

Ladybirds to the rescue: The aphidophagous ladybird beetle as a bio-control agent

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Abstract

The aphidophagous ladybird beetle is one of the potential predators of the mustard aphid, *Lipaphis erysimi* (Kaltenbuch) which is a key pest of the rapeseed and mustard. Mustard is a very important oilseed crop and constitute the major source of edible oil in India. The development of resistance to pesticides and toxicity to the non target organism is largely responsible for the attention on biological control. The bio-control agents like coccinellids and others have been reported to be effective for controlling the aphid, *Liphapis erysimi*. Biological control is an environmentally sound and effective means of reducing or mitigating pests and pest effects through the use of natural enemies.

Keywords: Ladybird beetle, mustard, bio-control agents, natural enemies.

1. Introduction

Aphids constitute one of the key pests and main phyto-sanitary problems in rapeseed and mustard crops. The aphidophagous ladybird beetle *Coccinella septempunctata* L., is one of the potential predators of the mustard aphid, *Lipaphis erysimi* (Kaltenbuch) which is a key pest of the rapeseed and mustard. Mustard is a very important oilseed crop and constitute the major source of edible oil in India. Among the insect pests the mustard aphid, *Liphapis erysimi* (Kaltenbuch) is a serious insect pest, infesting the crop right from seedling stage to maturity, it ravages the crop during the reproductive phase and act as a limiting factor in the production.

The bio-control agents like coccinellids and others have been reported to be effective for controlling the aphid, *Liphapis erysimi*¹.

2. Ladybird or Ladybeetle?

Ladybird is a name that has been used in England for more than 600 years for the European beetle *Coccinella septempunctata*. As knowledge about insects increased, the name became extended to all its relatives, members of the beetle family, Coccinellidae. Now, the word ladybird applies to a whole family of beetles, Coccinellidae or ladybirds, not just *Coccinella septempunctata*. Coccinellidae are known colloquially as ladybirds (in Britain, Ireland, the Commonwealth, and some parts of the southern United States), ladybugs (originating in North America). However entomologists in the United States widely prefer the names ladybird beetles or lady beetles as these insects are not true bugs.

The ladybird beetles (Coleoptera: Coccinellidae) are bright in colors. Ladybird adults are oval, range in length from about 1 mm to over 10 mm depending upon species, and have wings. They are associated with good fortune in many myths and legends. They may be entomophagous or phytophagous². Cannibalism of eggs, larvae and pupae are common, especially when prey is scarce. They have several generations in a year and reproduction is slowed in winter, when adults may hibernate.

Females on average are larger than males. Adults of some species are brightly colored. Their mandibles are used for chewing. Adult ladybirds are able to reflex-bleed from the tibio-femoral articulations (leg joints). The blood (haemolymph) is repellent by having a repulsive smell as well as containing (in some species) various alkaloid toxins (adaline, coccinelline, exochomine, hippodamine, etc.). The haemolymph is yellow and its repellency and toxicity are believed to be a defense mechanism against predators. Some people have claimed that the bright (red on black, or black on red) colors of some adult ladybirds are aposematic, which is to say that the colors warn would-be predators that the beetles are distasteful or toxic³.

About 6000 species of ladybird beetles found all over the world. Ladybird beetles are generally considered useful insects as many species feed on soft bodied insects like aphids, jassids, psyllids, whiteflies, scale insects, mealy bugs, insect eggs, small larvae and phytophagous mites which are injurious to agricultural crops and forest plantations.

3. Ladybirds to the Rescue

They are of interest and importance in agriculture and forestry, since adults and larvae of the most species are predators of herbivorous pests such as aphids, *Aphis glycines* Matsumura; adelgids, *Adelges cooleyi* (Gillette); psyllids, *Psylla oblonga* Mathur; mealy bugs, *Maconellicoccus hirsutus* Green and scale insects, *Icerya purchase* Maskell. As such, they have been employed in biological control since the late 1800s⁴. Ladybugs have voracious appetites and can clean up large amounts of aphids in no time. As with many beneficial insects, the larvae eat more than the adults. The rate of development of ladybirds is determined both by food quality and temperature. Each species tends to feed on relatively few species of prey in nature.

Cruciferous crop like mustard, radish s are attacked by many insect pests. The mustard aphid, *Lipaphis erysimi* (Kaltenbuch) (Hemiptera: Aphididae) is one of the serious pests of cruciferous crops⁵ and is distributed in many countries of the world⁶. The damage is caused by both nymphs and the adults, these are louse-like and pale greenish insects, are seen feeding in large numbers, often covering the entire surface of the flower buds, shoots, pods etc .

1. Bio-control agent

Biological control or “biocontrol” is the use of living organisms to suppress the population of a specific pest organism, making it less abundant or less damaging than it would otherwise be. The antagonists used for this purpose are natural enemies of the pests, and are called “biological control agents”⁷.

In biological control, natural enemies of pests are used to control them. Biological control is generally the most environmentally safe and economically profitable pest management method. Aphid-eating (“aphidophagous”) ladybirds are used for the biological control of aphids. Population dynamics theory based on predator-prey interactions predicts that naturally occurring aphidophagous ladybirds are not able to control aphid populations effectively in nature and agro-ecosystems⁸. First, because females will never deplete a site with aphids where they lay their eggs since their offspring would starve. Secondly, because the development and reproduction of these ladybirds takes much longer than that of their prey, and as a result, they cannot keep up with the population growth of aphids. Several types of professional biological control are distinguished

With respect to conservation biological control in agro-ecosystems, the contribution of aphidophagous ladybirds varies largely. They will never attain longterm suppression of aphids, but may well reduce within-season aphid densities by reduction of peak aphid densities. Ladybirds have a long history in classical biological control programs. However, none of the aphidophagous species introduced in exotic geographical areas were considered to be successful by Dixon.

2. Bio-control strategies

Biological control constitutes the attempts to use natural enemies against pests either by introducing new species into the environment or by increasing the effectiveness of those already present. Monitoring for the presence and relative abundance of natural insects enemies is an important component of an area-wide pest control.

Several bio-control strategies can be distinguished:

- **Conservation biological control:** resident populations of natural enemies are conserved or enhanced by modification of the environment or existing practices. The aim is to reduce the effect of the pest, not to yield complete control.
- **Classical biological control** (also called inoculative control): the intentional introduction of an exotic biological control agent for permanent establishment and long-term pest control. This is the most widespread and successful mode of biological control. It is applied for outdoor pests that are usually invasive exotics. The agents are natural enemies of the pest species in their native range, and are introduced into the new geographic area following the pest species.
- **Augmentation:** the release of extra natural enemies at the place where the pest should be controlled.
- **Inundation or mass release:** large numbers of natural enemies released for immediate and short-term pest control by these specimens. They often cannot maintain a population after release, so they have to be re-applied when the pest returns or increases again in number.
- **Seasonal inoculation:** fewer individuals released, and reproduction at the place of release is expected, so both the generation released and their progeny contribute to control, aiming at an extended period of, but not permanent, control.

To be cost-effective, augmentative bio-control requires the possibility for cheap mass-rearing and high efficacy at a limited release frequency.

- **Integrated pest management (IPM)** The use of natural enemies exotic in the area released (for classical or augmentative control) is nowadays legally restricted. To be allowed, a risk assessment and evaluation of the impact have to be passed. When chemical and biological control methods are combined in agricultural practice, this is called integrated pest management (IPM). IPM as a holistic approach of crop protection based on the integration of multiple strategies viz., cultural, physical, mechanical, biological, botanical and chemical. Over the years IPM underwent several changes, shifting its focus from damage boundary, economic injury to economic threshold. Intensive agricultural practices relying heavily on chemical pesticides are a major cause of wide spread ecological imbalances resulting in serious problems of insecticide resistance, pest resurgence and pesticide residues. There is a growing awareness world over on the need for promoting environmentally sustainable agriculture practices.

3. Ladybird beetle as a bio-control agent

This beetle occupies quite a remarkable place among the naturally occurring biocontrol agents of mustard aphid: Mathur⁹ studied the relative abundance of the effective natural enemies of mustard aphid *L. erysimi*, in farmers' fields; the *C. septempunctata* was the highest (41.97%) occurring species¹⁰.

The development of resistance to pesticides and toxicity to the non target organism is largely responsible for the attention on biological control¹¹. Insecticides destroy all insects irrespective of whether they are beneficial or not and contaminate the environment, threatening the well being of the other creatures¹². Thus biological control is an environmentally sound and effective means of reducing or mitigating pests and pest effects through the use of natural enemies. It relies on predation, parasitism, herbivory or other natural mechanisms, but typically also involves an active human management role.

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