The Pharma Innovation Journal 2021; 10(5): 962-966

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2021; 10(5): 962-966

www.thepharmajournal.com
Received: 24-03-2021
Accepted: 27-04-2021

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Aspects of Biopesticides: A review

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Abstract
In agriculture to reduce the pest attack there are many chemicals available in market. Farmers used chemicals for control of Pests in the field. they get well and instant results of chemicals on the pests hence they have the approach to use chemicals in the field but there is side effect of chemicals not onlyon soil quality but also on ecosystem.
The new generation is of biopesticides. There are different types of biopesticides and are used for proper ecofriendly control of pests by using botanical compounds and different microorganisms. microorganisms like bacteria, fungi, virus, nematode, protozoa, etc. are used for control of pests. Botanical compounds like Nicotinoid, Pyrethroids, Rotenoids, Ryania, Sabadilla, Margosa etc. are used in proper manner to control pests. all the aspects of biopesticides are given in the review.

Keywords: Biopesticides, agriculture, Farmers, botanical compounds

1. Introduction
Biopesticides, which include entomopathogenic viruses, bacteria, fungi, nematodes, and plant secondary metabolites, are becoming more common as alternatives to chemical pesticides and are becoming a major part of many pest control types. Bacteria like *Bacillus thuringiensis*, fungi like *Metarhizium anisopliae*, viruses like Baculovirus, nematodes like *Steinernema* (Rhabditida), protozoa like *Nosema* all above examples are of biopesticides used for control of pests.
They don't have any residue issues, which is a major concern for con- summers, particularly when it comes to edible fruits and vegetables. Biopesticides can be as effective as traditional pesticides when used as a component of insect pest control, particularly for crops such as fruits, vegetables, nuts, and flowers. Biopesticides work efficaciously with the tractability of minimal application constraints and superior resistance control capability (Kumar 2012) [11] by integrating synthetic pesticide efficiency and environmental protection.
Biopesticides have been gaining recognition and support from those concerned with creating environmentally sustainable and healthy integrated crop management (ICM)-compatible methods and strategies for pest management, according to Copping and Menn (2000) [4]. Insecticides derived from microorganisms provide developed countries with a rare opportunity to study and grow natural biopesticide tools for crop protection.

1. Botanical compounds
1.1 Nicotinoid/Nicotine
Tobacco is the primary source. Nicotine levels in Nicotiana tabacum and Nicotiana rustica leaves range from 0.5 to 5.5 percent and 3.5 to 8.0 percent, respectively. Passlet and Reimann conducted the first systematic study of the insecticidal properties of Nicotine alkaloid used in tobacco leaves in 1828. Nicotine's structure was discovered in 1893: 1-3 (1-methyl - 2-pyrrolidyl) pyridine.
Nicotine is a touch and nerve poison that kills insects, particularly those with soft bodies. Its primary influence is on aphids, which is why it was formerly known as aphidae before the introduction of modern insecticides. Since it has no phytotoxic or residuary effects, the sprayed crops can be harvested after just two days. However, it is particularly poisonous to humans and is sold as Nicotine Sulphate. It can be used as a fumigation in the glass house due to its high volatilization quality. In the presence of moisture, a dust mixture of nicotine sulphate releases nicotine.

1.2 Pyrethroids/Pyrethrins/Pyrethrum

Jute of Armenia discovered that the tribes of the Caucasus (the region between the Caspian Sea and the Black Sea) were using the flower dust of Chrysanthemum cineraria folium (Goldani's the beginning of the 19th century (1800-1899) Jute of Armenia discovered that the tribes of the Caucasus (the area between the Caspian Sea and the Black Sea) were using the flower dust of Chrysanthemum spp.

Pyrethrins are blended esters of Pyrethrolone and Cinerolone that contain 0.7 to 3 percent chrysanthemic and Pyrethrie acid.Since these esters cannot be isolated, they are referred to as Pyrethrins collectively. Pyrethrins are potent touch insecticides that paralysed the housefly quickly. The "knock down" result is the name for this activity. Since it is highly volatile, it has a high time value for field crops. Pyrethrum is mixed with DDT's solvent, e.g., Flint. DDT serves as a synergist, increasing the effectiveness of Pyrethrins. Allethrin, Cypermethrin, Dimethrin, and Barthrin are the equivalent synthesised pyrethrin compounds that are safe for humans.

1.3 Rotenoids/Rotenone:

Leguminous plant roots are the source of this. South American plants Lonchocarpus spp. and Derris eliptica (Malaysia) Rotenone infected insects exhibit a slow drop in oxygen intake, accompanied by paralysis and death. Touch fish poison is well-known. It was first used to combat leaf-eating caterpillars in 1848. Geoffrey was the first to isolate rotenone in 1895.

1.4 Ryania/Ryanodine

It's an alkaloid found in the roots and woody stems of a South American shrub. Ryania speciosa is a species of Ryania (family-Flacourtaceae). It's a stomach and touch poison that works against Lepidopterous bugs. It's also a muscular poison that prevents ADP from being converted to ATP in striated muscles. It is used as dust for caterpillars (20-40 percent).

1.5 Sabadilla

It's an alkaloid originating from the seeds of the South and Central American tropical lily Schoenocaulon officinale (Family: Liliaceae). The alkaloids cevadine and veratridine, in particular, are touch poisons used to monitor houseflies and other domestic insects. Pollinators, such as honeybees, are harmed.

1.6 Margosa (Neem)/Azadirachta indica

The active ingredients nimbidin-T, meliantriol, and azadirachtin are responsible for the exceptional gustatory repellant properties of neem tree (Azadirachta indica) kernels.The main active ingredient, azadirachtin, is found in the seeds and leaves and has a concentration of 2-4 mg/g Kernel.

Neem has a variety of insecticidal properties, including antifeedant activity, insect growth regulatory activity that prevents juvenile harmone synthesis, oviposition deterrent, repellant action, and a decrease in adult and intermediate life span. Neem cake is used to make insecticide vapacide. Neem seed kernel extract is used in industrial neem insecticides on the market (NSKE). Gronim, Neemazal, Achook, and Nimbecedine are some of the items available. UV light degrades neem-based materials, which means they degrade when exposed to sunlight.

Some other botanicals are yet to be used on large scale.

1.7 Citrus peel extracts Limonene and Linanool cause insect paralysis. They are used to combat aphids, mites, and fleas because they evaporate easily in the atmosphere.

1.8 Garlic oil has larvicidal properties and is toxic to mosquito Culex pipiens quinque fasciatus larvae due to the presence of diallyl disulfide and diallyl trisulfide.

1.9 Owing to the existence of isothiocyanates, root diffusates of the crucifers Brassica nigra and Sinapis alba hinder the appearance of the potato golden cyst nematode (Globodera rostochiens). Meloidogyne, Pratylenchus penetrans, and other species are suppressed by thiophenic compounds found in Tagetes sp. Asparagus racemosus root extracts prevent Meloidogyne javanica and Meloidogyne arenaria eggs from hatching. The nematode Longidorus elongatus is poisoned by tannin and polyphenols present in aqueous extracts of raspberry roots and canes (Rubus ideaus).

2. Bacteria

Bacterial biopesticides are often used as insecticides, but they can also be used to stop disease-causing bacteria and fungi from growing. Bacterial pesticides come into contact with the target pest and may be expected to be consumed to demonstrate their toxicity. They damage the digestive system by creating endotoxins that are also peculiar to the insect pest. For example, Moraxella osloensis, which is associated with Phasmarhabditis hermaphrodita, produces a heat and protease-tolerant endotoxin that biologically controls mollusk pests (slugparasitic nematode). This bacterium-feeding nematode serves as a vector, transporting M. osloensis into the slug's shell cavity, and the bacterium is the nematode bacterium complex's killing agent. M. osloensis produces endotoxins that destroy the slug when injected into the shell cavity.

3. Fungi

Insects, viruses, nematodes, fungi, and weeds can all be controlled with fungal biopesticides [13]. Biocontrol mechanisms vary and are dependent on both the pesticidal fungus and the target pest. Trichoderma secretes enzymes that aid in the biological regulation of plant diseases, such as chitinolytic enzymes, glucanases, cellulases, and proteases. These enzymes can destroy other fungi's cell walls, consume/dissolve susceptible cells, and multiply its own spores by expanding into the disease-causing pathogenic fungus' key tissue.

4. Virus

Baculoviruses

Bacteriophage is a virus that infects bacterial cell walls. Viral Biopesticides are host specific, infecting either one or a few closely related species. If these bacteriophages can attack bacteria that cause plant disease, they may be used as pesticides. Baculoviruses are insect-specific enveloped viruses with spherical, supercoiled double-stranded DNA genomes ranging from 80 to 180 kbp. Occlusion derived virus (ODV) and Budded virus are two phenotypes discovered (BV).

Baculoviruses are distinguished by OBs (Occluded Budded Viruses), which may contain a single virion or several virions. Nucleopolyhedroviral (NPVs) and Granulovirus (GVs) are the two main classes of baculoviridae based on morphology. Here

are a few examples of viral biocontrol agents. The codling moth is regulated by Cydia pomonella GV (CpGV) in apple, pears, and other fruit plants. Spodoptera frugiperda is a species of spider. For the management of the fall armyworm in maize crops, mononucleopolyhedrovirus (SFMNPV) and granulovirus (GV) were used. Spodoptera litura Nucleopolyhedrovirus (SlNPV) is a nucleopolyhedroviral that attacks Spodoptera litura.
Rice, pepper, corn, groundnut, and cotton are among the crops affected [14]. To reduce activity loss due to solar radiation, Colombian Spodoptera frugiperda NPV was microencapsulated with Eudragit S 100 polymer.

5. Nematodes
5.1 *Steinernema* (Rhabditida)
Nematodes are one of the newest biopesticides to hit the market. Cover crops, seed substitution, and the internalisation of organic matter into the soil will also help to control pest nematodes (McSorley 1999) [17] Various entomopathogenic nematodes from two genera, Steinernema and Heterorhabditis (Nematoda: Rhabditida), were discovered and developed as a biocontrol agent against insects in the early 1990s (Copping and Menn 2000) [4]. Insect-parasitic nematodes will infiltrate soil-dwelling insect stages and kill them within 48 hours by releasing pathogenic bacteria.
When the host dies, the nematode's infectious stages mature into adults, and a new generation of infective juveniles (IJs) emerges.
Entomopathogenic nematodes are widely used to protect plants from serious insect pests and diseases, and there have been several attempts to use IJs to biocontrol insect pest populations in the field by spraying. Despite this, little is understood about endogenous nematodes' capacity to influence insect pest species (Peters 1996) [20].
The parasitic loop in nematodes is started by the third stage. These non-feeding juveniles infest suitable insect hosts by entering through the anus, mouth, and spiracles of the insect (Grewal *et al*. 1997) [7] Nematodes infest the hemocoel after entering the host and then disperse their symbiotic bacteria into the intestine. The bacteria then induce septicemia, which kills the host within 24–48 hours. The bacteria manipulate the absorption of IJs quickly, causing the host tissues to decompose.
Within the host cadaver, nearly two to three generations of nematodes are completed (Pomar and Leutenegger 1968) [21].
Entomopathogenic nematodes have been shown to be effective biocontrol agents against some of the most common insect pest families present in storage products, such as Pyralidae and Curculionidae (Duncan and McCoy 1996) [5].
Morris (1985) has previously shown that insect pests present in preserved goods, such as Ephestia kuehniella Zeller and Tenebrio Molitor L., are susceptible to increased nematode concentrations. Georgis (1990) [6] recommended a field concentration of >2.5 billion nematodes/ha to combat some of the more common insect pests of row crops, although higher concentrations (7–15 billion/ha) are needed to achieve pest population control (Loya and Hower 2002) [14].

6 Protozoa
6.1 *Nosema*
Insect protozoan diseases are common in nature and play an important regulating role in insect species, according to previous research (Maddox 1987) [15]. Microsporidia, such as Nosema spp., are normally host-specific and slow-acting, causing recurrent infections in the majority of cases.Many entomopathogenic protozoa have complicated biological behaviors. They can only thrive in living hosts, and some species need a transitional host. The key benefits of Microsporidia organisms are their longevity and recycling in host populations, as well as their crippling impact on reproduction and general fitness of target insects.
Some species have been relatively active as inundatively used microbial control agents (Solter and Becnel 2000). Some protozoan species are pathogenic, such as Nosema locustae, which is the only species that has been recorded and commercially established for grasshoppers (Henry and Oma 1981). The first microsporidium, N. bombycis, is a pathogen of silkworm pébrine that was found in Europe, North America, and Asia in the mid-nineteenth century (Becnel and Andreadis 1999). Pébrine is also a problem in silk-producing countries, causing significant economic losses. for example (Cai *et al*. 2012).
Invertebrates, such as grasshoppers and heliothine moths, are attacked by about 1,000 protozoan species, mostly microsporidia. Nosema spp. and Vairimorpha necatrix are two well-known insect-pathogenic protozoan species.Protozoans create spores, which are the contagious process of a number of insect species. The spores of Nosema spp. are assimilated by the host and develop in the midgut. Germinating spores are released from the sporoplasm and attack target cells in the host, causing widespread inflammation and tissue destruction.When infected tissues are expelled and eaten by a vulnerable host, the sporulation process begins again, resulting in an epizootic infection. Naturally, parasitoids and insect predators are also used as disease vectors.

7. Biochemical Pesticides
7.1 Pheromones
Pheromones are chemicals produced by insects to elicit a certain behavioral response from other insects. These pheromones have a variety of effects and are named for the reaction they elicit, such as sex pheromones, aggregation pheromones, and alarm pheromones. A few pheromones serve as sex attractants, allowing individuals to identify and locate partners, while others cause congener trail following, oviposition, and aggregation. Pheromones have become indispensable instruments for tracking and managing agricultural pest species, and a massive array of over 1,600 pheromones and sex attractants has been recorded as a result.
There has been a significant amount of research published on insect pheromones in recent decades, and new opportunities have emerged to investigate the use of semi chemicals in the management of insect pest problems.
Pheromones have limitations when used alone to handle insects, but they may be used in conjunction with other methods in advanced pest management (Howse *et al*. 1998) [9]. Plant volatiles have been identified as an important component of the pheromone mechanism of many Coleopteran species that have been observed so far. How do insects' olfactory systems combine combinations of pheromones and plant volatiles so that they can distinguish between pheromone molecules alone and pheromone plus odor plume strands and react?Responding behaviorally to these cues is a matter of growing importance. (Baker and Heath 2004) [1].
Pest control has recently shifted away from calendar-based, broad-spectrum insecticide applications and toward more holistic, streamlined, and high-efficacy approaches.

Furthermore, emerging pest control policies in commercial agriculture are driven by environmental protection, food safety, and resistance management, to name a few main components (Witzgall *et al*. 2010) [25]. According to Kogan and Jepson (2007) [10], addressing the needs of a rapidly growing global population while still incorporating sustainability and environmental stewardship is a major challenge for modern agriculture. The use of pheromones and/or or allelochemicals as behavioral conditioning techniques in agricultural fields will substitute or supplement existing pest control systems. Resulting in a decreased rate of broad-spectrum use. Pheromones and other semi chemicals are also used on millions of hectares to detect and manage pests. Lower prices, specificity, ease of use, and high sensitivity are some of the benefits of using pheromones for pest monitoring (Laurent and Frérot 2007; Witzgall *et al*. 2010) [12, 25].

Monitoring insect pests with pheromone lures can lead to management decisions such as when to apply insecticides (Leskey *et al*. 2012) [13].

Insects emit pheromones that are extremely species specific. When expecting a mate, virgin female insects grow sex pheromones, and males along the concentration slope for the female producer. Insects such as wood-invading beetles emit aggregation pheromones to signal the availability of a good food supply to other insects (Copping and Menn 2000) [4]. Some alarm pheromones are produced by insects that are being pursued by a predator, and this leads to the insect pest's movement away from the source of origin, making it harmful. Plants and their derivatives are also known to communicate with insects and provide an important food supply. and,while combine with insect-derived attractantswill be developed a potent attraction to someinsect pests (Copping and Menn 2000) [4]. Mayer and McLaughlin (1991) [16] suggested that all insects generate an estimated type of pheromone and that businesses exist that synthesize a pheromone for every consumer in previous studies. The US EPA recently approved 30 mating-disruption pheromone-based products as biocontrol agents for lepidopteran pest species that can cause agricultural harm (Copping and Menn 2000) [4].

8. Advantages of Biopesticides

1. Biopesticides are normally inherently less harmful/toxic and produce less environmental load or pollutions.
2. As compared to chemicals that have a wide range of action, they are designed to target either one single pest or, in some cases, a few target pests.
3. Producing biopesticides is much less expensive than developing new chemical pesticides.
4. Their control is preventative rather than curative, and their effects on flowers are minimal.

9. Disadvantages of Biopesticides

1. The level of specificity is high, which could necessitate a precise identification of the target pest/pathogen.
2. Biopesticides are also unsuitable if an insect outbreak occurs quickly and poses a danger to crops due to their sluggish pace of action.
3. Biopesticides are not suitable for use as a stand-alone treatment; instead, they must be used in conjunction with a comparable approach to achieve high effectiveness.
4. Living species adapt and become more resistant to molecular, chemical, physical, and other forms of regulation as time goes by.

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