

# A Review on Biopesticides from Natural Products

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## Abstract

Biopesticides are natural, organic compounds which may be used to govern various agricultural pests. Exclusive sorts of biopesticides had been advanced from numerous sources as according to availability of the herbal merchandise. This paper suggests utilization of biocontrol dealers composed of microorganisms together with micro organism, cyanobacteria, and microalgae and plant-primarily based compounds. These techniques and recommendations are made for their software in modern agricultural practices for managing crop yield losses because of pest infestation. Biopesticides have several blessings over their chemical counterparts and are expected to occupy a huge share of the marketplace in the coming period.

**Keywords – Biopesticides, Biocontrol, Agriculture**

## Introduction

Biopesticides are certain forms of insecticides derived from such herbal substances as animals, flowers, micro organism, and sure minerals. Biopesticides are typically inherently less toxic than conventional insecticides. Biopesticides usually affect only the target pest and carefully associated organisms, in comparison to large spectrum, conventional pesticides which can affect organisms as extraordinary as birds, bugs and mammals. Biopesticides regularly are powerful in very small quantities and often decompose quick, resulting in lower exposures and largely heading off the pollutants problems as a result of traditional pesticides. When used as an element of integrated pest management (IPM) packages, biopesticides can greatly lessen the usage of traditional pesticides, even as crop yields remain high. The world population is growing swiftly, while agricultural areas and food manufacturing are restrained. Agricultural pests are the leading cause of crop loss in agriculture. Consequently, those dangerous dealers someway ought to be controlled. Many techniques have been advanced to control agricultural pests. The most preferred method is chemical manipulate in these management techniques. Therefore, one of the principal additives of plant production is insecticides. Utilization of extensive pesticide reasons fitness and environmental issues all around the international. For that reason, much less harmful control strategies were investigated against to conventional pesticides. The use of herbal compounds of flowers as in the beyond. At present, a number of those compounds had been commercialized collectively with development of modern chemical generation. The toxicity of those compounds is decrease and the half of-lifestyles duration is shorter than traditional chemical compounds. Pesticide active compounds derived from vegetation usually have an effect on best the target pest and carefully associated organisms, in comparison to broad spectrum. On this study, some plant species used as biopesticides have been compiled. Most recognised compounds used as biopesticide are pyrethrin, rotenone, nicotine and azadirachtin derived from species of *tanacetum*, *derris*, *nicotiana* and *azadirachta* respectively. Many other plants are used for this motive. Those compounds derived from plant life have deadly, anti-feeding, repellent, ovulation blocker, germination and increase inhibitory and comparable properties towards harmful insects, pathogens, nematodes, weeds and different pests. Interest in biopesticides is increasing day by day.

Commercial chemical corporations are making big investments in this subject. Using biopesticides is growing now not simplest in natural agriculture but additionally in traditional agriculture. The global populace is exploding exponentially and is expected to attain approximately 9.7 billion by 2050, the biggest proportion of which is in Africa and Asia. This has imposed a massive burden on agriculture and its allied sectors in terms of assembly food demands, which requires extra inputs for crop manufacturing. Anthropogenic sports have affected people's surroundings and feature additionally had terrible affects on the surroundings and ecosystems, inclusive of discounts in agricultural regions because of creation, the explosion of nutrient mining, degradation, and infection of water resources (resulting in scarcity), aggregation of xenobiotics in the soils, and degeneration and deterioration of the excellent, fertility, and performance of soil, with implications of soil erosion and weather change. So as to triumph over those demanding situations and meet the requirements for food and resources, the productivity and sustainability of agricultural practices need to be stepped forward and novel and improved techniques ought to be discovered. Greater agricultural productiveness may be done in lots of ways, which includes via increasing crop yield by means of imparting manure and natural-primarily based treatments, inclusive of biopesticides, or by proscribing yield loss because of excessive environmental situations (along with biotic and abiotic stresses). Abiotic strain can be in large part managed through the use of biostimulants and bioeffectors. Biopesticides, which might be pest control agents primarily based on living microorganisms or herbal products, offer a terrific promise in controlling yield loss without compromising the quality of the product.

The chemical insecticides utilized in crop protection, to reduce the damage resulting from pathogens and pests in agricultural fields, pose many long-time period threats and risks to dwelling beings due to their harmful facet consequences. They may be known to cause cancers and foetal impairments and they persist within the surroundings for many years (i.e., they may be non biodegradable). Furthermore, based totally on their capacity application and sturdy inhibitory activity against pests, these synthetic pesticides dominate the marketplace and have a large impact at the manufacture of merchandise. Based on a report by Business Communications Company (BCC), Inc., research on the global biopesticide and synthetic pesticide market showed that it was worth USD 61.2 billion in 2017 and is expected to rise to approximately USD 79.3 billion by 2022. Nutrient reduction and an improved ailment occurrence are pretty common in vegetation grown on soils closely subjected to chemical insecticides, and that is unwanted from the rural soil management for food and dietary protection viewpoint. According to the Food and Agriculture Organization (FAO), United Nations (2017–2018), the pinnacle 3 leading pesticide-consuming nations are China, the USA, and Brazil.. Further, pesticide consumption in India extensively increased from 50,410 tonnes (T) in 2016 to 58,160 tonnes (T) in 2018. The insecticides utilized for vegetation are as follows: fibre crops account for round 67%, fruits 50%, vegetables 46%, spices 43%, oilseeds 28%, and pulses 23%. In keeping with an annual file with the aid of the Ministry of Chemicals and Fertilizers, India (MoCF) (2019–2020), the production or manufacture of chemical pesticides increased from 186,000 metric tons (MT) in 2014–2015 to 217,000 MT in 2018–2019. The FAO also reported that from 2015 to 2018, the share of global pesticide consumption was 52.2% in Asia, 32.4% in the USA, 11.8% in Europe, 2% in Africa, and 1.6% in Oceania. The per hectare consumption of pesticides by country is highest for China, followed by the UK, with the least in India. Of the Indian states, Jammu and Kashmir had the best chemical pesticide consumption, accompanied by way of Andhra Pradesh. Biopesticides are evidently happening compounds or retailers which can be obtained from animals, plant life, and microorganisms including bacteria, cyanobacteria, and microalgae and are used to manipulate agricultural pests and pathogens. According to the environmental safety agency, biopesticides are 'derived from herbal materials such as animals, flora, bacteria and certain minerals'. Using biopesticides is, by using some distance, extra tremendous than the use of their counterparts, traditional chemical insecticides, as they

may be green and host specific. The use and application of agro-primarily based chemicals within the agricultural area to shield crop flora from invading and infecting pests may be greatly stepped forward with the aid of employing biopesticides.

#### Types of Biopesticides

There are numerous types of biopesticides, and they are labeled according to their extraction sources and the sort of molecule/compound used for their training. Such as

##### 1. Microbial insecticides

These are derived from microorganisms consisting of bacteria, fungi, and viruses. The active molecules/compounds isolated from those organisms' assault particular pest species or entomopathogenic nematodes. The ones referred to as bioinsecticides, goal insects that damage plants, whilst those who manipulate weeds thru microorganisms, together with fungi are called bioherbicides. Over the last decade, massive research activities on microbial biopesticides have caused the invention and improvement of an excellent number of biopesticides and have paved the way for their marketability. The a hit use of *Bacillus thuringiensis* (Bt) and a few different microbial species brought about the invention of many new microbial species and traces, and their valuable pollutants and virulence factors that could be a boon for the biopesticide industry, and a number of these have been translated into commercial products as well. Foremost corporations of bacterial entomopathogens include species of *Pseudomonas*, *Yersinia*, *Chromobacterium*, etc., while fungi comprise species of *Beauveria*, *Metarhizium*, *Verticillium*, *Lecanicillium*, *Hirsutella*, *Paecilomyces*, etc.. Other crucial microbial pesticide manufacturers are baculoviruses which are species precise and their infectivity is related to the crystalline occlusion bodies which are energetic against chewing insects (lepidopteran caterpillars). The baculoviral occlusion body is largely a virion that is blended with the bt toxin to supply recombinant baculovirus (color btrus), producing occlusion our bodies that incorporate the Bt insecticidal Cry1Ac toxin protein for boosting the velocity of movement and pathogenicity with respect to its wild-type counterpart. Entomopathogenic nematodes (EPNs) used as biocontrol dealers belong mostly to species inside the genera *Heterorhabditis* and *Steinernema*, related to mutualistic symbiotic micro organism of the genera *Photorhabdus* and *Xenorhabdus* and are safe to mammals, surroundings, and non target organisms. Their commercial development as biocontrol sellers has been handy due to their ease in mass manufacturing, using in vivo or in vitro techniques, and exemption from registration.

##### 2. Biochemical insecticides

Biochemical pesticides are naturally happening products that are used to manipulate pests via trustworthy mechanisms, whereas chemical pesticides use artificial molecules that directly kill pests. Biochemical pesticides are further categorised into differing types depending upon whether they characteristic in controlling infestations of insect pests by using exploiting pheromones (semiochemicals), plant extracts/oils, or natural insect growth regulators.

##### 3. Insect pheromones

These are chemicals produced through bugs that are mimicked for use in controlling insects in the included pest management applications. These chemical substances are effective in disrupting insect mating to save you the fulfillment of mating, thus decreasing the range of insect progeny. The bugs exploited in this method act as dispensers of pheromones that come to be careworn because of the presence of pheromone flumes subtle inside the surroundings. Insect pheromones are not authentic 'pesticides' considering that they do not kill insects but have an effect on their olfactory machine to affect behaviour. An in depth account of the mode of motion of pheromones is the antennae of the perceiving insect adsorb pheromones, which then diffuse into the interior of the sensilla through microscopic pores in the cuticle. Once inner, those are transferred through the hydrophilic sensillum to the chemosensory membranes by means of pheromone-binding proteins (PBPs). Finally, the pheromone or pheromone-pbp complex

interacts with a specific receptor protein, which transducers the chemical signal into an amplified electric powered signal via a 2d messenger machine related with neuronal machinery.

#### 4. Plant-primarily based extracts and crucial oils

Over the last several years, plant-based extracts and critical oils have emerged as appealing options to synthetic insecticides for insect pest management. Those pesticides are obviously occurring pesticides as they're derived from plants and include more than a few bioactive chemicals. Relying on physiological characteristics of insect species in addition to the type of plant, plant extracts and important oils (EOs) showcase a extensive variety of action towards bugs: they are able to act as repellents, attractants, or anti feedants; additionally they may additionally inhibit breathing, bog down the identification of host flowers through insects, inhibit oviposition and reduce adult emergence by way of ovicidal and larvicidal consequences. Their composition varies greatly. Well-known examples in this regard are neem and lemongrass oil, which can be very common in global herbal markets. A comprehensive have a look at by using halder et al. Confirmed that a combination of neem oil with entomopathogenic microorganisms, along with *Beauveria bassiana*, became very a hit against vegetable sucking pests. However, it's miles very vital to decide the dose of azadirachtin content material in neem oil in order now not to kill the nontarget organisms. A similar method must be set up for the entomopathogenic fungi that want to be supported with the aid of complementary laboratory bioassays, station, and/or subject experiments for powerful management of the goal pests with out affecting nontarget bugs. As regards the marketability of vital oils, they in fact, represent a marketplace anticipated USD 700.00 million and a total world production of 45,000 tons, and industries inside the us are capable of being critical oil-based totally pesticides to marketplace in a shortened time period, compared to the time taken in traditional pesticide launch.

#### 5. Insect boom regulators

Insect boom regulators (IGs) inhibit sure fundamental tactics required for the survival of insects, thereby killing them. Moreover, those compounds are notably selective and much less toxic to non goal organisms. Depending at the mode of movement, igrs were currently grouped in chitin synthesis inhibitors (CSIs) and substances that intervene with the motion of insect hormones (i. E., juvenile hormone analogues and ecdysteroids). IGRs can manage many varieties of bugs including fleas, cockroaches, and mosquitoes despite the fact that they are now not so deadly for person insects. Even though low in toxicity to humans, they prevent replica, egg-hatch, and molting from one level to the subsequent within the young insects, at the same time as blending them with different pesticides is capable of kill even the person insects.

#### Mode of action of Biopesticides

Biopesticides act in a diffusion of methods on microorganisms relying on their type and nature. Some mechanisms thru which biopesticides attack or kill pathogens are listed as follows.

##### 1. Microbial biopesticides –

Fungicides and bactericides: those biopesticides usually inhibit or disrupt the manner of translation and for this reason protein synthesis in severa approaches, inclusive of thru binding of 50s ribosomes in prokaryotes, to save you the transfer of peptides and inhibit chain elongation (such as blasticidin). On occasion they intrude with the binding of aminoacyl trna to 30s and 70s ribosomal subunit complexes and inhibit translation (such as kasugamycin). Within the case of streptomycin and mildiomycin, binding with the 30s ribosomal subunit causes extraordinary synthesis of protein (nonfunctional) and blocks the pastime of peptidyltransferase, respectively. They can also disrupt plasma membrane permeability and motive leakage of substances (amino acids and electrolytes), thereby inflicting cell death (consisting of natamycin), and can inhibit chitin synthase interest (polyoxins) and inhibit trehalase, preventing the formation of glucose (validamycin). Insecticides upon attaining nerve endings, release gamma-aminobutyric acid (GABA), which causes GABA-gated Cl-ion channels to open, consequently running by hyperpolarising the nerve membrane ability and blockading the electric nerve conduction (avermectins and

emamectin). Polynactins can reason leakage of potassium ions from mitochondria. Herbicides inhibit phosphorylation in plants through blocking off glutamine synthase, which causes an increase in ammonia (bilanafos).

## 2. Biochemical pesticides –

These insecticides are derived from flora. Flora have advanced and advanced many compounds, which can help to fight pathogenic microorganisms at some stage in the course of infection and attack. Those compounds consist of steroids, alkaloids, phenylpropanoids, phenolics, terpenoids, and nitrogenated compounds. For instance, nicotine turned into the primary insecticide obtained from tobacco leaves in the 17th-century that used to kill plum beetles. Nicotine in tobacco is poisonous to most herbivore insects and insecticides derived from them were appeared as ‘green pesticides’ with excessive hobby and coffee toxicity. Duan et al. Have noted tobacco to be containing some useful elements, consisting of solanesol and nicotine, which exhibit potent inhibitory interest in opposition to staphylococcus aureus, bacillus subtilis, and micrococcus lysodeikticus. Insecticides, consisting of azadirachtin and nicotine, characteristic by using both disrupting respiration enzymes or inhibiting insect boom regulators, or with the aid of binding to sodium channels, whilst microbicides impair metabolic feature and disrupt the integrity of plasma membrane and inhibit conidial formation.

## 3. Biopesticides from algal and cyanobacterial sources –

Microalgae can be used as an opportunity era to growth productiveness in sustainable agricultural structures. A number of microalgae lines produce biologically lively compounds that consist of antimicrobial compounds with the capacity to behave as biopesticides. The biomass (extracts) can be implemented as an opportunity to chemical insecticides, when you consider that it could enhance plant boom and shield agricultural crops. The filamentous cyanobacterium nostoc piscinale and two unmarried-celled inexperienced algae, *Chlamydomodium fusiforme* and *Chlorella vulgaris* are suggested to have biopesticide interest in opposition to positive pathogens. Some vital microalgae have been exploited for his or her beneficial biopesticide activity inside the cultivation of spices. The usage of chemical insecticides can bring about numerous unwanted effects, consisting of (i) killing of beneficial and nontargeted organisms and now and again resurgence; (ii) rapid multiplication of secondary pests; (iii) development of pesticide resistance; (iv) contamination of the surroundings/surroundings; (v) accumulation of pesticide residues in food materials; (vi) inflicting imbalanced ecological processes, which include pollination (pollinators suffering from insecticides) and harm to residing beings; (vii) carcinogenic and teratogenic outcomes in nature; and (viii) inflicting imbalances in hormone structures. Several microorganisms have been explored for their ability in growing biopesticides. Microalgae have proved to be an remarkable source because of their benefits over traditional chemical pesticides. They produce a plethora of compounds with stimulating activities, along with biomass and compounds, which can be used inside the preparation of biopesticides, thereby improving crop safety. Microalgae can be produced the use of wastewater, as they require nitrogen, phosphorus, and carbon and ammonium, which are considerable in wastewater, hence representing a nitrogen source. *Chlorella vulgaris* is usually used within the remedy of wastewater and is able to tolerate ammonium degrees efficaciously. Ranglova et al. Assayed the efficacy of *Chlorella vulgaris* against several phytopathogens, together with *Rhizoctonia solani*, *Fusarium oxysporum*, *Phytophthora capsica*, *Pythium ultimum*, *Clavibacter michiganensis*, *Xanthomonas campestris*, *Pseudomonas syringae*, and *Pectobacterium carotovorum*, at the same time as staring at its antibacterial and antifungal pastime, which had been higher while cultivated in wastewater. Gonçalves argued that rice fields closely sprayed with synthetic fertilisers to promote higher productiveness and yield left many damaging effects at the environment and beneficial soil microflora, inclusive of reduced performance of fertiliser utilisation by means of the merchandising of rice illnesses, inhibition of

microbiological nitrogen fixation, and improved nonpoint supply pollution; importantly, they had been additionally no longer fee powerful.

#### 4. Nanobiopesticides –

The concept of ‘nano’ in biopesticides has revolutionised the sphere because of the scale, shape, and nature of materials, which are fashioned in a length variety of 1–one hundred nm. Those small biologically lively particles can prevent the growth of pathogens through either destroying or repelling them. Nanoencapsulation, nanocontainers, and nanocages, due to their belongings of degradability, increase the steadiness and efficacy of pest manage, and decrease quantities are used while delivering nanobiopesticide. The damages due to the phytopathogens also can be overcome by way of the application of nanobiopesticides, commonly the steel nanoparticles (nps) of zinc, gold, silver, nickel, and titanium owing to their inherent antimicrobial homes. Those have a few delivered blessings over other biopesticides because of their expanded solubilisation abilities and target-oriented shipping of the compound with more desirable efficiency. Bacterial, fungal, and plant extracts are used for the synthesis of nps. It's been shown that silver nanobiopesticides (AgNPS) may be synthesised the usage of marine organisms such as *Sargassum muticum*, *Mesocyclops longisetus*, and *Caulerpa scalpelliformis*. The benefit of the usage of microorganisms inside the arrangements of nps is that microorganisms can resist high concentrations of metals over flora and additionally their price of production and management is much easier, as compared to the flora. Needless to pressure right here that microorganisms being very tiny, have higher penetration ability than vegetation. Bioherbicides have additionally been used within the formulations of nanobioherbicides. The efficacy of metabolites of *Photobacterium luminescence*, an endosymbiotic bacterium of the *Heterorhabditis indica*, entomopathogenic and parasitic nematodes, are managed. In addition, nanofungicides have additionally been organized to govern numerous pathogenic fungi which encompass *Bipolaris sorokiniana*, *Fusarium* sp., *Alternaria alternata*, and many others through AgNPs and *Magnaporthe grisea* and *B. sorokiniana* using metallic nanoparticles. Apart from their potential of being quite simply soluble, the nano fungicides are very cost-effective, eco-friendly, and secure.

#### 5. Biopesticides from aquatic plants –

Duckweed (*Lemna minor*), muskgrass (*Chara* spp.), water hyacinth (*Eichhornia crassipes*), hydrilla (*Hydrilla verticillate*), water lettuce (*Pistia stratiotes*), and filamentous algae (*Lyngbya wollei*) are a few common aquatic vegetation. It's miles located that a few vegetation produce allelopathic compounds that have the capability to save you the boom, germination, survival, and replica of surrounding organisms. Neem (*Azadirachta indica*) extract kills many insects, while *Eichhornia crassipes* has the capability to inhibit the growth of *Spodoptera litura*, a lepidopteran pest. In addition, *Chenopodium album* is inhibited through the presence of duckweed and water lettuce. Those examples illustrate that similar plant life (or weeds) and their allelopathic chemicals have noticeably effective inhibitory residences in opposition to the pathogens and consequently may be substituted for traditional chemical insecticides.

#### Merits of biopesticides over chemical insecticides –

Biopesticides have several merits over traditional chemical insecticides. They are environmentally pleasant, target precise, and not deleterious to nontarget organisms and therefore effective sufficient to replace artificial pesticides for pest control presents an outline of the hazards of using traditional chemical pesticides rather than biopesticides. In latest years, the usage of biopesticides is gaining momentum due to the fact they can be efficaciously used in sustainable agricultural practices. Biopesticides are pretty effective in small quantities and decompose quickly without leaving complicated residues and therefore can reduce the use of traditional pesticides as an vital aspect of ipm packages.

#### Conclusions

The software of biofertilisers consisting of micro organism, cyanobacteria, or fungi can improve and repair the fertility of the soil and make certain sustainable agricultural production the usage of

inexperienced generation. The use of microorganisms and microalgae as biopesticides can reduce the call for electricity and consumption of artificial fertilisers and restore the efficiency of agroecosystems and wastelands. Those organisms, when blended with the use of biotechnical innovations consisting of rna era, can play a huge role in the production of secondary metabolites, biofertilisers, bioenergy, and bioprocessed products that might be additionally beneficial in pest manage. Widespread studies on organic manipulate sellers, which include biopesticides, is required for the improvement of the biopesticide marketplace inside the future. Scientists from various studies institutes around the arena are engaged in sizeable research efforts within the area, however very few whole and systematic reports are available. Right here, the utmost collaboration amongst firms and studies institutes is needed, without which a state of affairs whereby biopesticides completely update chemical insecticides seems not possible. Inside the present day state of affairs, the rural quarter needs to rely on each biopesticides and chemical pesticides. However, rushing up the realistic application of laboratory effects ought to facilitate large-scale business improvement. The inflow of biopesticides, however, has drastically reduced the use of artificial chemical substances because of stringent guidelines. Many materials had been researched to illustrate their application as biopesticides, however great area research is required with a purpose to examine their efficacy for specific pest issues beneath diverse cropping structures. Farmers and society at huge have to benefit from the mixed and judicious use of both traditional chemical pesticides and biopesticides, at the same time as it is imperative to emphasise the research in the region of biopesticides for reaping extra blessings from it in the destiny.

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