International Journal of Biological Innovations
http://ijbi.org.in | http://www.gesa.org.in/journals.php
https://doi.org/10.46505/IJBI.2024.6106
IJBI 6(1): 44-48 **(2024)**
E-ISSN: 2582-1032

IMPACT OF BIO-CONTROL AGENT ON THE MANAGEMENT OF RICE INSECT PESTS

Shamik Dey[1*] and Nandini Pal[2]

[1]Faculty of Agriculture, JIS University, Kolkata (W.B.), India
[2]Department of Zoology, RBC College for Women, Kolkata (W.B.), India

**Corresponding author*: deyshamik93@gmail.com

Article Info:
Review Article
Received
14.02.2024
Reviewed
31.03.2024
Accepted
20.04.2024

Abstract: Insect pests and disease infestations are the primary problems in rice (*Oryza sativa*) cultivation. Mostly lepidopteran and hemipteran like yellow stem borer and brown plant hopper respectively are the important insect pests. Concerns about chemical free agriculture have promoted widespread introduction of integrated pest management, an ecologically based approach to control the harmful insects and pests. Integrated pest management is intended to reduce ecological and health damage from chemical pesticides by using natural parasites and predators to control pest population. This review article describes the impact of various biocontrol agents with respect to management of rice insect pests.

Keywords: Bio-control, Environment, Insect pests, Parasitoids, Pesticides, Predators, Rice, Yield.

Cite this article as: Dey Shamik and Pal Nandini (2024). Impact of Bio-control Agent on the Management of Rice Insect Pests. *International Journal of Biological Innovations*. 6(1): 44-48. https://doi.org/10.46505/IJBI.2024.6106

INTRODUCTION

Rice, as the single most essential human energy source, gives food to about half of the world's population. Great advances were made in irrigated rice which provided over 72 % of total yield and will remain outstandingly important with ecologically comparable rainfed lowland rice; it produces more than 92 % of the world's crop, of which over 91 % is grown in Asia. In almost all rice producing countries of the world, insect pests and crop diseases are considered the major factors that contribute to a decrease in rice production (Ali *et al.,* 2021).

Unfortunately, pest problems enhanced with the intensification of irrigated rice production, which included increased investments such as insecticides. More than 200 million tonnes of rice are lost every year due to biotic and abiotic factors (Khan *et al.,* 1991). Many devastating diseases of rice, such as tungro and yellow dwarf disease, are transmitted by insect-borne viruses (Heinrichs *et al.,* 1985). The most destructive insects for rice are the lepidopteran stem borers (*Scirpophaga incertulas* and *S. innotata*) and the rice leaf folder (*Cnaphalocrocis medinalis*) which cause annual losses in the order of ten million tonnes.

In particular, insecticide use preceded outbreaks of secondary pests, notably the brown plant hopper, *Nilaparvata lugens* (Stal) (Hemiptera: Delphacidae), which was previously of minor significance (Kenmore, 1991). The insecticides are effective against insect pests but exert negative effects on animals as well as on biodiversity and environment (Kumar, 2017; Prakash and Verma, 2014; Verma and Prakash, 2018). Over anthropogenic activities, pollution, pesticides etc. also affect the environment in various ways (Chaudhary *et al.,* 2021; Prakash and Verma, 2022; Verma and Prakash, 2022; Singh *et al.,* 2023; Rani *et al.,* 2024).

Biological control is the control of one organism by another (Beirner, 1967). The biological control depends on knowledge of biological interactions at the ecosystem, organism, cellular, and molecular levels and often is more complicated to manage as compared with physical and chemical methods. Biological control is also likely to be less spectacular than most physical or chemical controls but is usually also more stable and longer lasting (Baker and Cook, 1974), however, such type of control has some risks also (Wright *et al.,* 2005).

BIOCONTROL AGENTS

The bio-control agents protect plants from their natural enemies like parasites, predation, etc. They help in controlling the infestation of plant pests such as weeds, nematodes, insects, and mites. The biological control agents are specific to harmful organisms and do not kill useful organisms present in the soil. It includes bacteria, fungus, virus, nematodes and other insects. The insects used for bio-control agent can be categorised into two groups *namely* predator and parasitoid. The details of biocontrol agents against the insect pest of rice are given in table 1.

Entomopathogenic Bacteria: Entomopathogenic bacteria are unicellular prokaryotic organisms having size ranging from less than 1 mm to several mm in length. Bacteria with rigid cell walls are cocci, rod-shaped and spiral while bacteria without cell walls are pleomorphic. More than 100 bacteria have been identified as arthropod pathogens among which, *Bacillus thuringiensis, B. sphaericus, B. cereus* and *B. popilliae* have received most attention as microbial control agents. The majority of bacterial pathogens of insect pests occur in Bacillaceae, Pseudo-monadaceae, Enterobacteriaceae, Streptococcaceae, and Micrococcaceae families. These are at present over 40 Bt products available for the control of insect pests accounting for 1% of the global insecticide market (Evans, 2008). An example is *Bacillus thuringiensis.*

Entomopathogenic Fungi: The fungus which can kill the insect is called entomopathogenic fungus. Entomopathogenic fungi are found in the divisions: Zygomycota, Ascomycota and Deuteromycota as well as the Chytridiomycota and Oomycota (Samson *et al*., 1988). The origin of the entomopathogenic lifestyle may have arisen several times from a common saprophytic ancestor inhabiting soil and leaf litter (Humber, 1984; Samson *et al.,* 1988; Evans, 1989; Spatafora and Blackwell, 1993). The examples are *Beauveria bassiana, Metarhizium anisopliae.*

Entomopathogenic Virus: Entomopathogenic viruses are obligate intra-cellular parasites having either DNA or RNA encapsulated into a protein coat known as capsid to form the virions or nucleocapsids. In general, viruses are divided into two broad non-taxonomic categories *namely* occluded-viruses and non-occluded-viruses. The first category is the occluded-viruses in which the mature virion particles (virions) are embedded within a protein matrix, forming para-crystalline bodies that are generally referred to as OBs, while the second category is the non-occluded-viruses in which the virions occur freely or occasionally form para crystalline bodies, characterized by the absence of occlusion body protein interspersed among the virions (Federici, 1999). Currently, Baculoviridae is divided into two genera: Nucleopolyhedrovirus (NPV) and Granulovirus (GV) (Francki *et al.,* 1991; Murphy *et al.,* 1995). The examples are Nuclearpolyhedrosis virus, Granulosis virus.

Entomopathogenic Nematodes (EPNs): The EPNs of the families Heterorhabditidae and Steinernematidae are obligate parasites of insects and are used as biological control agents of economically important insect pests. Infective juveniles (IJs), considered the only free-living stage of EPNs, enter the host insect through its natural apertures (oral cavity, anus and spiracles) or in some cases through the cuticle (Dowds and Peters, 2002). The nematodes complete their development and live for two or three generations inside their host. When food is depleted, IJs exit from host cadaver searching for new hosts (Grewal and Georgis, 1999). The examples are *Steinernema carpocapsae*, *Heterorhabditis bacteriophora.*

Predators: The organism that attacks their prey and consumes them directly is called predators. They are free living in nature and do not depend on any host to complete their life cycle e.g. Dragonfly, Damselfly, Ladybird beetle, Preying mantis.

Parasitoids: These are the special type of insects that parasitize their host insect at specific host stage and complete their life cycle and emerge as an adult by killing the host e.g. *Trichogramma japonicum*, *Chelonus blackburni.*

Table: 1: Bio-control Agents against the Insect Pest of Rice.

Biocontrol Agent	**Order**	**Family**	**Attacked Insect Pest**
1. Parasitoids			
1.1. Egg Parasitoids			
Tetrastichus schoenobii	Hymenoptera	Eulophidae	Yellow stem borer
Trichogramma japonicum	Hymenoptera	Trichogrammatidae	Yellow stem borer
Telenomus rowani	Hymenoptera	Scelionidae	Yellow stem borer
Copidosomopsis nacoleiae	Hymenoptera	Encyrtidae	Leaf folders
Oligosita yasumatsui	Hymenoptera	Trichogrammatidae	Brown planthopper
Anagrus spp.	Hymenoptera	Mymaridae	Brown planthopper
1.2. Larval Parasitoids			
Temelucha philippinensis	Hymenoptera	Ichneumonidae	Yellow stem borer, Leaf folders
Pseudogonatopus spp.	Hymenoptera	Dryinidae	Brown planthopper
1.3. Pupal Parasitoids	**Order**	**Family**	**Attacked Insect Pest**
Tetrastichus ayyari	Hymenoptera	Eulophidae	Yellow stem borer
Xanthopimpla spp.	Hymenoptera	Ichneumonidae	Leaf folders
Pseudogonatopus spp.	Hymenoptera	Dryinidae	Brown planthopper
2. Predators			
2.1 Egg Predator			
Conocephalus longipennis	Orthoptera	Tettigoniidea	Yellow stem borer, Leaf folders
Cyrtorhinus lividipennis	Hemiptera	Miridae	Leaf folders, Brown planthopper
Micraspis crocea	Coleoptera	Coccinellidae	Leaf folders
2.2 Larval Predator	**Order**	**Family**	**Attacked Insect Pest**
Lycosa pseudoannulata	Araneida	Lycosidae	Yellow stem borer
Water bugs	Hemiptera	belostomatidae	Leaf folders
Ants	Hymenoptera	Formicidae	Leaf folders
2.3. Pupal Predator	**Order**	**Family**	**Attacked Insect Pest**
Paederus fuscipes	Coleoptera	Staphylinidae	Brown planthopper

Advantages of Bio-control Agents:

a) Biological control is less costly and cheaper than any other methods.
b) Bio-control agents give protection to the crop throughout the crop period.
c) They do not cause toxicity to the plants.
d) Application of bio-control agents is safer to the environment and to the person who applies them.
e) They multiply easily in the soil and leave no residual problem.

Disadvantages of Bio-control Agents:

a) Biocontrol agents are not easily available at the local market at the right time.
b) They are less effective than the fungicides.
c) Unavailability of bio-control agents in sufficient quantity and good quality.
d) Biocontrol agent is not available for all insect pests, weeds and plant diseases.
e) Biocontrol agents do not show its effect immediately.

CONCLUSION

To meet the need of food to the over growing population of our country farmers are using fertilizers, pesticides in excessive amounts. To increase the agricultural production several problems *viz.* soil pollution, water pollution, air pollution, biomagnification, eutrophication etc. must be faced. If these challenges met appropriate and timely measure or treatment, the agricultural production will not be hampered. So that biological control plays an important and alternative role to manage the pest population and increase production. Though a successful biocontrol programme requires time, money, patience, knowledge, experience but it is eco-friendly and has no side effects like resistance and resurgence problem.

REFERENCES

1. **Ali M.P., Nessa B., Khatun M.T., Salam M.U and Kabir M.S.** (2021). A way forward to combat Insect pest of rice. *Bangladesh Rice Journal*. 25(1): 01-22. https://doi.org/10.3329/brj.v25i1.55176.
2. **Baker K.F. and Cook R.J.** (1974). Biological Control of Plant Pathogens, W.H. Freeman and Co, San Francisco, California. 433 pp. (Book, reprinted in 1982, Amer. Phytopathol. Soc., St. Paul, Minnesota).
3. **Beirner B.P.** (1967). Biological control and its potential. *World Rev. Pest Control*. 6(1): 7-20.
4. **Chaudhary V.K., Arya S. and Singh P.** (2021). Effects of Pesticides on Biodiversity and Climate Change. *International Journal on Environmental Sciences*. 11(2): 95-99.
5. **Dowds B.C.A. and Peters A.** (2002). Virulence mechanisms 2002. Pp. 79-98 in R. Gaugler, ed. Entomopathogenic nematology. New York.
6. **Evans H.C.** (1989). Mycopathogens of insects of epigeal and aerial habitats. In: Wilding N. Collins NM, Hammond PM. Weber JF (eds) Insect-fungus interactions. Academic Press, London, pp 205-238.
7. **Evans J.** (2008). Biopesticides: from cult to mainstream. *International Journal of Plant Protection*. 2(2):11-14.
8. **Federici B.A.** (1999). A perspective on pathogens as bio-logical control agents for insect pests. In: Bellows, T.S., Fischer, T.W. (Eds.), Handbook of Biological Control: Principles and Applications of Biological Control. Academic Press, CA, pp. 517-548.
9. **Francki R.I.B., Fauquet C.M., Knudson D.L. and Brown F.** (1991). Classification and nomenclature of viruses: Fifth Report of the International Committee on Taxonomy of Viruses. *Arch. Virol*. 2, 117-123.
10. **Grewal P.S. and Georgis R.** (1999). Entomopathogenic nematodes. Pp. 271-299 in F.R. Hall, and J.J. Menn, eds. Methods in Biotechnology, vol. 5: Biopesticides: Use and Delivery. Totowa, NJ: Humana Press.
11. **Heinrichs E.A., Medramo F.G. and Rapusas H.R.** (1985). Genetic evaluation for insect resistance in rice. *Oryza*. 40(3): 22-28.
12. **Humber R.A.** (1984). Foundations for an evolutionary classification the Emcenophthorales (Zygomycetesi). In: Wheeler Q, Blackwell M (eds) Fungus-insect relationships Columbia University Press, New York, pp 166-183.

13. **Kenmore P.E.** (1991). Indonesia's integrated pest management -a model for Asia. Food and Agriculture Organization, Manila, p 56.

14. **Khan Z.R., Litsinger J.A., Barrion A.T., Villanueva F.F.D., Fernandez N.J. and Taylo L.D.** (1991). World bibliography of rice stems borers 1794–1990. International Rice Research Institute, Los Baños.

15. **Kumar A.V.** (2017). Multiple effects of Unsustainable Agriculture. *International Journal on Agricultural Sciences*. 8(1): 24-26.

16. **Murphy F.A., Faquet C.M., Bishop D.H.L., Gabrial S.A., Jarvis A.W. and Martelli, G.P.** (1995). Classification and Nomenclature of Viruses: Sixth Report of the International Committee on Taxonomy of Viruses. Springer-Verlag, Berlin.

17. **Prakash S. and Verma A.K.** (2014). Effect of Organophosphorus Pesticide (Chlorpyrifos) on the Haematology of *Heteropneustes fossilis* (Bloch). *International Journal of Fauna and Biological Studies*. 1(5): 95-98.

18. **Prakash S. and Verma A.K.** (2022). Anthropogenic activities and Biodiversity threats. *International Journal of Biological Innovations*. 4(1): 94-103. https://doi.org/10.46505/IJBI.2022.4110.

19. **Rani K., Singh S., Prakash S. and Arya S.** (2024). Role of Pesticides in Biodiversity Loss. *International Journal of Bioscience and Biochemistry*. 6 (1): 01-03. 10.33545/26646536.2024.v6.i1a.47.

20. **Samson R.A., Evans H.C. and Latgé. J.P.** (1988). Atlas of entomopathogenic fungi. Springer, Berlin Heidelberg New York.

21. **Singh R., Verma A.K. and Prakash S.** (2023). The web of life: Role of pollution in biodiversity decline. *International Journal of Fauna and Biological Studies*. 10(3): 49-52. 10.22271/23940522.2023.v10.i3a.1003.

22. **Spatafora J.W. and Blackwell M.** (1993). Molecular systematics of unitunicate perithecia ascomycetes: the Clavicipitales-Hypo creales connection. *Mycologia*. 85: 912-922.

23. **Verma A.K. and Prakash Sadguru** (2018). Haematotoxicity of Phorate, an Organo-phosphorous pesticide on a Freshwater Fish, *Channa punctatus* (Bloch). *International Journal on Agricultural Sciences*. 9 (2): 117-120.

24. **Verma A.K. and Prakash S.** (2022). Microplastics as an emerging threat to the fresh water fishes: A review. *International Journal of Biological Innovations*. 4(2): 368-374. https://doi.org/ 10.46505/ IJBI.2022.4212.

25. **Wright M.G., Hoffmann M.P., Kuhar T.P., Gardner J. and Pitcher S.A.** (2005). Evaluating risks of biological control introductions: A probabilistic risk-assessment approach. *Biological Control*. 35(3): 338-347. https://doi.org/10.1016/j.biocontrol.2005.02.002.