and plastic jar to maintain culture. In laboratory, in the watch glass, 50 newly laid eggs of *E. capitatus* were kept on a moist blotting paper and these were covered by a hurricane glass lantern chimney covered at top by fine muslin cloth. In this chimney two newly mated female *Trissolcus* taken out from the culture were released. These were removed from the chimney after two days. The eggs of the chimney were kept under observation for emergence of parasitoid or 1st nymph of *E. capitatus*. The experiment was repeated during peak population period during three consecutive years 2007 to 2009. The data are recorded in table - 43 which reveals that in laboratory per cent of parasitization varied from 94 to 100% with an average of 96.54%. This high parasitization percent was
due to availability of eggs of *E. capitatus* to the parasitoids in limited space easily.

**(6) BIOCONTROL EFFICACY: -** Biocontrol efficacy was worked out while doing experiments for predation percentage of *Hierodula* species of *mantis*, *Harpector marginatus* and parasitization per cent of *Trissolcus* species simultaneously. These experiments were carried out in laboratory as well as in field.

Predation capability of *Praying mantis* was recorded 28-64% with an average of 48% per day in laboratory condition (Table - 41).

In field large wooden wire gauze cage was kept having 5 potted plants of *O. sanctum*. These plants were irrigated regularly and at inflorescence stage, 15 pairs of *E. capitatus* were released in it. After one month period, when progeny of the bugs of *E. capitatus* upto 5th instars appeared on the plants having all stages egg to adult, then at this juncture, one healthy *Praying mantis* was released and its predation capability was analysed after 24 hrs. each day for 10 days and experiment was repeated during three consecutive years 2007-2009 and recorded in table - 44. The data of this table revealed that *Praying mantis* consumed minimum 10 and maximum 16 bugs with an average of 13.86 nymphs and 2 to 6 adults with an average of 3.36 adults of *E. capitatus* per day. Therefore, biocontrol efficacy of a *mantis* in field cages is calculated 5.2 to 8.09% with an average of 6.72%.

In a separate experiment another big size wooden wire gauze cage (2×1×1mm) was taken like that of previous experiment and 5 potted plant of *O. sanctum* were kept in it. These plants were irrigated at regular interval and at inflorescence stage, 15 pair of *E. capitatus* were released in it. After one month at the appearance of progeny of the bug upto 5th
instar, one adult *H. marginatus* (Heteroptera: Reduviidae) was released and its predation capability was analysed after 24 hrs. each day for 10 days and experiments was repeated during three consecutive years 2007-2009. Data are recorded in table - 45 which revealed that *H. marginatus* consumed minimum 10 and maximum 16 bugs with an average of 13.33 nymphs and 2 to 6 adults with and average of 3.5 adults of *E. capitatus* per day. Its biocontrol efficacy was observed 4.85 to 8.18% with an average of 6.39% per day.

In another cage one pair of newly emerged *Trissolcus* species (Hymenoptera: Braconidae: Scelionidae), was released and 30% honey solution was kept in the cage as food for them. Data of parasitization or biocontrol efficacy were recorded after each 24 hrs. for 10 days and experiment was repeated during three consecutive years 2007-2009. The data are maintained in table - 46 which revealed that number of eggs of *E. capitatus* found parasitized by single mated female of *Trissolcus* species was 12 to 62 eggs with an average of 34.16 eggs of *E. capitatus* per day while parasitized per cent in field cages was recorded 11.11 to 35.71% with an average 23.41%.

Among all the three natural enemies of *E. capitatus*, biocontrol efficacy was recorded higher for *Trissolcus* than that of other natural enemies. In field, where Tulsi plants are present in kitchen garden as well as in farmers field, the biocontrol efficacy decreases due to availability of aforesaid three natural enemies in less number as well as interference of climatic factors. However, in nature, upto some extent, these natural enemies help in decreasing the population of *E. capitatus*. These can be multiplied by rearing in laboratory and can be released in field at appropriate time when population of *E. capitatus* rises.