



Bio pesticide : A paradigm shift of pesticide development in India

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ABSTRACT

Biopesticides terminate the problems of pest resistance, environmental burden and ensure the safety of human beings. Although the overriding challenges associated with biopesticides are fulfilling market expectations of the industry, this greener tool is now struggling for its establishment in pesticide market. The technological adaptability among farmers is still far behind regarding the uses of biopesticides especially cost-effective microbiological pesticide. Besides these constraints, long-term sustainability is the major breakthrough which needs to be considered. Off late the ongoing efforts from the government side towards adaptation will certainly show the light of better way of manufacturing in near future.

Keywords: biopesticides, biocontrol, sustainable agriculture

Biopesticides by definition as the name suggests, are naturally occurring materials that control harmful pests biologically. Biopesticides are produced from either plant derived (primary or secondary metabolites) or microorganisms (bacteria, fungi, virus or algae), which are solely non-toxic to non-target organisms, eco-friendly, safer to mammals and also compatible to integrated pest management (IPM). Science has given new intervention which makes our life easy and shortcut. In the agricultural science, the effective use of scientific techniques leads to many inventions which upgraded agriculture sector to a greater height. The path breaking researches are done for the betterment of the society, but in return it always gives some negative impact one way to other just like Newton's third law depicts 'For every action there is equal and opposite reaction'. In contrary to synthetic chemical pesticides, biopesticides act as a green tool towards sustainable agriculture. Since long back, biopesticides are traditionally controlling pests and pathogens invented by farmers as their indigenous practice. Although, they are still on the race for market place amongst agrochemicals. Overall in the global domain, the consumption of biopesticides has been accelerated fairly, particularly in the western countries specially European and American region. This is understandable from the fact that more than half of the biopesticides produced worldwide are being used by America. Although the scope of biopesticides in India is highly promising, but the gear of usage needs to be enhanced in view of the today's organic agriculture.

Types of Biopesticides

One of the important components of Integrated Pest Management (IPM) is biopesticides as it has capacity to maintain the natural ingredients without use of any synthetic parts. Other than plant and microorganisms based Biopesticides, there are genetically modified plants (GM) which can be integral part of biopesticides. *Trichoderma* spp., and *Bacillus* spp., are some of the important microbial biopesticides. Neem and garlic based biopesticides are the popular herbal biopesticides. GM varieties are resistant to different pests and diseases (e.g. Bt brinjal, Bt cotton).

There are primarily three categories in biopesticides:

- **Biochemical pesticides:** These are plant based substances which are naturally produced by a plant or any organism as their secondary metabolites are the main active ingredient. They are non-toxic and biodegradable in the environment. They act as a defense molecule against pests e.g. polyphenols, fatty acids, pheromones etc.
- **Microbial pesticides:** These pesticides originated from micro-organisms such as fungi, bacteria, or other microorganisms groups. These mostly act as target-specific organisms aiming to kill one or more group of pests.
- **Plant incorporated protectants:** These are GM materials produced by researchers by modifying a



protein molecule and introducing into any plant so that it produces its own defense molecule as pesticide.

Biopesticides Technology

The biopesticide sector occupies a small portion of the large pesticide market in India. In 2005, it has increased to just 2.89%; till 2011, there was only 12 different types of biopesticides registered in India. In recent years it has witnessed a wide growth in this sector, especially on production standardization techniques of different organisms like *Gliocladium*, *Trichoderma*, *Pseudomonas*,

Paecilomyces, *Trichogramma*, *Bacillus* and NPV to use them to control many pests and diseases (Table 1). These are successfully used as biocontrol agent in India. *Trichogramma*, a stingless wasp which feeds on the eggs of sugarcane borers, can control the borers in different states of India. *Trichogramma* has also been used against leaf folder and rice stem borer. Similarly, *Chelonus*, *Bracon* and *Chrysopa* spp are used in controlling cotton bollworms. The predatory coccinellid beetles can control sugarcane scale insect in different northern and southern states.

Table 1: Different technologies used in producing bio pesticides

Bio Agent	Manufacturing process	Utilization
<i>Trichogramma</i> spp. (egg parasite)	Mass multiplied by using stored grain pest as a host. Production involves the multiplication of host insect on sorghum grains, which is allowed to be parasitized by <i>Trichogramma</i> . Then eggs are clued in cards as 'tricho cards'	Used for control of sugarcane early shoot borer, cotton bollworms, sorghum stem borer
<i>Crysoperla carnea</i> (Chrysopid predator)	Mass multiplied in the laboratory on the eggs of stored grain pest	To control larval pest in pulses, vegetables and fruits
<i>Cryptolaemus montrouzieri</i> (Ladybird beetle)	Mass multiplied on mealy bugs with the help of pumpkin as under laboratory conditions	To control mealy bugs especially on fruits
NP Virus of <i>Helicoverpa armigera</i> & <i>Spodoptera litura</i>	Production starts with rising of pod borer and tobacco caterpillar larvae (host culture) on semi-synthetic diet. NP Virus is smeared on cultured larvae. Then the diseased larvae are collected to obtain virus suspension by blending, filtration and centrifuging	Used against bollworms in cotton and pod borers
<i>Trichoderma</i> Fungal spp	Multiplied in labs and formulated in a powder form with the help of carrier material (talc powder)	To control root rot and wilt diseases especially on pulses
Pheromone lures for <i>Helicoverpa armigera</i> & <i>Spodoptera litura</i>	Sex pheromones are filled into plastic traps at required concentration with the help of micro-pipettes and placed into rubber septa. The septa is fixed to the trap	To trap productive male of gram pod borer and tobacco caterpillar

Biopesticides in India

In India, the inception of biocontrol of plant pest and diseases was not very old (Schmutterer 1995). Azadirachtin and its derivatives from different parts of neem tree (*Azadirachta indica*) i.e. seed kernel, leaf extract or seed cake have been tremendously used as biofertilizers and also for protecting substances to minimize the risk of post-harvest loss due to store grain pests in cereals (Isman 1997; Brahmachari 2004, Copping

et al., 2000, Gupta et al., 2010). There are few evidences where some insects, viruses and birds also were used in pest eradication (Subramaniam 1952). During early 60's, the concept of integrated pest management (IPM) was evolved with the aim of judicious application of pesticides in field. Later, few more concepts were added in the way of IPM and different complementary approaches were undertaken. In India, the failure of chemical insecticides in controlling *Helicoverpa armigera*, *Spodoptera litura*, and other pests in cotton encouraged to boost up the biocontrol in the field of pest management (Kranthi et al.



2002, Hikal et al., 2017, Seiber et al., 2014). Since then it gave the momentum in using biopesticides as a safer eco-friendly approach to control the resistance induced by the synthetic insecticides towards insects. Later, it became a part of IPM which was earlier completely dependent upon the use of chemical pesticides.

Current status of biopesticides in India

i) Technological development

Biopesticide production technology core research development consisting of 4 different pillars: (i) biocontrol agent selection (ii) selection of formulation type (iii) manufacturing processes (iv) packaging and (v) application methodology. Off late research on technology development in biocontrol sector is at advance stages in India. The broad spectrum activity of certain biopesticides paves the way in deciding the fate in the pesticide market. However, the entire process of the development is still facing some technological challenges such as narrow host range, lesser shelf-life, etc.

ii) Production and consumption

Total 361 biocontrol laboratories and their units are functional in India as per information of the Directorate of Plant Protection, Quarantine and Storage (DPPQS), but very few of them are used in production purposes. However, the consumption of biopesticides is increasing in India in last few decades as for example, consumption of neem as biopesticides, the most popular biopesticides used in India has hiked from 83 metric tons (MT) during 1994–1995 to 686 MT during 1999–2000. *Bacillus thuringiensis* (Bt) consumption has increased from 40 to 71 MT during the same duration. DPPQS data suggested that the overall consumption of biopesticides has been raised by 40% from 2014–2015 to 2018–2019. In northern parts of our country, biocontrol programs are less undertaken compared to southern. Till date, there are 970 biopesticide products registered in the Central Insecticides Board and Registration Committee (CIBRC) which is the major governing authority related to all types of biopesticides products usage in India. The different industries are producing fungal, bacterial, viral and other biopesticides with a 66, 29, 4 and 1% share respectively .

Conclusion

Biopesticides have been playing a role of perfect replacement of synthetic pesticides since decades in

controlling pests and pathogens. However, its market placement among the agrochemicals are still somewhat behind in comparison to conventional synthetic chemicals. Technological and scientific interventions helped biopesticides a lot towards development and market security but still lack of understanding of its mode of action at field level in reality. Here lies the absence of penetration in the market of pest control by biopesticides. Overall, in the global map, the consumption of biopesticides is still increasing fairly, particularly in the American and European region. The challenges behind the popularity of biopesticides to the end users in India are related to the shelf-life, efficacy, production methods, poor performance in the field, narrow range of target pests, delivery system and regulations. Both public, private partnership is the need of the hour for better production, economy build up and in sensitizing end users, especially farmers at the grassroots level. To make our ecosystem more sustainable, government's policy and support are the main backbone in providing better R&D infrastructure and ease of regulations for better penetration of biopesticides in India.

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