PROJECT REPORT ON

Comparative Predatory Potential of Ladybird Beetles

Submitted by

Ms. Prabhjot Kaur(Reg. No.: 11508803)

In fulfillment of the requirement for the award of degree of
Master of Science in Zoology (Hons.)

Under the guidance of

Dr. Jibanananda Mishra

Associate professor
Department of Bioengineering and Biosciences
Lovely Professional University, Phagwara, Punjab-144411, India

CERTIFICATE

This is to certify that Prabhjot Kaur (Regd. No.11508803) have completed project entitled "Comparative predatory potential of Ladybird beetles" under my guidance and supervision. To the best of my knowledge, the present work is the result of her original imagination and study. No part of this report has been submitted for any other degree at any university.

The project is fit for submission the partial fulfilment of the conditions for award of Master of Science in Zoology (Hons.).

Date:

Dr. Jibanananda Mishra
Associate professor
Department of Bioengineering and Biosciences
Lovely Professional University
Phagwara, Punjab-144411, India

DECLARATION

I hereby declare that the project work entitled **"Comparative Predatory Potential of Ladybird Beetles"** is an authentic record of my work. The work has been carried out at Department of Bioengineering and Biosciences Lovely Professional University Phagwara, Punjab, India under the guidance of Dr. Jibanananda Mishra Associate professor, Department of Bioengineering and Biosciences, Lovely Professional University, Phagwara, Punjab for the award of the degree Master of Science in Zoology.

Date:

Prabhjot Kaur

(Regd. No. 11508803)

This is to certify that the above statement made by the student is correct to the best of my knowledge and belief.

Dr. Jibanananda Mishra
Associate professor
Department of Bioengineering and Biosciences
Lovely Professional University
Phagwara, Punjab-144411, India

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Last but not the least I would like to thank all who supported directly and indirectly to complete my research. If there be any weakness in this project report or inconvenience caused on my behalf, I would like to extend my apologies.

Thank you!

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CHAPTER 1

INTRODUCTION

INTRODUCTION

Aphids are commonly called as Plant Lice. They are very small insects with soft bodies and found abundantly all over the world. They have been considered as pestsacross various agriculture fields; gardens etc., which cause severe damage to various crops (Minks and Harrewijn, 1987). In nature, aphids serve as the prey for ladybird beetles (Hodek *et. al*., 2012). About 4,400 species of aphids are found and all of them belong to the family Aphididae. Mostly they are green in colour but sometimes they are found in black and white colour. Some of the species of the Aphids are also colourless. Generally they are found on the leaves of the plants. That means they are plant suckers who suck the sap from the leaves and cause damage of the crop. Piercing and sucking type of mouth parts help them in sucking of plant sap. They destroy the food products standing in the field's as well stored food (Kring, 1998). Since, they damage the crop; they are called as the **enemies of the farmers** as well as Gardeners.

Small quantity of Aphids seem tocause very less damage compared to their presence in clusters that cause very serious damage of the crops. They also changes the shape of leaves by making them curly and also changes the colour of the leaves from green to yellow by depositing a toxic substance on them and this substance is known as "**Honeydew"** (Lohar, M.K, 2001).Honeydew is an excretory product of the Aphids, which is formed from the moisture taken by the aphids from the stem and leaves of the plants. When they take the moisture from the leaves their colour changes into black from the yellow. This honeydew serves as a food source for the ants and attracts large quantity of the ants which alternatively causes damage to the crops. Honeydew secreted by the aphids also serves as a culture medium for the growth of various fungi as well as transmits virusesfrom infected plants to healthy plants. They cause damage by removing the sap (the plant becomes weak) and curling of the leaves.

So, the farmers were protecting their crops with the help of two ways.

(1) With the help of Pesticides
(2) With the help of biological control agents.

Systemic position of Aphids:

Table 1. Classification of Ladybird beetles

Kingdom	*Animalia*
Phylum	*Arthropoda*
Class	*Insecta*
Order	*Hemiptera*
Family	*Aphididae*

Figure 1. *Lipaphis erysimi*

Lipaphiserysimiis one of the species of Aphids, generally found on the Mustard plant (*Brassica compestris)* (Ghosh, 1975). It infects the mustard crop and reduces the yield of the crop (Singh and Sachan, 1994). Mostly Aphids cause the damage of the crops and are known as destructive insects (i.e. pests). To control various kinds of aphid pests varieties of insecticides or pesticides are being used (Pearson, 2004). However with theheavy use of these synthetic pesticides, some of the aphid species have emerged as resistant pests and sometimes kills the non-target organisms (Patel *et. al.*, 1998; Sonkar and Desai, 1998).
Heavy use of chemical pesticides for controlling the pests has observed to have various kinds of harmful impacts and some of them are:

- Contaminate food and some food products.
- Cause various kinds of environmental pollution such has air, water, soil (Sarhad J, Agric, 2007).
- Sometime kills beneficial insects.
- Yield and quality of the crop is reduced.
- Fertility of the soil is reduced.
- Cause different kinds of human diseases.
- High Cost.

For controlling various kinds of pests, varieties of methods are used. Recently it is observed that the most important and effective method for controlling different types of pests is **Biological Control Method** (Habeck, 1990, Pedigo and L.P, 2004).In this

method, the predator-prey relationship plays a crucial role controlling a particular pest effectively.

There is a competition between two species for same resources and sometime they kill the other predator (Shorrocks *et. al.;* 1984). Some of the species also shows the Cannabalism (Fox, 1975; Kawai, 1978; Mills, 1982; Takahashi, 1987, 1989; Agarwala and Dixon, 1991, 1992, 1993; Dong and Polis, 1992).These ladybird beetles act as predator and they are proficient to be used as biological control agents for controlling various types of aphids (Solomon, 1949).These ladybird beetles are the example of most successful biological control (Fleming, 2000). When there is a less amount of prey in agricultural fields then they migrate to the areas where there is a large amount of prey population occurs (Evans & Richards, 1997).In this study, the Ladybird Beetles served as predators who fed on the Aphids (prey).

The **Advantage** of using ladybird beetles is that they tolerate many insecticides and their larvae are also not killed by these insecticides (Saharia, 1982). The female ladybird beetle feed more on aphid species as compare to the male (Chowdhury, S.P, 2008). The male consume fewer aphids because of their Small size, early gonadal maturation and easily found the mate (Sunila *et. al.,* 1982). These ladybird beetles are used as biological control agents in integrated pest management for controlling various kinds of pests (Hodek, 1970). They are produced in large number and sold as biological control agents to various farmers for controlling the population of aphids, with this method crops are protected from pests (Oerke, 1994).

These ladybird beetles are having remarkable place for naturally biological control of the mustard aphids *Lipaphis erysimi* (Mathur, 1983). They are most efficient predator which was checking the population of aphids (Gilkeson and Kelin, 2001). So, for avoiding the use of various kinds of chemical insecticides it is very important to adopt the biological control method for protecting the plants (Marizy *et. al.*, 1987). The growth and distribution of the aphids and their predator ladybird beetles is influenced by many abiotic factors such as temperature, rainfall, humidity, sunshine (Ferran and Larraque, 1980). The biotic as well as abiotic environmental conditions effect on the population of prey as well as predator.

Several species of the family Coccinellidae are feeding on various kinds of aphids species (Anand, 1983; Elliott and Kieckhefer, 1990). Their larval as well as adult stages feed on

the insects which are harmful for the plants (Anonymous 1997) such as aphids; because they are having high amount of protein (Atwal & Sethi, 1963; Srivastava, 2000) and they also feed on mealy bugs, scale insects, whiteflies, thrips and many other species (Dixon 2000, Omkar and Pervez, 2004, Omkar and Bind, 1996; Joshi and Sharma, 2008; Sharma and Joshi 2010.,).

It is seen in various studies that the adults of ladybird beetles can eat more than 100 aphids per day (Arnett Jr., *et. al.*, 1980). This method is the safe and cheap method for controlling the pests according the integrated pest management (Solangi, 2004).For avoiding the aphids naturally we can take some steps:

- Remove the weeds near the crop.
- Use insect nets.

Systematic position of Beetles:

Kingdom	*Animalia*
Phylum	*Arthropoda*
Class	*Insecta*
Order	*Coleoptera*
Family	*Coccinellidae*

Table 2. Classification of Beetle **Figure2.Ladybird beetle**

In ladybird beetle the word lady is derived after the Lady Mary (Majerus, 1994a). They belong to the family coccinellidae and the word *coccineus* is derived from the scarlet that means a little sphere. They are distributed all over the world (Ipteri, 1978). They may be entomophagous that is feed on insects or phytophagous that is feed on plants (Riddick, E.W.,Cottrell, T.E. and Kidd, K.A., 2009). Generally they are bright in colour such as red, yellow, and orange. Also they are having dark coloured spots on their body, for their protection from other insects. There are about 5200 species of the ladybird beetles are observed in the whole world (Hawkes wood, 1987). Females are much larger than the males (Omkar & Bind, 1993) and feeding potential of females is more than the males because they survive more days as compare to the male and also they produces eggs (Mrosso *et. al.*, 2013).

The adult ladybird beetles lay the clusters of eggs on the leaves of the plants and on the colonies of other insects on which they feed. The eggs are like a football or cigar shaped and yellow in color. Each female lays 50 to 60 eggs/day. The life cycle of the ladybird beetles is very complex and wonderful. They are holometabolous insects, so they are showing complete metamorphosis. The length of life cycle depends upon the temperature, humidity and food supply. Their life cycle is consists of four stages:

Egg >> Larva >> Pupa >>Adult

The stages between the larval molts are known as instars. Each instar stage is larger than the previous one.

Coccinella septempuncutata is a large species having seven spots on their body and generally occurs in the Indian agroecosystems so that's why this species is called as Indigenous species (Omkar & Bind, 1993; Omkar & Srivastava, 2003). This species is most common and important example of the biological control agents. This species is having voracious nature and highly reproductive capability (Karpa cheva, 1991). *Coccinella septempunctata* is spread rapidly in this new world that's why this is called as **Boom and Burst population dynamics of C7** (Krasfur *et. al.*, 1997). There is large difference in the body sizes of that species so that's why this C7 species are easily adapting themselves in all types of the environmental conditions (Evans, 2000).*Coccinella transversalis* is also large species and this species is native of India, but mainly this species is found in the South Asia (Omkar & Bind, 1993).

Our aim is to reduce or stop the use of highly toxic pesticides which are harmful for the environment. Prey is having different types of predators. Predators attack their enemies then they kill them and then eat them (Sathe, T.V. and Y.A. Bhosale, 2001).

CHAPTER 2

ABBREVIATIONS

ABBREVIATIONS

DW - Distilled water

Rh – Relative humidity

IPM – Integrated pest management

C.septempunctata – *Coccinella septempunctata*

L. erysimi – *lipaphis erysimi*

C.transversalis – *Coccinella transversalis*

H_2O – Water

BCM – Biological control method

% - percentage

h – Hour

C.septempunctata – *Coccinella septempunctata*

L.erysimi – *lipaphis erysimi*

C.transversalis – *Coccinella transversalis*

ND – Natural diet

AD – Artificial diet

7-spotted ladybird beetle or C7 – *Coccinella septempunctata*

TRSM - Tomato red insect bug

Linn. – Linneus

SD – Standard deviation

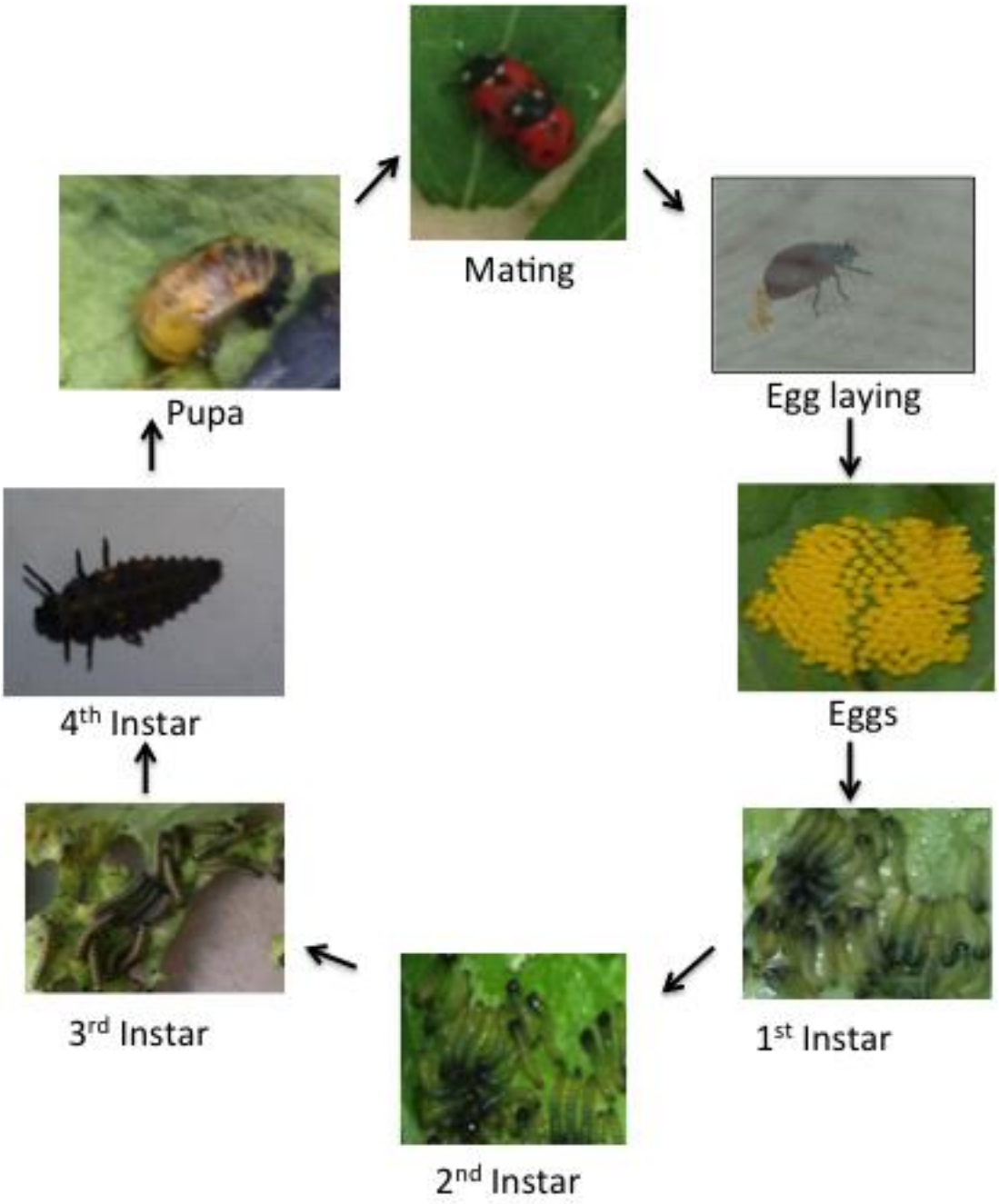


Figure 3. Life Cycle of Ladybird beetle

CHAPTER 3

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Coccinella septempunctata is one of the important biological control agents having great economic value (Solomon, 1949, Fleming, 2000, Hodek, 1970, Mathur, 1983 and Solangi, 2004). Literature search showed that there are a number reports available on the feeding potential of this species.

One of the study conducted by M. Sarwar and S.M. Saqib (2010) conducted an experiment on rearing of *Coccinella septempunctata* (seven spotted ladybird beetle) by providing them natural as well as artificial diets. Natural diet given to the beetles is the aphid species.When they reared the beetles on natural diet (aphids) then they complete their all life stages (egg, larva, pupa and adult) in less days as compare to the artificial diets and development is totally affected because of the diets given. So, artificial diet contains some ingredients which are very helpful for their growth as well as reproduction. Both the larval as well as adult stages of *C. septempunctata* feed on aphids (Prey). If aphids were not provided to the beetles then their reproduction is very difficult.

Solangi *et. al.,* (2007) performing an experiment in which they studied searching behavior as well as feeding potential of the *Coccinella septempunctata* (seven spotted ladybird beetle) on *Lipaphis erysimi* (mustard aphids). They observed that the consumption of food by the prey (ladybird beetles) is generally depends upon the density of host species (Aphids). So, the larval stages are affected by the food. Among all the larval stages, the fourth instar feed on more aphids as compare to others.

Further, (Khursheed *et. al*., 2006) performing an experiment on comparison of feeding potential between larval and adult stages of *C. septempunctata* showed that adults feed more on aphids as compare to larval stages. Among various larval stages, older larval stage feeds on more number of aphids.

Suhail *et. al.* (1999) observed the predatory potential of 7-spotted ladybird beetle (*Coccinella septempunctata*) on cotton aphid (*Aphis gossypii*). They observed that both the larval as well as adult stages of *C.septempunctata* feed on aphid species. The development period of the predator on aphids is 18.75 days. But, the feeding potential of adult beetles is

more as compare to larvae. They use this species because it acts as biological regulator of the cotton aphids.

Ashraf M, *et. al.*, (2010) showed the reproductive potential as well as development of the *Coccinella septempunctata* in laboratory conditions using different natural and artificial diets. This study showed a positive correlation between the feeding potential as well as reproductive potential. Because, the number of aphids consumed by *Coccinella septempunctata* was responsible for the production of its eggs. The rate of production of eggs was affected by the type of food which was consumed by the *C.septempunctata*. The longevity of these species was observed to be more in plain water among all the tested artificial diets such as plain water, honey syrup and sugar syrup.

Omkar and ShefaliShrivastava (2003) observe the comparative predatory potential of *Coccinella septempunctata* and *Coccinella transversalis*on prey population (Aphids) and searching capability of these species. They gave three aphid species, and these species are *Rhopalosiphummaidis*, *Myzuspersicae* and *Macrosiphmnrosae*. The larvae of *C. septempunctata* consumed maximum number of aphid species. The predatory potential of both the species is increases with increase in the prey population. It is observed that the predatory potential and searching efficiency of *C. septempunctata* was relatively higher than the *C. transversalis*. This experiment was conducted so that these species are used in biological control methods for decreasing the number of aphid species.

M. K. Lohar*et. al.*, (2012) check the biology and feeding potential of *H. convergens* on mustard aphid (*Lipaphis erysimi*). They observed that the feeding potential of female is much higher that the male. They also observed the longevity, oviposition, fecundity, hatching and mortality on mustard aphid. The emergence of the female species is generally more as compare to the male species. The adult age of the male as well as female is also different. They observed all these parameters so this so that this species *H. convergens* is used in biological control method for the control of the aphids which act as prey.

Rakhshan and Md. Equbal Ahmad (2015) conducted an experiment on *Coccinellids*. Because of their foraging behavior they are used in biological control for the control of pests (Aphids) and also other varieties of insects. They were examined the feeding potential of *Cheilomenes sexmaculata* against *Aphis craccivora*on different host plants. Development and feeding potential of *C. sexmaculata*is observed in each life stage. They

observed that grubs and adults of *C. sexmaculata* more feed on *A.craccivora* when they present on *P. sinensis* (host plant) than others. That means their feeding potential depends upon the host plant on which they are present. Also the host plant contains nutritional value and other chemicals which attract the predator. That means *P. sinensis* is having more nutritional value. By studying this, we can easily use these species for the control of prey in biological control program and also observed the feeding potential.

Perveen, F., Khan, A. and Habib, H. (2014) conducted an experiment in which they collects the different varieties of ladybird beetles from the different areas such as residential areas, administration area and main campus. They observed seven types of ladybird beetles. Mostly they found these beetles in residential areas. Mostly they collected *C.septempunctata* (seven spotted ladybird beetle). They observed that ladybird beetle is having great economic importance because they act as natural enemies of their prey.

R. A. Patel (2015) conducted an experiment on *M. Sexmaculatus* on different aphid species. They examined the longevity, food consumption and oviposition. They take the different aphid species such as *A. craccivora, A. nerri, A. gossypii, H. coriandari, L. erysimi, T. maculata* and *B.brassicae*. They observed that most suitable type of aphids for the *M. Sexmaculatus* is *A. nerri*. That species of aphids is mostly consumed. The life span of male and female is also observed on different aphid species.

Erika *et. al.,* (2009) check the feeding potential and reproduction behavior of the ladybird beetles (*Stethoru stridens*) Gordon as capacity of the tomato red insect bug (TRSM). Grown-up female of S. tridens were disconnected in tube shaped plastic fields, containing a leaf plate of *Solanum americanum T. evansi* nymphs. The quantity of prey expended and eggs laid were assessed every day for ten successive days, beginning at the oviposition. Oviposition of *S. tridens* was decidedly related with prey utilization.

Mahyoub A.J (2013) conducted an experiment in which they studied that *Coccinella septempunctata* (seven-spotted ladybird beetle) is most common and important predator of *coccinellid* in Egypt. Poor information is accessible in regards to the biology and mass rising of this predator in Egypt. Both larvae and adults (grown-ups) of *C. septempunctata* nourished on Bean Aphid, the adults laid their eggs in bunches, the aggregate quantities of groups eggs per female run from 1 to 25. The life span of the female predator is more as compare to the male.

Sattar et al. (2008) examined the predatory potential and biology of seven spotted ladybird beetles (*Coccinella septempunctata*.) nourished on cotton aphid. The feeding potential of the adults were more as compare to the other stages. Aphids were consumed by a newly hatched single larva during its first, second, third and fourth instars, individually examined. A female laid 177eggs during its whole life period.

Pervez (2004) studied the Predatory potential, development, immature survival and reproduction of an aphidophagous ladybeetle, *Propyleadissecta* (Mulsant) was examined when encouraged on seven aphid preys, viz. *Aphis gossypii*, *Aphis craccivora*, *Lipaphis erysimi*, *Uroleuconcompositae*, *Brevicorynebrassicae*, *Rhopalosiphummaidis* and *Myzuspersicae*. *A. gossypii* was most appropriate and consumed by the larvae and adults of *P. dissecta*, while *M. persicae*, the minimum. Pre-imaginal advancement of *P. dissecta* was fastest when *A. gossypii* was utilized as prey, while slowest on *M. persicae*.

Kumar B. *et. al.,* (2013) Performed an experiment in which they planned to survey the predatory potential, transformation productivity and development rate, as measures of prey suitability. For this reason, fourth-instar larvae and 10-day-old adult females of four co-happen ladybirds, to be specific *Coccinella septempunctata* (C7), *C. transversalis*, *Cheilomenes sexmaculata* and *Propylea dissecta* (Mulsant), nourished on two fundamental types of aphid prey, *Aphis craccivora* Koch and Lipaphis erysimi (Kaltenbach), and were studied. The results show that, except for C7, the other three ladybirds performed better on *A. craccivora*. Past reviews in view of regenerative and formative characteristics have likewise demonstrated that *A. craccivora* is a more appropriate prey for these three ladybirds, showing a solid relationship and confirming the suitability of utilizing these measures as a characteristic of prey appropriateness. In a comparable way, fourth instars and adult females of C7 performed better on *L. erysimi* over *A. craccivora.* This distinguishable contrast in utilization and usage of aphid prey species by the four ladybirds demonstrates that these predatory parameters can be utilized as apparatuses for surveying prey reasonableness in ladybirds.

CHAPTER 4
SCOPE OF THE STUDY

SCOPE OF THE STUDY

- Introduction of many highly toxic chemical agents in different forms like insecticides, fungicides, rodenticides etc. in our agriculture fields and residences have potential detrimental effects on the ladybird beetles population.
- Chemical pesticides not only harm the aphids, but also have many other harmful effects on our ecosystem as well as on the public health.
- There is a number of public health issues have been addressed in these days due to extensive use of thesetoxic pesticides.
- They also cause environment pollution.
- Also, the cost of these pesticides is very high.
- Aphids are one of the major pests that cause severe damage to various crops in our agricultural fields across the globe, hence termed as "enemies of the farmers".Ladybird beetles are natural enemies (biological control agent) of theseaphid pests which serve as an integral part of the modern integrated pest management (IPM). It is essential to mention that IPM is safer and cost-effective, and involves less toxic agents. Using natural enemies has been highly appreciated due to the production of high quality food grains with limited contamination of the toxic chemicals.
- So, by using ladybird beetles we can protect the damage of crop.

CHAPTER 5

OBJECTIVE OF THE STUDY

OBJECTIVE OF THE STUDY

The main objectives of this study are as following:

- To **Rear** Ladybird beetles in laboratory..
- To study the **Feeding potential** of ladybird beetles on aphids under different life stages

(Egg, Larva, Pupa, Adult)

- To **comparethe feeding potentialof two** unique types of ladybird beetles.

These species are:

Coccinella septempunctata and *Coccinella transversalis.*

- To study the **longevity (Life span)** of ladybird beetles on different artificial diets.
- To **compare of feeding potential of starved versus unstarved conditions** of ladybird beetle.
- To **compare the feeding potential of male and female** ladybird beetles.

CHAPTER 6

MATERIALS AND METHODS

MATERIALS

The materials required

- Ladybird beetles
- Aphids
- Pesticides
- Beakers
- Petri dishes
- Brush
- Whatsman Filter paper
- Net
- Rubber bands
- Cotton balls
- Honey
- Distilled water
- Muslin Cloth
- Incubator (maintained at 27 °C, 95)
- Mustard leaves

CHAPTER 7

METHODS AND EXPERIMENTAL PLAN

METHODS

The experiment was conducted in the zoology research laboratory of Department of Bioengineering and Biosciences at Lovely Professional University, Phagwara, Punjab, India.

1) Collection of Ladybird Beetles:

- The adults of Ladybird Beetles mainly the species *Coccinella septempuncutata* and *Coccinella transversalis* were collected from the agricultural fields of Phagwara, Punjab.
- They were collected in the well ventilated glass beakers.
- The beaker was covered with net.
- The rearing was done on the aphids in the laboratory.

Figure 4.Collection of ladybird beetles

2) Collection of Aphids:

- The mustard aphids *Lipaphis erysimi* were collected from the mustard fields of Phagwara region.

Figure 5.Showing the collection of aphids

- The aphids were very minute insects so they were collected with the help of magnifying glass lens.

3) Rearing of Ladybird Beetles:

- The Beetles were reared in the laboratory conditions with temperature 23±2 °C and Relative humidity 60±10%.

- Place the Beetles in the Beaker and provide them aphids daily.

- The upper open end of the beaker was covered with the help of muslin cloth and tied with the help of rubber bands.

- The cotton ball was soaked in water and placed in the beaker for avoiding the humidity.

- After the mating, female released cluster of eggs. These eggs were yellow in color and

- Leaves were added in the beaker for the egg laying of beetles**.**

Figure 6.Showing the mating and egg laying of ladybird beetle

Figure 7.Showing the eggs of ladybird beetle

-With the help of fine brush separate the eggs and add these eggs into the petridish.

Figure 8. Showing the separation of eggs

- After the hatching of egg, larva was formed. Provide mustard leaf as well as aphids to the larva. The larva takes too much time to grow.Different instar conditions were observed. Then, large (bigger) larva was formed. Provide large amount of aphids to the bigger larva.

- The larva was changes into pupa stage.

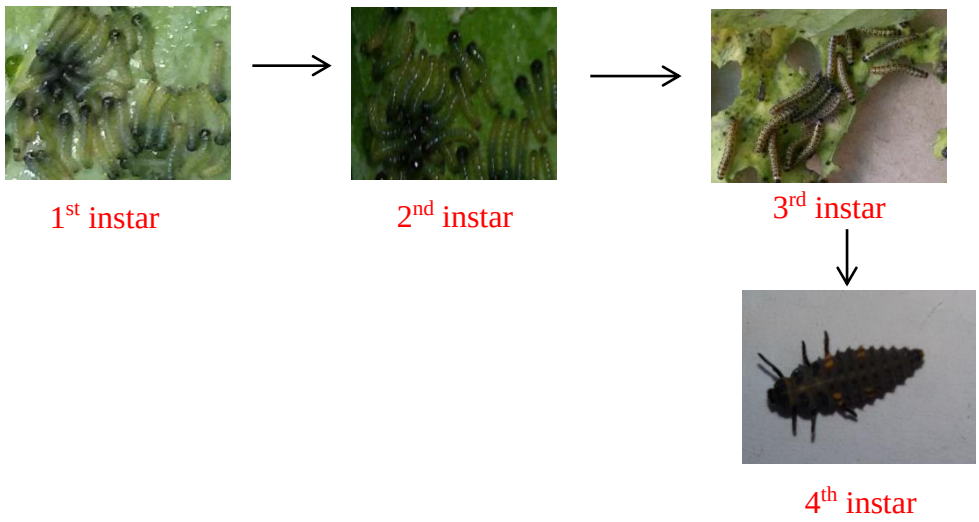


Figure 9. Showing the different instars conditions.

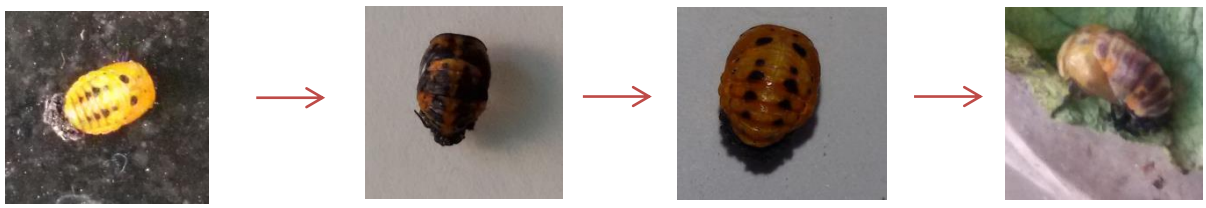


Figure 10.Pupal stage

-After the moulting (Shedding of cuticle), the Adult was formed within few days.

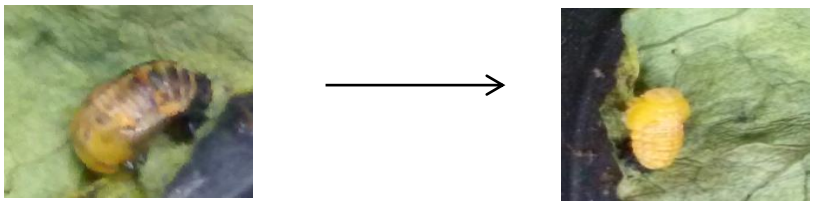


Figure 11.Shedding of cuticle (Moulting)

Figure 12.Adult Beetles

EXPERIMENTAL PLAN

Procedure:

Starved vs. Unstarved Conditions:

- Two beakers were taken. In beaker 1, one beetle was placed. Food was not provided such as Aphids to that beetle. So, this was the **Starved** condition.

- In beaker 2, another one beetle was placed. Food such as Aphid was provided to that beetle.
- After, 24 hours 50 Aphids were provided to each beetle.
- Then, after each hour how much Aphids were consumed by one Beetle was recorded.
- Subtract the aphids which were left in the beaker from the initial aphids. This will give the result.

Formula to calculate:

= Initial number of Aphids – final Number of Aphids

Comparison between two species:

- Take two different species of Ladybird Beetles.

- Two beakers were taken. In beaker 1, ***Coccinella septempunctata*** was added and 100 Aphids were provided. The number of Aphids was counted.

- In beaker 2, ***Coccinella transversalis*** was added and 100 Aphids were provided.

Figure 13. Showing two different species feed on aphids

- On another day the number of Aphids was counted.
- The number of aphids left in the beaker was subtracted from the final number of Aphids. This was gave the final result.
- The process was repeated for three times.

Formula to calculate:

= Initial number of Aphids – final Number of Aphids

Comparison between Male and Female:

Male and female were takenfrom one species of ladybird beetle.

- Two beakers were taken. In beaker 1, male was placed and aphids were provided.

- In beaker 2, female was placed and also aphids were provided to that female.

- On another day, the aphids consumed by male and female were counted.

- The amount of final aphids was substracted from initial aphids.

- The process was repeated for three times.

Formula to calculate:

= Initial number of Aphids – final Number of Aphids.

Longevity:

- Two beakers were taken.
- In beaker-1, one beetle is added.
- Cotton plugs were made and they dipped in water. These plugs were added in beaker 1.
- Another beaker was taken and 1 beetle was added.
- Cotton plugs were made; also honey syrup (small amount of honey and distilled water) was formed.
- Cotton plug was dipped in honey syrup and added in beaker.
- Activity of each beetle was seen every day.

Pesticide effect

Malathion is an organo phosphorous pesticide which is commonly used throughout the world.

Figure 14. Showing the properties of Malathion

Treatments-

The culture of *Coccinella septumpunctata* was maintained and the exposure of Malathion pesticide was given to the adult of ladybird beetles by the serial dilution of Malathion pesticide. For serial dilution, first stock solution was prepared by dissolving1ml of Malathion into 99ml of distilled water. After that serial dilution of selected pesticide was prepared as in table–

Table 3. Serial dilution of stock solution

Concentration (ppm)	Solute	Solvent
Stock solution	1ml of Malathion	99ml of distilled water
A=10^{-3}	1ml of stock solution	9ml of distilled water
B=10^{-4}	1ml of solution A	9ml of distilled water
C=10^{-5}	1ml of solution B	9ml of distilled water
D=10^{-6}	1ml of solution C	9ml of distilled water
E=10^{-7}	1ml of solution D	9ml of distilled water
F=10^{-8}	1ml of solution E	9ml of distilled water
G=10^{-9}	1ml of solution F	9ml of distilled water
H=10^{-10}	1ml of solution G	9ml of distilled water
I=10^{-11}	1ml of solution H	9ml of distilled water

Figure 15. Stock solution of Malathion pesticide

Figure 16. Shows pesticide effect on ladybird beetle

Treatments:

Three beetles were treated with 1 ml of each serial dilution. For observation these beetles were exposed to the malathion pesticide for 24 hours, 48 hours and 72 hours and mortality rate was checked.

EXPERIMENTAL SETUP:-

Table 4. Experimental set up of beetles

Experiment #1			**Experiment #2**			**Experiment #3**		
Concentration (ml)	Beetles		Concentration (ml)	Beetles		Concentration (ml)	Beetles	
	Dead	Alive		Dead	Alive		Dead	Alive
10^{-3}	3	0	10^{-3}	3	0	10^{-3}	3	0
10^{-4}	3	0	10^{-4}	3	0	10^{-4}	3	0
10^{-5}	3	0	10^{-5}	3	0	10^{-5}	3	0
10^{-6}	3	0	10^{-6}	3	0	10^{-6}	3	0
10^{-7}	2	1	10^{-7}	2	1	10^{-7}	3	0
10^{-8}	1	2	10^{-8}	2	1	10^{-8}	1	2
10^{-9}	1	2	10^{-9}	0	3	10^{-9}	2	1
10^{-10}	0	3	10^{-10}	0	3	10^{-10}	1	2
10^{-11}	0	3	10^{-11}	0	3	10^{-11}	0	3

CHAPTER 8

RESULTS AND DISCUSSIONS

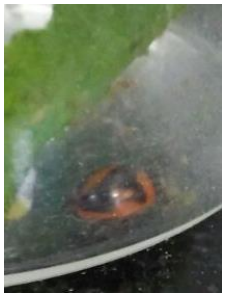
RESULTS

Under the laboratory conditions, the activity and feeding potential of ladybird beetles and aphids is studied. The results obtained from comparative feeding behavior of *coccinella septempunctata* and *coccinella transversalis* was collected and showed. The prey-predator interaction was examined.

1) Feeding potential of two different species:

Two different species of Ladybird Beetles were taken (***Coccinella septempunctata*** and ***Coccinella transversalis)*** in a beaker.100 Aphids were provided.

Coccinella septempunctata



Coccinellat ransversalis

Figure 17. Shows feeding behaviour of two different species(Coccinellids)

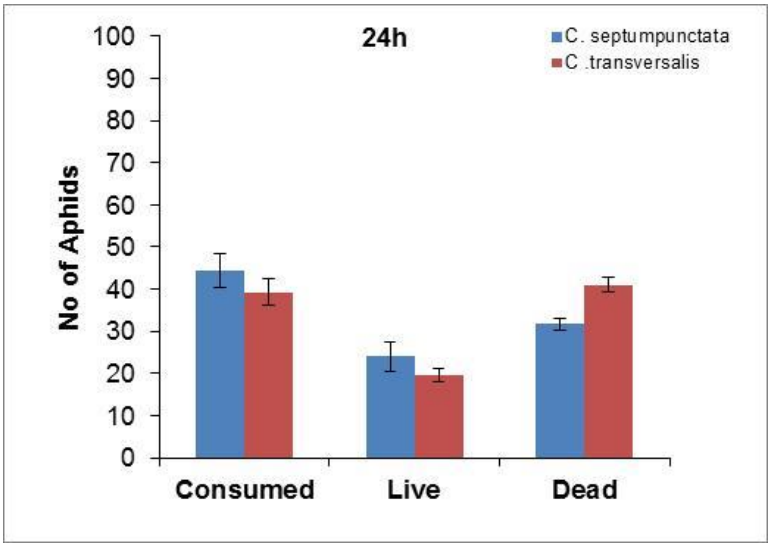
The experiment was conducted for 24h, 48h and 72h respectively. The data was calculated from the all the experiment. The experiment was performed in three replica.

The data was collected from all replica and showed in tabular as well as graphic forms. Which is shown as below:

24hours

	Coccinellaseptempunctata	*Coccinellatransversalis*
Consumed		
R1	48	40
R2	45	42
R3	40	36
Live		
R1	20	20
R2	25	18
R3	27	21
Dead		
R1	32	40
R2	30	40
R3	33	43

Table 5. showing the comparison of feeding potential between two different species(24h)



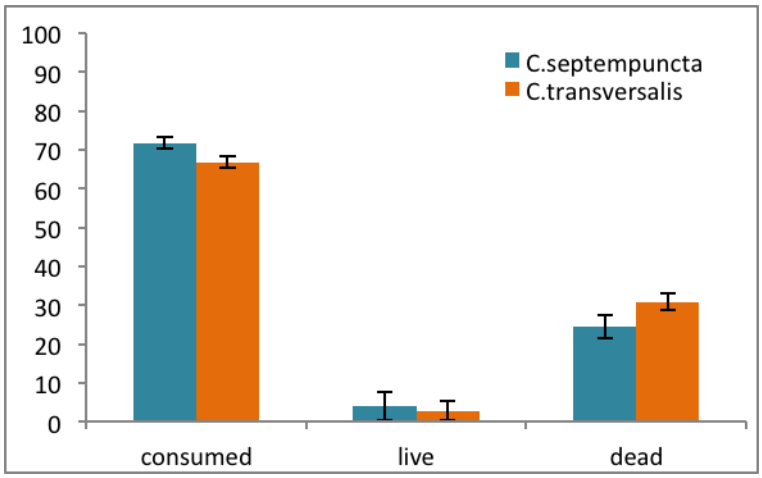
Graph 1. Showing the comparison of feeding potential between two different species (24h)

This data (Table and Graph) shows that the feeding potential of *Coccinella septempunctata* is more as compare to the *Coccinella transversalis*.

48 hours

	Coccinella septempunctata	*Coccinella transversalis*
Consumed		
R1	73	67
R2	70	65
R3	72	68
Live		
R1	0	0
R2	5	5
R3	7	3
Dead		
R1	27	33
R2	25	30
R3	21	29

Table 6. showing the comparison of feeding potential between two different species(48h)

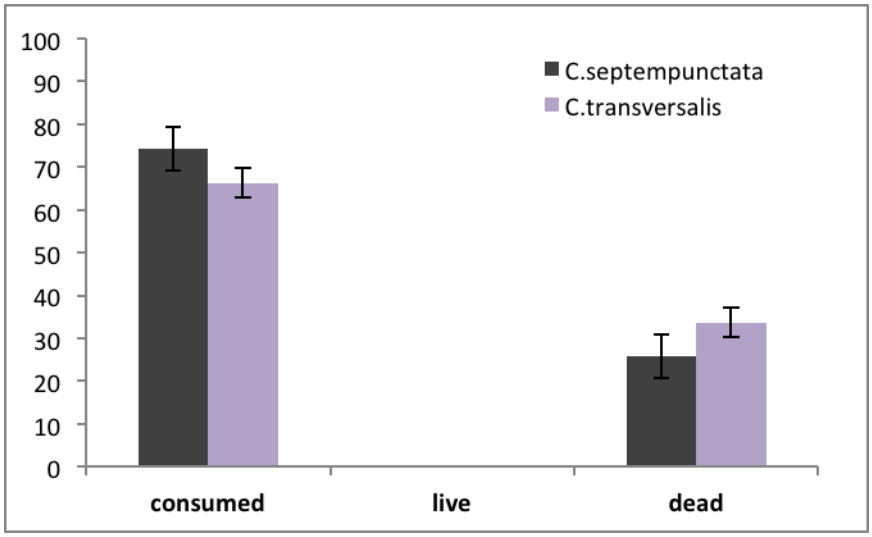


Graph 2. Showing the comparison of feeding potential between two different species(48h)

72 hours

	Coccinella septempunctata	*Coccinella transversalis*
ConsumedR1	80	70
R2	70	63
R3	73	66
Live R1	0	0
R2	0	0
R3	0	0
Dead R1	20	30
R2	30	37
R3	27	34

Table 7. Showing the comparison of feeding potential between two different species(72h)

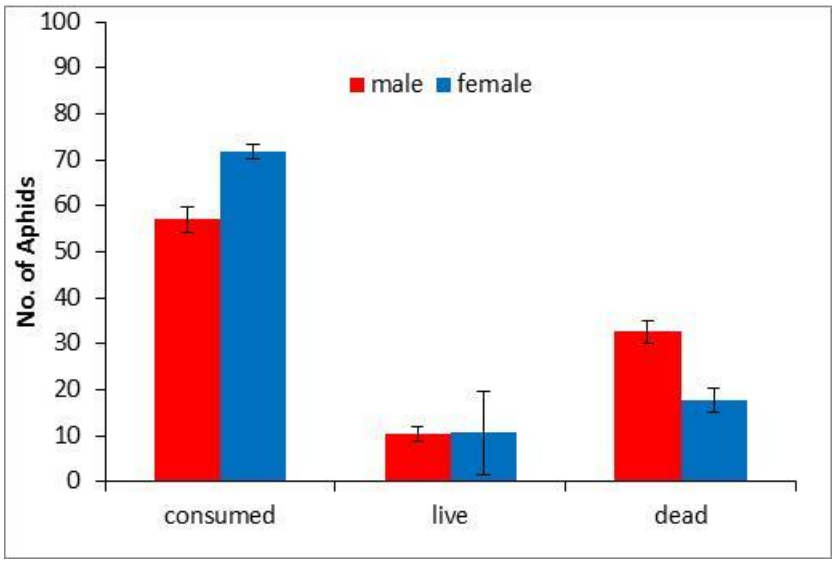


Graph 3. Showing the comparison of feeding potential between two different species(72h)

2) Feeding potential of male and female:

	Male	Female
Consumed R1	60	72
R2	55	70
R3	56	73
Live R1	10	10
R2	12	15
R3	19	7
Dead R1	30	18
R2	33	15
R3	35	20

Table 8. Showing the comparison of feeding potential between male and female (24h)

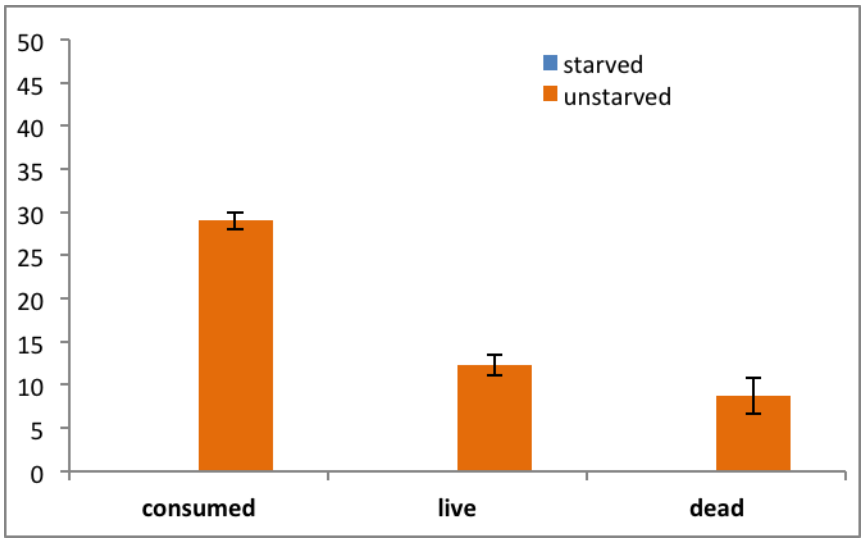


Graph 5. Showing the comparison of feeding potential between male and female(24h)

3) Feeding potential of Starved vs. Unstarved Conditions:

	Starved	Unsatrved
Consumed R1	0	30
R2	0	28
R3	0	29
Live R1	0	13
R2	0	11
R3	0	13
Dead R1	0	7
R2	0	11
R3	0	8

Table 9. Showing the comparison of feeding potential between starved & unstarved conditions (24h)



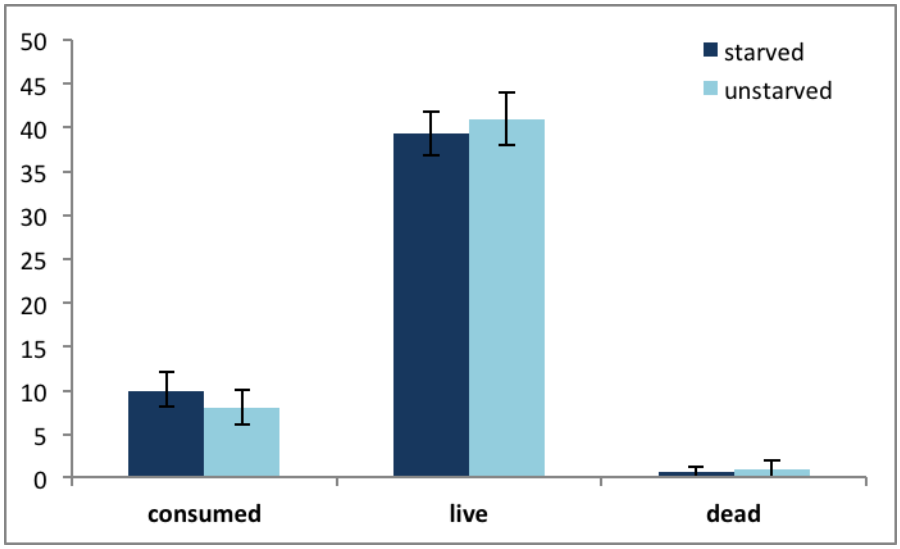
Graph 2. Showing the comparison of feeding potential between starved and unstarved conditions (24h)

Post Starved

After 1 hour:

	Starved	Unsatrved
ConsumedR1	10	8
R2	8	6
R3	12	10
Live R1	39	41
R2	42	44
R3	37	38
Dead R1	1	1
R2	0	0
R3	1	2

Table 10. Showing the comparison of feeding potential between starved and unstarved conditions (1h)

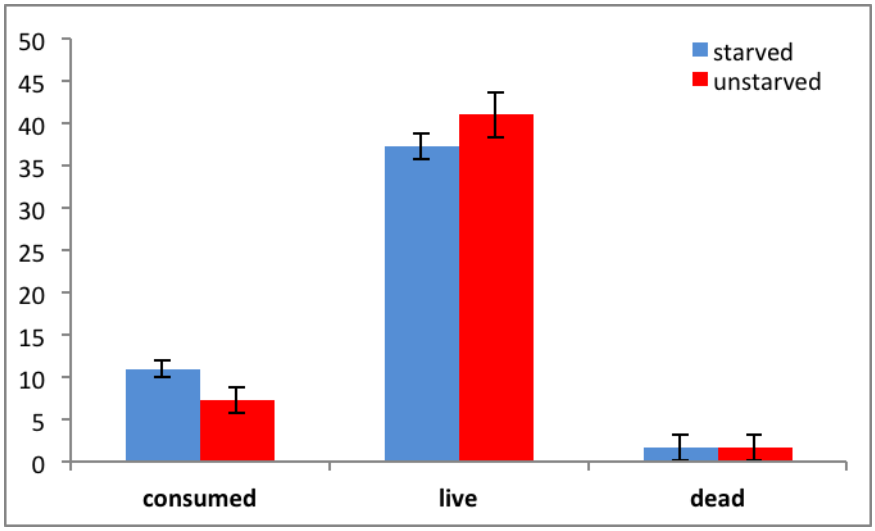


Graph 6. Showing the comparison of feeding potential between starved and unstarved conditions (1h)

After 2 hours:

	Starved	Unsatrved
ConsumedR1	11	7
R2	10	9
R3	12	6
Live R1	39	43
R2	37	38
R3	36	42
Dead R1	0	0
R2	3	3
R3	2	2

Table 11. Showing the comparison of feeding potential between starved and unstarved conditions (2h)

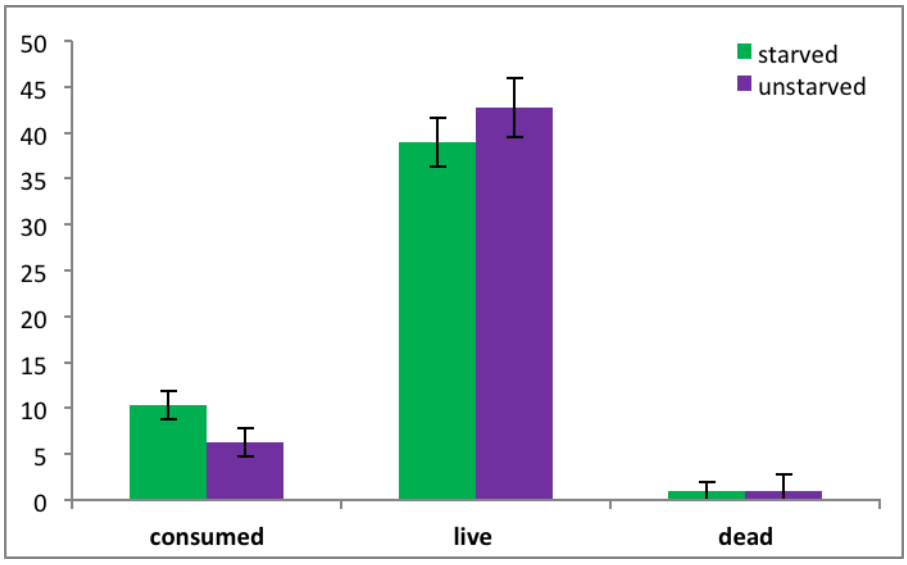


Graph 7. Showing the comparison of feeding potential between starved and unstarved conditions (2h)

After 3 hours:

	Starved	Unsatrved
ConsumedR1	9	5
R2	12	8
R3	10	6
LiveR1	41	45
R2	36	39
R3	40	44
Dead R1	1	0
R2	2	3
R3	0	0

Table 12. Showing the comparison of feeding potentialbetween starved & unstarved conditions(3h).

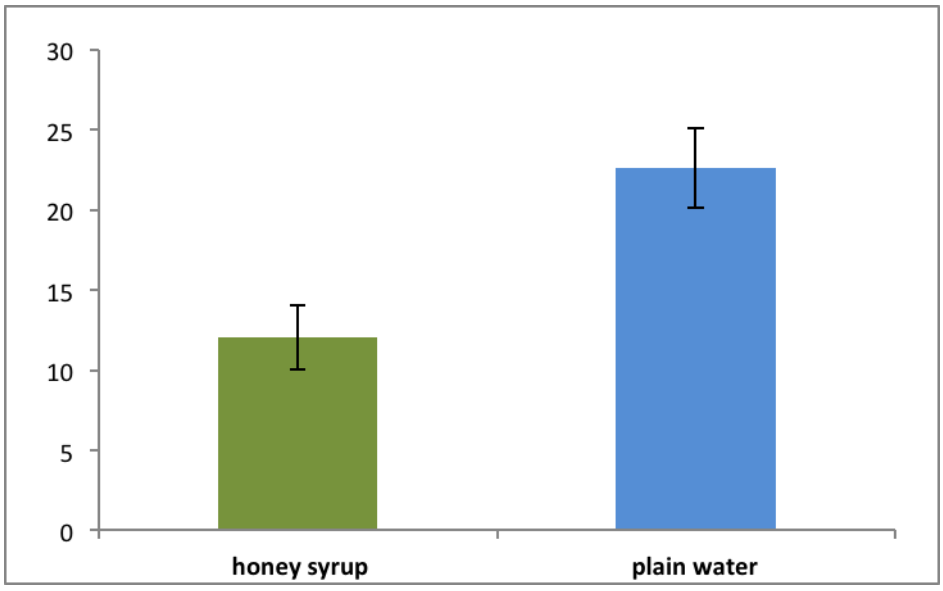


Graph 9. Showing the comparison of feeding potential between starved and unstraved conditions (3h)

Longevity

	Honey syrup	Plain water
R1	10	20
R2	12	23
R3	14	25

Table 13. Showing the comparison of longevity between two artificial diets.



Graph 10.showing the comparison of longevity between two artificial diets

PESTICIDE EFFECT:

Table 14. shows the Mortality rate

Concentration	Average mortality		
	24 hours	48hours	72hours
10^{-3}	3	3	3
10^{-4}	3	3	3
10^{-5}	3	3	3
10^{-6}	3	3	3
10^{-7}	2.3	2.1	2.21
10^{-8}	1.3	1.01	1.2
10^{-9}	1	1	1
10^{-10}	0.33	0.3	0.29
10^{-11}	0	0	0

Discussions

Results showed that the feeding potential of *Coccinella septempunctata* was higher than *Coccinella transversalis* at all the time points (24h, 48h, and 72h) studied. From this feeding potential experiment, it has been found that C. septempunctata consume more aphids (Table 1, Table 2, Table 3).This is agreement with the earlier report by Omkar and Shrivastava (2003). They showed that the feeding potential of *Coccinella septempunctata* is more as compare to *Coccinella transversalis*. That means if we use this species in integrated pest management (IPM) as biological control agents then they would be quite beneficial for controlling aphids (pests).

In this species (*Coccinella septempunctata)* feeding potential of females is more as compare to the males (Table 4), because they survive more days as compare to the males. Also, they produce eggs, so they require more food. Mrosso *et. al*., (2013) also perform an experiment in which they studied that females were more voracious as compare to males.

The data from starved versus unstarved conditions shows that the feeding potential of starved conditions is more as compare to the unstarved conditions. It has been observed that if they are starved for 24 hours, they becomes more voracious and they consume more aphids as compare to unstarved conditions (Table 5). If, we use unstarved ladybird beetles in integrated pest management then they consume more aphids.

The data (Table 10) from the longevity shows that the survival rate of *C.septempunctata* is more on plain water as compare to the honey syrup. It may be due to some ingredients present in honey syrup responsible for the early aging of ladybird beetles or these ingredients seem to be not beneficial for the survival. Muhammad A. *et. al.*, (2010) also have observed higher longevity on plain water.

Table 11. Shows the effect of pesticides on ladybird beetles. In this, it is seen that mortality depends upon the amount of dose given. As the quantity of pesticide increases, the mortality rate increases. So, more mortality occurs on concentration $10^{-3,}$ $10^{-4,}$ $10^{-5,}$ 10^{-6}.

CHAPTER 9

CONCLUSION AND FUTURE SCOPE

CONCLUSION AND FUTURE SCOPE

This experiment is generally for determining the predatory potential of the ladybird beetles. That means, to determine the feeding potential of the ladybird beetle that is how much they consume aphids (prey) in their different stages of their life. The use of the ladybird beetles in the crop is very easy method and cheap method. So, if we use too much pesticides then high amount of money is required because, all the pesticides are very costly.

It is concluded that *Coccinella septempunctata* consume more aphids as compare to *Cocccinella transversalis*. At the time of rearing, male and female were differentiated. The feeding potential of both male and female is determined. The feeding potential of female is more as compare to the males. Also, the starved conditions consume more aphids as compare to the unstarved conditions.

The longevity of ladybird beetles is more on plain water as compare to the honey syrup. That means, they are having some ingredients which are helpful for their survival.

The scope of the study is that ladybird beetles are used in integrated pest management as biological control agents for the control of the pests such as aphids. *Coccinella septempunctata* is most important species for the control of pests. If, we reared ladybird beetles in laboratory conditions then plain water is more efficient for the growth of ladybird beetles.

CHAPTER 10

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