Plant Archives Vol. 16 No. 2, 2016 pp. 902-906 ***ISSN 0972-5210***

BIOPESTICIDES - AN ALTERNATIVE AND ECO-FRIENDLY SOURCE FOR THE CONTROL OF PESTS IN AGRICULTURAL CROPS

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Abstract

Chemical pesticides have strongly affected both the abiotic and biotic components of the environment. Due to the side effects of chemical pesticides, sustainable crop production through eco-friendly management is essentially required in the current scenario. Biopesticides are alternatives source of chemical pesticides and offer potent tools to create a new generation of sustainable agriculture products. Biopesticides are employed in agricultural and use for the purposes of insect control, disease control, weed control, nematode control and plant physiology and its productivity. biopesticides are pesticides derived from microorganisms, natural sources and genetic modified plants. With the rapid development of new techniques such as molecular biology, genetic engineering, protein engineering and other techniques are gradually improving the biopesticides productions that destroy crop pests. The development of biopesticides stimulates modernization of agriculture. Globally, the use of biopesticides has steadily increased by about 10% per year. This review paper describes different types of biopesticides and the potential use of biopesticides for the control of pest at global level.

Key words : Biopesticides, microorganisms, bacteria, fungi, viruses and pests.

Introduction

Agriculture is one of the most important livelihoods in India. Now a day's two-thirds world population basically depends upon agriculture but production of agricultural crops are continuously getting vulnerable due to attack of pests. A variety of pest such as insects, bacteria, fungi, nematodes, virus etc destroyed agriculture crops through diseases. Chemical pesticides are used to reduce pest populations that harm the agricultural crops. Chemical pesticides are used widely in agriculture to protect the plants from destruction caused by insects and weeds etc but may harmful to native microorganisms and excessive use of chemical pesticides has cause various types of environmental problems (Arora *et al.,* 2012). Chemical pesticides are widely used worldwide but they are ecologically unacceptable. Use of chemical pesticides has resulted in the disturbance of our environment. (Gulhane *et al*., 2015). Biopesticides replaced chemical pesticides Biopesticides are effective, ecofriendly, biodegradable and do not leave any harmful residue on environment so it is used widely. In current years, production of chemical pesticides decreased by 2% per year whereas production of biopesticides increased at the annual rate of 20% (Cheng *et al*., 2010).

Concept of Biopesticides

The importance of Biopesticide is to protect agricultural crops from insects, fungal, bacterial and viral diseases etc. Bio-pesticides are used to control insects, bacteria and fungi etc. Bio-pesticide does not show any harmful effect on our ecosystem. Biopesticides is ecofriendly pest control pesticides (Hubbard *et al*., 2014). Biopesticides contain microbial pesticides derived from micro-organisms, biochemicals derived from natural sources and genetic modified plants or transgenic plants to express genes responsible for insecticidal toxins. Biopesticides and their by-products are widely used for the control of varieties of pests (Mazid *et al*., 2011). Biopesticides are certain types of pesticides obtained from such as microorganisms, natural sources and genetic modified plants and certain minerals (US Environmental Protection Agency Pesticides, 2008). Widely used

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biopesticides are living organisms which are mostly pathogenic for the target species only. Various types of bacterial, fungal and virus are widely used as biopesticides. Many bacterial species such as *Bacillus thuringiensis*, *Bacillus popilliae* and *Pseudomonas fluorescens* etc, fungus species such as *Beauveria bassiana*, *Verticillium lecanii* and *Paecilomyces fumosoroseus* etc and viruses such as *Lymantria dispar* and *Neodiprion sertifer* etc have capacity to protect the crops from various diseases that caused by pests.

Advantages of Biopesticides

1. Biopesticides are mainly designed to affect on target species only and non toxic to beneficial insects.
2. Biopesticides are ecofriendly biodegradable. They decompose rapidly into small residues and do not show any negatively impact on groundwater and surface water.
3. Biopesticides are effective in minute quantities which eliminates various environment pollutions.
4. Biopesticides have low-residue, high-performance and less poisonous side effects.
5. Difficult for insects to develop resistance.
6. Biopesticides are usually inherently less toxic as compared to chemical pesticides.

Categories of biopesticides and their characteristics feature.

Biopesticides contain microorganisms, naturally occurring substances and pesticidal substances produced by genetic modified plants that control pests. Biopesticides are categorized into three most important classes are given below (Kumar, 2012) :

1. Microbial pesticides
2. Biochemical pesticides
3. Plant-incorporated protectants

1. Microbial pesticides

Microbial pesticides consist of microorganisms such as bacterium, fungus, virus or protozoan. These microorganisms used as the active ingredient. Microbial pesticides have showed toxicity as compared chemical pesticides (MacGregor, 2006). Microbial biopesticides are living organisms, which are mainly pathogenic and widely used for the control of pests. Microbial pesticides are derived from naturally occurring or genetically altered bacteria, fungi, viruses and algae. They suppress pests through numerous modes of action such as producing poisonous substances specific to the target pest, regulating establishment of new microorganisms by competition and also causing diseases (Clemson, 2007). Example of microbial pesticides such as biofungicides eg *Trichoderma*, bioherbicides eg *Phytophthora* and bioinsecticides eg *B. thuringiensis* (Bt) (Gupta and Dikshit, 2010). Microbial pesticides are categorized in three classes such as bacterial biopesticides, biofungicides and viral pesrticides given below:

a) Bacterial biopesticides

Bacterial biopesticides are the most common form of microbial pesticides. Bacterial based Biopesticides have been used to control several plant diseases. Both spore forming and non spore forming bacteria are used for the control of insects and diseases. They are normally used as insecticides. Bacteria interrupt the digestive system of insect by producing endotoxins (insecticidal proteins), which are specific to the specific insect. The mostly used bacterium is *Bacillus thurigiensis* commonly referred to as Bt. *B. thuringiensis* has show their effect against different insect pests in forestry, agriculture etc fields (Mazid and Kalita, 2011). Around 40,000 species of *Bacillus thuringiensis* are control *Lepidoptera* or *Diptera* pest. At the time of spore formation Bt produces Bt ä-endotoxin protein that binds to cellular lining of the insect digestive tract and finally stop feeding and die. All over the world presently, several Bt strains are registered as biopesticides (Glare and O'Callaghan, 2000). Some strains of *B. subtilis* and *Pseudomonas aureofaciens* are used to control damping off and soft rots disease causing pathogens (Kloepper *et al*., 2004; Haas and Defago, 2005; Berg, 2009). *Agrobacterium radiobacter* are also used to control pests such as *Agrobacterium tumefaciens* (causal agent of crown gall disease). More than one hundred *Bt* based bioinsecticides have been formed and used against dipteran, lepidopteran and coleopteran larvae.

b) Biofungicides

The fungi causes many types of diseases on several important crops, resulting in severe plant yield losses (Khandelwal *et al*., 2012). Fungal biopesticides effective against numerous insects as well as plant diseases. Several biofungicidal products excite plant defence systems that can make plants more resistant to a variety stresses such as biotic and abiotic stresses (Srinivasa *et al*., 2008). *Trichoderma* spp. and *Beauveria bassiana* both are used as fungal bio-pesticides mainly applied in the nursery, field crop, ornamental and vegetable. *Trichoderma* used as a fungicide against soil born diseases for example root rot. So, it is widely used on some crops such as black gram, green gram, groundnut and chickpea because they susceptible to root rot (Islam *et al*., 2010). *Trichoderma* is a fungicide efficient against several foliar and soil-borne plant pathogens such as *Rhizoctonia*, *Sclerotium*, *Fusarium*, *Pythium*, *Ceratobasidium*, *Macrophomina* and *Phytophthora* spp. (Dominguesa *et al*., 2000; Anand and Reddy, 2009). *Beauveria bassiana* has used against various plant pests such as aphids, thrips, whitefly and Q-Biotype Whitefly (chemical pesticide-resistant strains of whitefly). Entomopathogenic fungi are used as mycoinsecticide agents against various insect pests (Dutta *et al*., 2015). Seven strains of entomopathogenic fungi against *Ceratitis capitata* adults (Castillo *et al*., 2000).

c) Viral pesrticides

A bacteriophage is a virus that infects bacterial cell walls. It is used as a pesticide. They are helpful for the control the lepidopterous pests of vegetables, cotton and rice. When ingested by the host insect, infectious virus particles are liberated internally and become active. Once in the larval gut, the virus's protein overcoat quickly disintegrates, and the viral DNA proceeds to infect digestive cells. Within a few days, the host larvae are unable to digest food and so weaken and die (Thakore, 2006). In 1975, Elcar™ (first viral insecticide) was proposed, by Sandoz Inc. (Ignoffo and Couch, 1981). Elcar™ was prepared by *Heliothis zea* NPV. HzSNPV work not only against cotton bollworm, but also the pests of tomato, maize, beans, soybean and sorghum. In India, HaNPV based biopesticide is used (Srinivasa *et al*., 2008).

2. Biochemical pesticides

Biochemical pesticides protect the environment from pesticidal pollution which is a global problem (Dutta, 2015). Biochemical pesticides are naturally occurring substances used for the control of pests. It is ecofriendly, biodegradable and specific for target organisms. Many plants have developed natural as well as biochemical mechanisms to protect themselves from various insect, bacterial and fungal attacks. Secondary metabolites such as flavanoids, phenols, alkaloids, terpenes, suberins and carotenoids etc. are also involve in plant immune system and defend them against both invertebrate pests and microbial pathogens (Golob *et al*., 1999; Wink and Schimmer, 1999). The plant extracts as well as mineral oil have several benefits they selective to natural enemies and other non-target species. Various plant growth extracts provide help for abiotic stress such as drought, salinity and heat. A plant extract from the giant knotweed *Reynoutria sachalinensis* has control powdery mildew disease caused by *Oidium neolycopersici* in tomato (Trottin *et al*., 2003) powdery mildew disease caused by *Leveillula taurica* in onion (Konstantinidou *et al*., 2006). The oils derived from several plants are toxic to diverse insect pests such as *Artemisia judaica* showed antifeedant action against *Spodoptera littoralis* (African cotton leafworm), *chinensis* Zingiber officinale control *D. melanogaster* and *Nigella sativa* control *Callosobruchus* (Abdelgaleil *et al*., 2008; Chaubey, 2008; Xu *et al*., 2007).

3. Plant-Incorporated-Protectants (PIPs)

Plant-Incorporated-Protectants (PIPs) are pesticidal substances that plants construct from genetic material that has been added to the plant. In agricultural biotechnology insect resistance and disease resistance transgenic plants have used for research and development. *B. thuringiensis* and Cry proteins are alternatives source of chemical pesticides for the control of insect pests (Roy *et al*., 2007; Kumar, 2012).

In 1996 first commercialized production of transgenic plants (*Bt* plants) that express insecticidal δ-endotoxins derived *Bacillus thuringiensis*. The expression of these toxins protein control insect crop damage (Shelton *et al*., 2000). In different crops plants the insecticidal crystal proteins coding genes have been transferred. Cry proteins form transmembrane pores, which lead to osmotic cell lysis (Roh *et al*., 2007). Some plants have recently produced that code Cry proteins.

In North America Maize hybrids developed that express the Cry3Bb1 protein, which used for the control of *Diabrotica* spp. (Coleoptera), Cotton developed that express the Cry1Ac protein used for the control of *Helicoverpa zea* Boddie (Lepidoptera), potato developed that express the Cry3A or Cry3C protein used for the control of *Leptinotarsa decemlineata* Say) (Coleoptera). Zhang *et al*. (2011) transformed hpRNA expression vectors containing targeting coat protein gene of maize dwarf mosaic virus to the susceptible maize inbred line, which overcame the low efficiency of agronomic protection from maize dwarf mosaic disease.

Conclusion and Future Prospects

Developing countries such as India are vastly dependent upon agriculture. Many disadvantages associated with chemical pesticides such as reduction of valuable species, damage to the ecosystem and many serious health related diseases is overcome with the use of biopesticides. The use of bio-pesticides has emerged as alternative tool to chemical pesticides. Biopesticide is considerably safer for humans as well as our ecosystems because they are valuable and rapidly biodegradable and shows no residue problems and safe for non target organisms as well as human. The demand for bio-pesticides is increasing progressively in all over the world. The use of Biopesticide will be work an enormous improvement in coming years. In coming years, their role will be more significant in agriculture and forestry. Biopesticides evidently have a potential role to play in development of future integrated pest management strategies.

Acknowledgments

We gratefully acknowledge the financial support provided by U.P. Council of Agricultural Research, Lucknow (U.P.), India.

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