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Recent Trends in Biological Control in India

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SUMMARY

Nowadays, we all might be known that the chemical pesticides load on crops is so huge which can ultimately affect human health and also detrimental effect on environment. Due to use of chemicals, pests may become resistant to certain chemicals so we are need to develop alternative methods of pest control which will give more emphasis on advanced biological control and biological control will be the safe pest management option. Biological control approach is very valuable and proved the better in pest management. So we are going to take some information related recent activities of biological control against fruit crop pests.

INTRODUCTION

In recent decades, elevated awareness of the impacts of pesticide use on the environment and human health has resulted in efforts to reduce reliance on chemical controls. Biological control is the action of predators, parasites, pathogens, and competitors in controlling pests and their damage. Biological control relies on predation, parasitism, herbivory or other natural mechanisms, but typically also involves an active human management role. The term biological control was first used by Smith 1919 to signify the use of natural enemies. Biological control is one of the major components of IPM programme. Biocontrol is often viewed as a progressive and environmentally friendly way to control pests. Maximum degree of success with classical biological control agents in India has been achieved in biological control of aquatic weeds (55%) followed by homopterous pests (46.70%) and terrestrial weeds (23.80%).

HISTORY

Year	Historical event
1762	The Indian myna bird, *Acridotheres tritis* was introduces to Mauritius where it successfully controlled the red locust, *Nomadacris septemfasciata*
1795	The first successful classical biological control was achieved in India when cochineal insect, *Dactylopius ceyonicus* was introduced from brazil to control Prickly pear in the mistaken belief that it was the true caramine dye producing insect, *D. coccus*
1898	First intentionally introduced beneficial biocontrol agent was the coccinellid predator, *Cryptolaemus montrouzieri* which was introduced by Mr. H.O. Newport.
1921	The agromyzid seed fly, *Ophiomyia lantanae* was introduced from Hawaii and released in South India for suppression of *Lantana camera*.
1926	The coccinellid beetle, *Rodolia cardinalis* was introduced to India in 1926 via USA and South Africa and in 1930 via Egypt for control of *Icerya purchasi*. The beetle was released in the Nilgiris in 1930 and it successfully controlled *I. purchasi*
1937	For the control of woolly aphid, exotic aphelinid parasitoid, *Aphelinus mali*, a native of North America, was introduced from UK at Saharanpur (UP)
1957	In India, organized and systematic biological control research began with the establishment of the Indian station of Commonwealth Institute of Biological Control (CIBC) at Bengluru
1958	Aphelinid parasitoid, *Encarsia perniciosi* strain from California was introduced in 1958 and Illinois, Chinese and Russian strains were introduced in 1960 for the biological suppression of San Jose scale
1977	An insectary was established at the Central Horticultural Experiment Station, Chethalli, Kodgu (Karnataka), for the multiplication of *Cryptolaemus montrouzieri*
1981	The first insectary Biocontrol resaerch laboratory was established in Banglore

1982	Three exotic natural enemies were introduced in India viz., hydophilic weevils- *Neochetina bruchi* and *N. eichhorniae* and galumnid mite, *Orthogalumna terebrantis* from their original home via USA for the biological suppression of water hycinth.
1983	The encyrtid parasitoid, *Leptomatstix dactylopii* was introduced in India from Brazil which is a parasitoid of *Planococcus citri* and *P. lilacinus*
1983	A chrysomelid beetle, *Zygogramma bicolorata* was imported for management of parthenium
1883-84	Exotic weevil, *Cryptobagus salviniae* was released for the control of water fern, *Salvinia molesta* in a lily pond in Banglore
1987	the first issue of the Journal of Biological Control was published
1988	The coccinellid predator, *Curinus coeruleus* was obtained from Thailand in 1988 for the biological suppression of *Heteropsylla cubana*
	AICRP on Biological control of crop pests and weeds started in 1977 then upgraded in 1993 as (Project Directorate of Biological Control)
2009	PDBC renamed as National Bureau of Agriculturally Important Insects (NBAII)
2010	The National Bureau of Agriculturally Important Insects (NBAII), Banglore took efforts in importing three exotic papaya mealy bug parasitoid such as *Acherophagus papayae*, *Pseudleptomastix mexicana* and *Anagyrus loecki*
2014	NBAII renamed as National Bureau of Agricultural Insect Resources (NBAIR)

Biological Control:

- Based on ecology as a phase of natural control it can be defined as "the action of parasitoids, predators or pathogens in maintaining another organism's population density at a lower average than would occur in their absence" (Paul De Bach, 1964)
- When the activities of man are concerned as a phase of applied control "it can be defined as the destruction or suppression of undesirable insects, other animals or plants by the introduction, encouragement or artificial increase of their natural enemies."

Methods of Biological Control:

There are three basic strategies for biological pest control:

Importation (Classical):

Importation or classical biological control involves the introduction of a pest's natural enemies to a new locale where they do not occur naturally. Early instances were often unofficial and not based on research, and some introduced species became serious pests themselves. Most successful with pests of fruits and forest trees.

e.g.: The vedalia beetle, *Rodolia cardinalis* was imported from Australia to California in the 19th century, successfully controlling cottony cushion scale.

Augmentation:

- Augmentation involves the supplemental release of natural enemies that occur in a particular area, boosting the naturally occurring populations there.
- Augmentation can be effective, but is not guaranteed to work, and depends on the precise details of the interactions between each pest and control agent.
- It is of two types: a. innundative releases and
  b. inoculative releases

Inundative Releases:

- Pest control is through release of natural enemies and not by their progeny.
- Basically the mortality of pest is immediate.
- Massive releases have been attempted in several programmes involving natural enemies like *Trichogramma* spp. parasitizes insect eggs and in addition to this, general predators like green lace wing and lady bird beetles are used in augmentation programmes.

Inoculative Releases:

- Control is dependent upon the progeny being produced for more than one generation following the colonization of individuals of beneficial species.
- Control using this method lasts longer than with inundative releases.
- Small numbers of natural enemies are released.
- e.g. Citrus mealy bug, *Pseudococcus citri* by the release of predator, *Cryptolaemus montrouzieri*.

Conservation:

- Defined as making the environment better suited to the natural enemies.
- The objective is to protect and maintain the exiting populations natural enemies in Agro-ecosystems.
- This method usually includes using chemical less toxic to natural enemies, reducing number of applications and reducing dosage level.
- Basically, this approach requires knowledge about all aspects of natural enemies communities.

Biological control agents:

Predators (Ladybird beetles, Syrphid flies, lacewings, etc.), Parasites/ Parasitoids (Ichneumonid wasps, Tachinid flies, etc.), Entomopathogen (*Bacillus thuringiensis* (Bacteria), *Metarhizium anisopliae* (Fungi), NPV (Viruses), etc.) Entomopathogenic Nematodes (*Heterorhabditidae* spp, *Steinernematidae* spp, etc.) and Biorational pesticides (Botanicals (pyrethrins, azadirachtin), Minerals (kaolin clay, iron phosphate), synthetics, etc.)

Current Scenario on Biological Control in India:

Table No. 1: Area under cultivation and under use of Chemical and Bio-pesticides during 2014-15 to 2018-19

Year	Area Under		
	Cultivation	Pesticides	
		Chemical	Bio-pesticides
2014-15	96.628	53.141	5.405
2015-16	126.957	69.058	6.478
2016-17	120.798	71.645	7.267
2017-18	132.011	82.189	7.738
2018-19	167.499	87.957	14.636
Source: Directorate of Plant Protection, Quarantine and Storage			

Table No. 2: Pesticide wise consumption of Bio-pesticides during 2014-15 to 2018-19

Biopesticide	2014-15	2015-16	2016-17	2017-18	2018-19
Azadirachin	175.49	120.57	945.12	109.31	113.50
Bacillus subtilis	-	-	1.90	22.10	21.00
Bacillus thuringiensis	83.78	88.23	163.97	87.93	81.33
Beauveria bassiana	268.44	296.05	407.82	345.26	407.97
Metarhizium anisopliae	73.36	210.95	413.74	314.00	305.41
Neem based insecticides	436.48	515.75	397.04	338.34	376.16
NPV (H)	123.72	42.17	167.10	35.54	179.70
NPV (S)	0.89	102.88	2.59	48.25	298.50
Pascilomysis	60.22	51.05	63.86	57.49	55.00
Photorhabdus	3.00	3.00	-	-	-
Pseudomonas fluorescens	551.26	518.69	503.29	599.60	371.95
Tricoderma harzianum	16.24	20.49	57.74	381.43	10.67
Tricoderma spp.	20.02	20.02	346.69	21.00	234.82
Tricoderma viride	970.71	807.86	567.34	790.63	449.78
Verticillium lecanii	158.32	201.53	347.59	321.98	290.15

Other Bio-pesticides	0.01	0.71	-	0.07	-
Total	**2941.94**	**2999.94**	**4385.79**	**3472.92**	**3195.94**
Source: Directorate of Plant Protection, Quarantine and Storage					

Table No. 3: Consumption of Bio-pesticides formulations in various states during 2014-15 to 2018-19

States	2014-15	2015-16	2016-17	2017-18	2018-19
Maharashtra	486	1173	1454	1271	1164
West Bengal	680	950	838	951	997
Kerala	631	606	662	717	862
Karnataka	530	505	473	544	544
Haryana	330	340	380	390	410
Tamil Nadu	286	286	294	630	500
Chhattisgarh	284	370	380	405	505
Source: Directorate of Plant Protection, Quarantine and Storage					

Field application of Natural Enemies recommended by NBAIR:

Natural Enemy	Used as	Target organism (Pest)/host	Dose of application
Acerophagus papayae, Anagyrus loecki, Pseudleptomastyx mexicana	Endo parasitoids	**Papaya mealy bug,** *Paracoccus marginatus*	250 adults/ha
Cryptolaemus montrouzieri (Mulsant) (E)	Adults/Grubs	**Mealy bugs**, *Maconellicoccus hirsutus, Planococcus citri, P. lilacinus*	10 beetles or 50 grubs/infested plant or tree or 5000 beetles/ha
Scymnus coccivora	Adults	**Mealy bugs** on citrus, grapes and other fruit crops (*M. hirsutus, Planococcus* spp.)	600-2500 adults/ha
Chilocorus nigrita	Adults	**Citrus scale,** *Aonidiella aurantii*	10 adults/tree
Chrysoperla carnea (Stephens)	Eggs / First instar larvae	Sucking pests on fruit crops	10,000 first instar larvae/ha
Mallada spp.	Cocoons	Sucking pests on fruit crops	10,000 first instar larvae/ha
Beauveria bassiana	Spore cum mycelia formulation 1X10^8 CFU/g/ml	Several insect pests of crops	2.5-5.0 kg/ha for foliar spray 2.5-5.0 kg + 250- 500 kg FYM/ha for soil application
Metarhizium anisopliae	Spore cum mycelia formulation 1X10^8 CFU/g/ml	Several insect pests of crops	2.5-5.0 kg/ha for foliar spray 2.5-5.0 kg + 250-500 kg FYM/ha for soil application
Verticillium lecanii	Spore cum mycelia formulation 1X10^8 CFU/g/ml	Sucking pests of various crops	2.5-5.0 kg/ha for foliar spray
Paecilomyces fumosoroseus	Spore cum mycelia formulation 1X10^8 CFU/g/ml	For mite control	2.5-5.0 kg/ha for foliar spray

CONCLUSIONS

The use of indigenous/exotic natural enemies to suppress pest population has long been an integral part of biological control, which has continually proved very valuable in pest management. More use of advanced techniques i.e. use of nanoparticles/biotechnological/molecular approach for the development of new strains of bio-pesticides as well as natural enemies It is important that the Government/Universities/Private Companies/Organizations all should make more efforts to create awareness regarding utilization and conservation natural enemies for their future use as a natural tool for control of various sucking pests of fruit crops. So, the biological control can be alternate system, which may play an important role in achieving the goal of sustainable agriculture.

REFERENCES

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