"Evaluating the Feeding Potential of *C. septempunctata* on Various Aphid Species Across Different Time Intervals and Temperature Conditions."

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ABSTRACT

Research was undertaken at the Agricultural Research Institute in Mingora (N) Swat to assess the predatory capabilities of the Ladybird Beetle *C. septempunctata* against three distinct aphid species: *Brevicoryne brassicae L, Macrosiphum rosae,* and *Lipaphis erysimi.* The study revealed that *C. septempunctata* serves as an effective biological countermeasure against aphids. While *C. septempunctata* consumed all tested aphid species, it exhibited the highest predation rate on Rose aphids, followed by Walnut and Brassica aphids. Aphids were presented to *C. septempunctata* at varying intervals: 24h, 48h, 72h, 96h, 120h, 144h, and 168h. The most substantial aphid consumption was observed after a 24-hour interval, with a subsequent decline noted after 48 hours. However, consumption rates between 72 hours and 96 hours remained relatively consistent, showing no significant difference. A notable resurgence in aphid consumption was observed at the 120-hour mark. These consumption patterns may be influenced by temperature variations ranging from 23° to 27° Celsius. Further research is imperative to validate these findings and to enhance the utilization of *C. septempunctata* as a viable biological control agent in various integrated pest management (IPM) strategies.

Key words: Ladybird beetle, Aphids species, IPM and Swat

Introduction

In Pakistan agricultural crops have different insect pests that effect the plant growth and subsequently effect the crop yield. Many insect pests also act as a vector of plant viruses (Qazi, 2005). Due to the intensive and indiscriminate use of many pesticides poison, people suffer from many diseases, and some of these are chronic for human beings. Besides contaminating food and food products, pesticides have been accumulating in the soil, air and water to a critical stage. This calls for a safe and cheap control method. This can only be achieved by the practice of Integrated Pest Management (IPM); a pest control management which ensures environmental safety (Solangi, 2004).

Aphids are small sap-sucking insects and members of the superfamily Aphidoidea. Common names include greenfly and blackfly, although individuals within a species can vary widely in color. Aphids are distributed worldwide but are most common in temperate zones. In contrast to many taxa, aphid species diversity is much lower in the tropics than in the temperate zones. They can migrate great distances, mainly through passive dispersal by winds. Winged aphids may also rise in the day as high as 600 m where they are transported by strong winds. For example, the currant-lettuce aphid, *Nasonovia ribisnigri*, is believed to have spread from New Zealand to Tasmania around 2004 through easterly

winds. Aphids have also been spread by human transportation of infested plant materials, making some species nearly cosmopolitan in their distribution. Aphids are among the most destructive insect pests on cultivated plants in temperate regions. In addition to weakening the plant by sucking sap, they act as vectors for plant viruses and disfigure ornamental plants with deposits of honeydew and the subsequent growth of sooty molds. Because of their ability to rapidly increase in numbers by asexual and sexual reproduction, they are a highly successful group of organisms from an ecological standpoint (Nazia Suleman *et al.,* 2017).

Although small (1–10 mm) compared to many other insects, professional as well as amateur entomologists have always been interested by their specialized life cycles that are influenced by their host plant relationships. This results in both sexual and asexual (pathogenic) reproduction. Yet, when the photoperiod shortens and the temperature cools, offspring are produced that reproduce sexually. In addition, aphids have life cycles with a polymorphism in adults that have wingless (apterous) and winged. Most aphids live on or under the leaves of plants, piercing them and extracting sap, which can cause leaves to deform or curl up. Grey-white root aphids, on the other hand, live in the soil and can attack plants causing them to suddenly wilt and die. Aphids can transmit mosaic virus to plants, which turns the leaves a mottled yellow color and stunts growth.

They excrete a sticky honeydew on plants that can be home to sooty molds, blocking the leaf pores. This is why ants actually farm aphids, protecting their eggs over winter and carrying the hatched aphids to plants so that they can feed from the honeydew they produce. The family *coccinellidae* consists of about 5200 described species in the world and this includes small beetles. *Coccinella septempunctata Lin.* is one of the most popular and well-known species among all British beetles.

Ladybirds (Coccinellidae) contain a large number of formally described species, and a worldwide distribution (Hodek, 1967). They are beneficial insects, feeding on pest species such as psyllids, aphids, scale insects, whiteflies, mealybugs, mites, small Lepidoptera and Coleoptera larvae (Obrycki & Kring 1998; Hodek 1967; Hagen 1962). They are also recorded feeding on nectar and pollen (Hodek 1967; Hagen 1962). The majority of coccinellid beetles are useful because of their predaceous nature upon a variety of pests viz., aphids, leafhoppers, scale insects, mealy bugs, mites and other soft bodied insects (Sharma & Joshi 2010; Joshi & Sharma 2008; Omkar & Bind 1996). Predaceous coccinellids have a wide range of accepted food. The larvae prey on the same prey as the adults. Hence, it is the adults, which select a certain type of food for the larvae, while laying their eggs. The natural enemies once established in the ecosystem are self-powered, self-sufficient and self-regulating, requiring no further investments in control (Pimental, 1991). Coccinellid beetles have been utilized as biological control agents for over a century (Obrycki & Kring, 1998). There have been some significant successes using ladybirds as biological control agents, but methods to enhance their efficacy are under continuous development (Obrycki & Kring, 1998). In fact, coccinellids could be considered crucial in developing an integrated approach to pest control (Obrycki & Kring, 1998). *Coccinella septempunctata Linnaeus* (Coleoptera: Coccinellidae) has been extensively used in the past as a biological control agent due to its voracity and polyphagy, being recorded to feed on up to 97 different prey species (Lucas *et al.* 2002; Hoy and Nguyen, 2000) and is a dominant species in almost all ecosystems. Aphids are very serious insect pests in agriculture everywhere in the world (Minks & Harrewijn, 1987). Most aphids are extremely host specific, feeding on one or a few plant species that are usually closely related. The mustard aphid, *Lipaphis erysimi Kaltenbach* (Hemiptera; Aphididae) is a major pest of *Brassica compestris* and Brassica juncea (Ghosh, 1975). The rose aphid *Macrosiphum rosae Linnaeus* (Hemiptera; Aphididae) infests rosebushes, especially around new buds. Mealybug *Phenacoccus solenopsis* Tinsley (Hemiptera: Pseudococcidae), is also a serious pest on a wide range of host plants (Arif *et al.,* 2002). It has been found to infest 154 plant species including field crops, vegetables, ornamentals, weeds, bushes, and trees. The economic losses had been recorded on cotton, brinjal, okra, tomato, sesame, sunflower and China rose. Coccinellid beetles, (Coleoptera: Coccinellidae) are very effective predators of mealybugs (Osborne *et al.* 2004; Mani & Krishnamoorthy

2008; Hameed *et al.* 2013). Adults and larvae of predatory beetle feed on immature as well as adult stages of mealybugs (Khuhroo *et al*, 2012). Lohar (2001) reported *Brumus sutuaralis* (Coleoptera: Coccinellidae) as a voracious feeder of mature and immature stages of mealybug on different field and vegetable crops. Moore (1988) also stated that despite the frequent use of predators, only the coccinellids can be considered successful. In order to have field application of coccinellid beetles for the integrated pest management (IPM) of various crops or vegetables, a year round availability of beetles is required. Field populations of natural prey can be relied on only at intervals during the year. For continuous laboratory rearing of ladybird beetles, a constant availability of prey is indispensable. Freezing and storing the host could be an approach in such circumstances (Khan & Khan, 2002). Use of frozen mustard aphid *Lypaphis erysimi* has been reported as a good host for rearing of Hippodamia convergens Guer under laboratory conditions (Bukero *et al.*, 2015). Mealybugs as prey are efficient food sources and have positive effects on the biological traits of ladybeetles (Hameed *et al.*, 2013).

The present experiments were therefore designed with the objective to test the feeding behaviour of seven spotted ladybeetle, C. septempunctata adults on two aphid species; mustard and rose aphids under laboratory conditions. The offered aphids were alive or frozen by keeping the adult beetles either hungry (starved) or normally fed (unstarved). The feeding potential of adult C. septempunctata on different stages of cotton Mealybug under starved and unstarved conditions was also tested (Nazia Suleman *et al.*, 2017). Integrated Pest Management (IPM) is pivotal in formulating effective strategies for insect pest control. This study aims to evaluate the feeding potential of *C. septempunctata* on three distinct aphid species, considering various time intervals and the influence of temperature.

Material and Method

Collection of *C. septempunctata* individuals

The *C. septempunctata* adults were collected from Brassica fields (Agricultural Research institute (N) Mingora Swat). The ladybird beetle individuals were placed in plastic cups and vials under controlled conditions in the Insect Bio control laboratory, Entomology section. A pair of male and female individuals were placed in separate cups. The opening of cups covered with muslin cloth. Eggs were placed in petri dishes and maintained in the laboratory conditions set at 25±2°C and 62±5% relative humidity.

Collection of Aphids species

Three aphid species, *Brevicoryne brassicae L*, *Macrosiphum rosae*, *Lipaphis erysimi*, And *Chromaphis juglandicola* Harris were collected from Brassica, Rose, Walnut, respectively.

Experiment for conducting feeding behavior of C. septumpunctata

Each adult pair starved for 24 h were offered with 50 individuals of aphids from each species. The time was noted when feeding of aphids were started by each pair of *C. septumpunctata*. The consumption rate of each aphid specie was observed and noted for each

adult pair of *C. septumpuntata*. The number of aphids consumed daily by *C. septumpunctata* was counted and mortality if any of *C. septumpunctata* was recorded on daily basis.

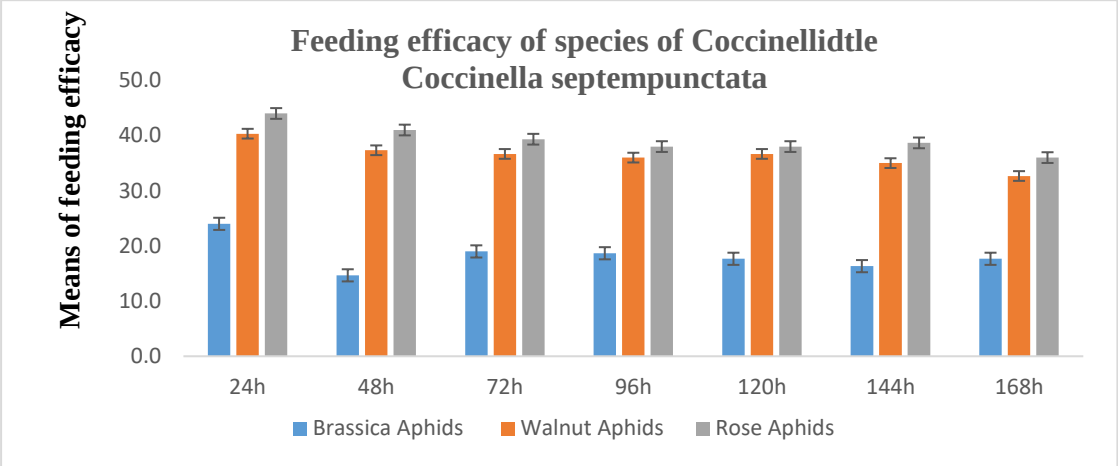
Experiment for conducting host preferences of *C. septumpunctata*:

Host preference of C. *septumpuntata* was recorded for each species of aphids after 24 h based on number of Aphids consumed during this period. The highest number of aphids from each species consumed was considered as the most preferable host for *C. septumpuntata.*

Statistical analysis

And identified using an online database for aphid's taxonomic identification. Y analysis of variance (ANOVA) with the help of computer-based software "Statistic v8.1" (Analytical Software, 2005), and a least significant difference test ($\alpha = 0.05$).

Results



The results in Fig. 1 showed that maximum consumption of Brassica aphids (*Brevicoryne brassicae L)* was after 24hrs as compared to 48hr, 72hr and 96hr there was no significant difference recorded in feeding behavior of Ladybird Beetles. After 120hr and 144hr consumption was decreased by the Ladybird Beetles. After 168hr the ladybird Beetle again increase the feeding due to increase in the temperature (23° to 27°). The results in Fig. 1 showed maximum consumption of Rose Aphids *(Macrosiphum rosae)* after 24hrs as compared to 48hr and 72hr. After 72hr consumption of ladybird beetle decreased. While no significant difference was recorded between 96hr and 120hr in feeding behavior of ladybird beetle. After 144hr consumption of aphids by ladybird beetle again increased. The high rate of aphid's consumption by ladybird beetle may be attributed to increase in temperature (23° to 27°) which is recorded 168hr. Again, a decrease in the ladybird beetle feeding was observed. The results Fig. 1 showed that maximum consumption of walnut Aphids *(Lipaphis erysimi)* was recorded after 24hrs no significant difference was recorded after 48hr and 72hr. 96hr reading again increase in feed taken by the Ladybird beetles. The high rate of aphid's consumption by ladybird beetle may be attributed to increase in temperature (23° to 27°) which is recorded 168hr. Again, a decrease in the ladybird beetle feeding was observed.

Discussion

These results showed that *Coccinella septempunctata* is a good biological control agent due to its predation level and it has short like cycle, which is also a good characteristic of a biological control agent. This species can be successfully used against sucking pests (aphid, jassid, whitefly, mites, leaf hoppers etc.) particularly against aphids. We can do collect the Ladybird beetle for the field and the starvation 24 hours to Coccinellids in laboratory and then augmentation release in the pest infested areas. These results are in conformity with Muzammil et al. (2008) who reported that incubation period in seven spotted lady bird beetle *C. septempunctata Linn*. Debaraj and Singh (1990) reported that the availability of food and temperature, Further studies on the predation rate of coccinellids on hemipteran preys both in the field and laboratory need to be done to enhance the ecological functions of agro ecosystems and to successfully incorporate them into IPM programs. Their results are similar to present findings i-e starvation duration affects the predation rate of the predators, longer the starved adult coccinellid beetle higher will be the predation rate. The hourly consumption of adults of C. septumpunctata for *L. eryisimi*. Present findings are like those reported by Arif et al. (2011), as the *Coccinella septempunctata* showed significant high predation on *L. eryisimi.*

Starvation of adults of ladybird beetles can enhance their feeding potential. The results of present study showed that the adults of *C. septempunctata* when kept starved consumed an equal number of live Aphids. Whereas, when the beetles were not starved, they showed preference for live aphids only. The present findings are in accordance with the Yen (1983) who reported that starved adults of the predators are more efficient than feed ones. This kind of eating behavior shows that starvation levels may increase the willingness of predators towards their hosts or they start feeding what they normally may not like. The results of another study also indicate that the starved adult beetles consumed a greater number of aphids than unstarved adults (Sharma & Joshi, 2010). The starvation of *C. septempunctata* increased the feeding potential of adults on *L. erysimi* (Pandey 2002).

In the anther study showed the Karnatak and Thorat (2006) also reported that starved adult of C. septempunctata consumed more aphids than unstarved or well-fed ones. Further, the predators starved for 24hr before release could be effective in increasing feeding potential of all the stages of ladybird under field conditions (Sharma & Joshi, 2010). Sarmad et al. (2015) reported that the rose aphid consumption rate of 24 hours starved adult *C. septempunctata* was a bit higher than 24 hours starved adult beetles.

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