ROLE OF PREDATORS IN INSECT PESTS MANAGEMENT FOR SUSTAINABLE AGRICULTURE

Predators are the species which feeds upon other animal (*i.e.*, prey) for their development, sustenance, and reproduction. They are generally larger than their prey, active and depend on more than one prey to complete their life-cycle. These predators use different approaches to find and kill their preys and their some body parts have been modified to assist predatory movement. In general both the immature and adult stages are predatory (Lady bird beetle) or some time immature stage is predatory (eg. Syrphid fly, Green lace wing). These predators can be transient (ladybirds) or residential (predatory mites) depending up on their nature.

Use of these predaceous/ insectivorus arthropods as biological control agent is very useful in insect pest management. More than 30 families of insects are predaceous in nature and among them, the Coccinellidae, Chrysopidae, Syrphidae, Anthocoridae, Staphylinidae, Cecidomyiidae, Reduviidae, Carabidae and Formicidae are important in agri-horticultural perspective. If we look back, the era of modern biological control also initiated with predator with the highly successful introduction of the Vadalia beetle, *Rodolia cardinalis* (Mulsant) from Australia to California to control the cottony cushion scale, *Icerya purchasi* Maskell of citrus during 1888 (Van Driesche *et al*., 2008).

Arthropod predators can be classified into two groups according their food habits (Van Driesche *et al*., 2008):

1) Generalist predators that depend on prey of different insect families and feed on different stages of prey (egg, larva, pupa and adult). These genera list predator can be increased by conservation biocontrol techniques or augmentative releases.
2) Specialized predators can be introduced to new site as part of classical biological control programs.

Aphids are devoured by various predators such *Cheilomenes sexmaculata*, *Coccinella septempunctata*, *Brumoides suturalis*, *Micraspis discolor*, *Scymnus castaneus*, *Pseudaspidemerus circumflexa* (Coleoptera: Coccinellidae) and syrphids like *Ischiodon scutellaris* and *Peragus sp*. and they are generally not species specific (Table 1). The neuropterans like *Chrysopa spp.* (Chrysopidae) are although generalist predators but mostly prefer soft-bodied insects. For augmentative release purpose *Cryptolaemus montrouzieri* are widely used to suppress the mealy bug population. They are easy to rear under laboratory condition. Beside insects, spiders are also act as predators and contribute an effective role in insect pest management in various agri-horticultural ecosystems.

In many European countries, the predatory mite *Phytoseilus persimilis* (Acari: Phytoseiidae) was commercially mass multiplied and released in glasshouse cucumber for the management of two spotted mite *Tetranychus urticae*. In Spain, predatory mite, *Amblyseius swirskii* (Acari: Phytoseiidae) and anthocorid bug, *Orius laevigatus* (Heteroptera: Anthocoridae) successfully manage the thrips and whiteflies on sweet peppers in greenhouses. These results are depicting how well biological control with predators can function in agricultural ecosystem.

PREDATION METHODS

There are various predation methods follows by predators to catch their preys in nature.

HUNTERS AS WELL AS CHASERS

Tiger beetles run down prey and catch it with their strong, curved jaws on the ground. In the air, dragonflies catch their prey by their strong spiny legs.

HUNTERS AS WELL AS WAITERS

These predators attack their prey by waiting. When the prey comes near to them, they catch them by their strong raptorial forelegs. Their shape and body coloring helps them to camouflage with surrounding nature eg. Praying mantids.

HUNTERS, COLLECTIVE ATTACK

Ants are the example of collective work and they use chemical signals to garner other worker ants for attack.

TRAPPERS

The spiders trap their prey by making typical web. To trap the food from the water, caddisfly larvae use silk to make different types of '*Capture nets*'. When water passes through these nets, the food particles *i.e.*, preys caught inside the nets.

EXAMPLES OF SOME IMPORTANT PREDATORS IN AGRI-HORTICULTURAL ECOSYSTEMS GREEN LACEWINGS CHRYSOPERLA SPP. (NEUROPTERA: CHRYSOPIDAE)

The Green lacewings *Chrysoperla* spp. is a widely popular polyphagous predator. Almost 50 species are known to act as predator in agriculture. They feed on soft-bodied insects like mealy bugs, aphids, jassids, whiteflies, thrips and neonate larvae (Halder and Rai, 2016). They are also vernacularly known as aphid lions because for their appetite for aphids. The adults are free-living and feed on honeydews and pollens. Larvae are cannibalistic in nature. So, due care should be taken during their mass rearing. The recommended rate of release for *C. zastrowi sillemi*, varies from 10 per m^2 in a low infestation to 20 per m^2 in a severe infestation.

MEALY BUG DESTROYER CRYPTOLAEMUS

MONTROUZIERI (COLEOPTERA: COCCINELLIDAE)

This beetle can control the various mealy bugs that lays eggs in ovisacs *viz*., papaya mealybug, *Paracoccus marginatus*, solenopsis mealybug, *Phenacoccus solenopsis* etc. However, they are ineffective against species such as long-tailed mealy bug, *Pseudococcus longispinus* that produce live nymphs, as the predator lays its eggs in ovisacs. Release of ***C****. montrouzieri* @ 10 beetles per vine can effectively control the mealy bugs, *Maconellicoccus hirsutus* infesting grapes.

CHILOCORUS NIGRITA (COLEOPTERA: COCCINELLIDAE)

Release of adult *C. nigirita* was effective for the management of red scale in citrus, *Aonidiella aurantii*.

COCCINELLA SEPTEMPUNCTATA (COLEOPTERA: COCCINELLIDAE)

They are effective in areas with mild temperature like northern parts of India. It suppresses the aphids like *Myzus persicae*, *Brevicoryne brassicae* and *Lipaphis erysimi* etc. infesting rabi oilseeds, cole crops and other vegetables.

CYRTORHINUS LIVIDIPENNIS (HEMIPTERA: MIRIDAE)

This insect is an effective predator against rice plant and leaf hoppers. Release of mirid bugs @ 100 or 50–75 eggs/m^2 at 10 day interval is effective for suppression of hoppers in rice ecosystem.

ORIUS SPP (HEMIPTERA: ANTHOCORIDAE)

These predatory anthocorids feed on soft-bodied insects like thrips, mites, aphids, whiteflies, lepidopteran eggs as well as pollen and plant sap, but are released mainly against thrips in crops like pepper, onion and cucurbits. Adult predatory anthocorid bug can devour @ 5 - 20 thrips per day. Some important species are *Orius sauteri, Orius laevigatus, Orius majusculus* and *Orius insidiosus*. The recommended rate of release ranges from 1 to 10 per m^2, depending on the level of pest infestation.

PHYTOSEIULUS PERSIMILIS (ACARINA: PHYTOSEIIDAE)
This predatory mite acts as a potential predator on two-spotted spider mite, *Tetranychus urticae*.

Many arthropod natural enemies are effective for pest management in vegetable crop ecosystem. The table 1 represent the effective natural enemies, their families, host range, feeding site in agri-horticultural ecosystems.

Table 1: Arthropod predators effective against major insect pests of various crops

Natural Enemy	Pest	Crop
The ladybird beetles *Menochilus sexmaculatus*, *Brumoides suturalis, Harmonia dimidiate* and *Coccinella septempunctata* and green lacewings, *Chrysoperla zastrowi sillemi*	Aphids; *Aphis craccivora, Myzus persicae, Lipaphis erysimi* (Hemiptera: Aphididae) and Leafhoppers; *Empoasca kerri*, *E. facialis*, *E. fabae* (Hemiptera: Cicadellidae) etc.	Vegetables, Fruits, Pulses, Oilseeds
Predatory mites such as *Phytoseilus persimilis* and several species of *Amblyseius spp.*	Spider mite; *Tetranychus spp.* (Acari: Tetranychidae)	Tomato, Brinjal, Sweet Peppers, Cucumber
Cryptolaemus montrouzieri, Scymnus spp.	Mealy bugs, *Paracoccus marginatus* and *Phenacoccus solenopsis*, green shield scale: *Pulvinaria psidii* (Hemiptera: Pseudococcidae) etc.	Brinjal, Okra, Tomato, Papaya, Guava, Sapota, Lemon
Coccinellids Chilocorus nigrita and *C. circumdatus*	Green scale, *Coccus viridis* (Hemiptera: Coccidae) on acid lime and white scale *Aulacaspis tubercularis* on mango (Hemiptera:	Acid lime, Mango

	Diaspididae)	
Predatory mirid bugs, *Nesidiocoris tenuis*	Tomato pinworm, *Tuta absoluta* (Lepidoptera: Gelechiidae) etc.	Tomato, Potato, Pepper
Predatory anthocorid bugs, *Orius sauteri*	Thrips; *Thrips palmi*, *Frankliniella occidentalis* etc.	Brinjal, Sweet pepper, Cucumber

(Source: Halder *et al*., 2018; Seni and Chongtham, 2013; Waterhouse and Sands, 2001)

FUTURE THRUST

Major constraints in using predators in pest management are the mass rearing difficulties and their adaptability to new weather conditions. Research should be directed to develop techniques for their easy mass production on artificial diet or searching other insect species that are easily available for their rapid multiplication under laboratory conditions. For this, sound knowledge of taxonomy and bioecology of predators, environmental effect on them, releasing method(s), prey- predator-crop plant interactions, efficacy studies, and proper documentation are imperative. Beside their role to suppress the insect pests population, more studies are also required to demonstrate the ecological impact of these predators under integrated pest management programme.

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