



Biopesticide
Industry Alliance

Advancing
Knowledge
About
Biopesticides



Biopesticides Offer Multiple Benefits for Agricultural Dealers and Consultants

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Introduction

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The need to feed an ever-growing global population combined with increasing demand for sustainable agricultural practices has fueled a significant rise in demand for biopesticides. Biopesticides offer unique benefits all along the food value chain, providing additional options for growers, buyers, dealers, consultants and retailers. While biopesticides have been around for more than 50 years, the market has experienced its most significant period of growth — in terms of both sales and user acceptance — over the past five years.

In the early years of biopesticide development, some products promised results but did not deliver. However, the commercially viable biopesticides found success in the market and still more biopesticide technologies have been developed that give growers more targeted and effective pest management options.

Regulatory changes, consumer demand for low residues, and the need for even more productive farming practices are inescapable market forces — biopesticides offer solutions in all of these areas. The result is increasing acceptance of biopesticides as an effective partner in crop protection programs.

Biopesticides Offer Significant Benefits to Dealers and Consultants

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What is a Biopesticide?

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As defined by the United States Environmental Protection Agency (EPA), biopesticides are certain types of pesticides derived from such natural materials as animals, plants, bacteria, and certain minerals.¹³ Plant growth regulators (PGRs), which exhibit no pesticidal activity but instead can promote, inhibit or modify the physiology of plants, are also regulated by the EPA as biopesticides. In commercial



Benefits of Biopesticides for Dealers and Consultants

- Product Differentiation
- Service Differentiation
- Improved Environmental Safety
- Access to Organic and Other Value-Added Markets
- Improved Profit and Yield
- IPM Programs in Partnership with Traditional Chemicals
- Resistance Management
- Labor and Harvest Flexibility
- Residue Management

terms, biopesticides include microorganisms that control pests (microbial pesticides), naturally occurring substances that control pests (biochemical pesticides), pesticidal substances produced by plants containing added genetic material (plant-incorporated protectants) and biochemical plant growth regulators. Biopesticides are employed in agricultural use for the purposes of insect control, disease control, weed control, nematode control, and plant physiology and productivity.

Benefits of Biopesticides for Dealers and Consultants

Biopesticides offer a variety of significant business benefits for dealers and consultants. Dealers and consultants are heavily relied on to assist growers as they adopt this emerging technology.

Product Differentiation

Biopesticides benefit progressive dealers who seek to offer a broad portfolio of crop protection products and serve customers with evolving product preferences. The

addition of quality biopesticides to a dealer's inventory differentiates it from outlets that deal solely in traditional chemical pesticides.

Service Differentiation

Because biopesticides work differently than traditional chemical products, dealers and consultants may provide information services to growers to support product use. These services range from product recommendation to application training to crop assessment.

Environmental Safety with Biopesticides

The general public's concern for environmental safety is one of the leading drivers of biopesticide usage. As growers focus on this aspect of production and market these practices to their customers, dealers may recommend biopesticides as an environmentally sound and efficacious product.

Non-toxic to non-target organisms, including beneficial insects and wildlife, many biopesticides also are biodegradable. They decompose quickly and do not negatively impact surface water and groundwater.

Biopesticides typically are effective in small quantities, which eliminates pollution concerns sometimes associated with traditional chemicals. In addition, biopesticides are manufactured from naturally occurring raw materials in an environmentally responsible and sustainable manner.

Access to Organic Market

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Organic farming represents a unique, fast-growing segment of the food industry. While only 5% of all current biopesticide use is for organic applications,⁵ many biopesticides are registered for and are effective in certified organic production systems. Dealers who supply biopesticides have access to the organic market and to emerging “no residue” or “pesticide-free” markets.

Biopesticides Add Value and Yield

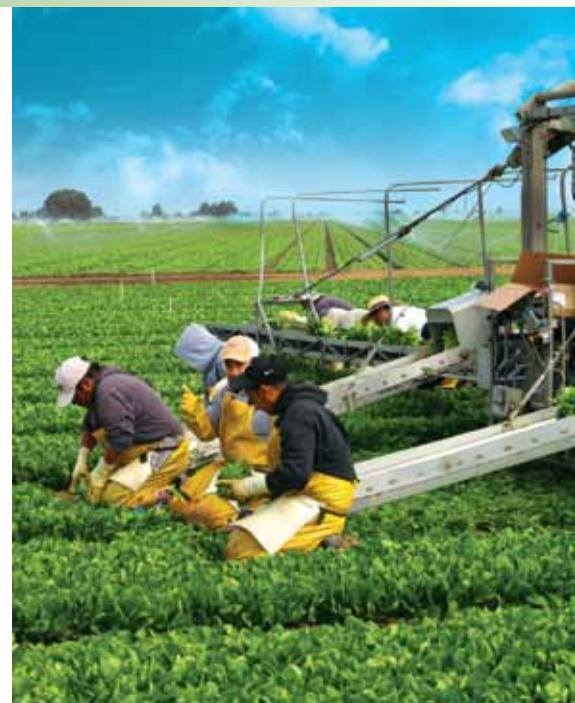
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Crop quality and yield largely determine a grower’s income. Biopesticides provide dealers with products that can markedly improve crop quality and yield by preventing pest damage and promoting physiological benefits in plants, including increased fruit size and enhanced color. Dealers who supply biopesticides and encourage their innovative use are on the forefront of yield-and-profit enhancement practices.

Biopesticides Partner with Traditional Chemicals in IPM Programs

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Sustainable agriculture relies on



integrated pest management (IPM) techniques — which combine proven cultural, biological, and chemical methods to control pests — as an environmentally sound approach to crop production. Dealers supply products that support these methods and many biopesticides are specifically designed for use in conjunction with stable traditional chemistries in an IPM program.

How Biopesticides Help with Resistance Management

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Long-term continuous use of a single class of pesticides may result in resistance to that class by the targeted pest. Biopesticides with novel modes of action provide dealers with products that manage pest resistance and extend the life of valuable traditional pesticides. Biopesticides — optimized for mixtures, tank mixtures and combinations — have been used in combination with traditional chemistries to effectively manage resistance, while maintaining high pest control standards.



Biopesticides Allow Labor and Harvest Flexibility

Biopesticides provide dealers with a solution to grower requests for products with labor and harvest flexibility. In terms of application, biopesticides generally have short worker restricted entry intervals. Workers can safely return to a field shortly after treatment, allowing them to assess crop conditions and follow up with applications of other crop inputs when needed. In addition, biopesticides generally have short pre-harvest intervals. This allows growers to better manage their labor, harvest and shipping schedules.

In terms of plant growth, Plant Growth Regulators (PGRs) may be used to control and optimize harvest times. PGRs that inhibit the biosynthesis of ethylene in plants, for example, can slow down fruit maturation, ripening, and abscission.

Biopesticides Make Residue Management Easier

Consumers are increasingly aware of chemical use in food production and the potential for chemical residue on food. Dealers may promote biopesticides, which leave little to no residue on food, to growers as residue management products. Many biopesticides are exempt from residue limits on fresh and processed foods. In addition, biopesticides may be applied in environmentally sensitive areas without residue concerns and may be used to manage residue levels for exported produce.

Types of Biopesticides

The EPA recognizes three major classes of biopesticides: microbial pesticides, biochemical pesticides, and plant-incorporated protectants.

Microbial Biopesticides

Microbial pesticides are products derived from various microorganisms (e.g., bacterium, fungus, virus or protozoan) that are used as an active ingredient to control pests. Microbial products may consist of the organisms themselves and/or the metabolites they produce. The microorganism may occur naturally, be dead or alive, or be genetically engineered. Microbial biopesticides are generally divided into six subcategories:



Bacteria ~ Many spore forming and non-spore forming bacteria are known to

be effective against a wide spectrum of insects and diseases. For example, more than 90 species of naturally occurring, insect-specific bacteria have been isolated from insects, plants, and the soil. To date, *Bacillus thuringiensis*, or Bt, is the species that has been most successfully developed as a microbial insecticide.

Viruses ~ Baculoviruses are a family of naturally occurring viruses known to infect only insects and some related arthropods. Most are so specific in their action that they infect and kill only one or a few species of Lepidoptera larvae.

Fungi ~ With complex lifecycles, some fungi are parasitic to various eukaryotes, including plants and insects. Fungi require specific environmental conditions to proliferate and their means of affecting the target pest are diverse.

Protozoa ~ Protozoa are single-celled eukaryotic organisms that exist in both water and soil. While most protozoa feed on bacteria and decaying organic matter, a wide range of protozoan species are insect parasites.

Yeast ~ A variety of non-pathogenic, naturally occurring yeasts have been investigated for their usefulness in controlling plant diseases.

Nematodes ~ Nematodes act as insecticides by invading insect larvae through bodily openings and releasing toxic bacteria that kills the host.

Biochemical Biopesticides

Biochemical biopesticides are naturally occurring compounds or synthetically derived compounds that are structurally similar (and



functionally identical) to their naturally occurring counterparts. In general, biochemical biopesticides are characterized by a non-toxic mode of action that may affect the growth and development of a pest, its ability to reproduce, or pest ecology. They also may have an impact on the growth and development of treated plants including their post-harvest physiology. Biochemical biopesticides are generally divided into six subcategories:

Plant Growth Regulators (PGRs) ~ Including both natural and manufactured versions of natural substances that affect major physiological functions of plants, PGRs can promote, inhibit, or modify the physiological traits of a range of fruit, vegetable, ornamental and agronomic crops. PGRs are used to maximize productivity and quality, improve consistency in production, and overcome genetic and abiotic limitations to plant productivity. There are five major classes of these natural plant hormones: gibberellins, cytokinins, abscisic acid, ethylene, and auxins.

Insect Growth Regulators (IGRs) ~ With a unique mode of action, these products prevent insects from reaching a reproductive stage, thereby reducing the expansion of pest populations. The direct impact of IGRs on target pests combined with the preservation of beneficial insects and pollinators aids growers in maximizing yield and product quality.

Organic Acids ~ Acids such as peracids are effective sanitizing agents used for control

of pathogens and algae. Peracid products can be used for sanitation of greenhouse surfaces, shock applications for tanks and piping, continuous application at a low concentration, and also as a bactericidal or fungicidal application to plant foliage or roots.

Plant Extracts ~ Many plants have developed natural, biochemical mechanisms to defend themselves from weed, insect and fungal attacks. These products act as insect growth regulators, feeding deterrents, repellents, and confusants. Some plant growth extracts provide relief for abiotic stress such as heat, drought, salinity and even frost.

Pheromones ~ Chemical signals that trigger a natural response in another member of the same species, pheromones are used to disrupt pest ecology and reduce crop damage. Synthetic female pheromonea are used as lures to attract males into traps and are also used for mating disruption.

Minerals ~ Minerals play a key role in a wide range of biopesticide applications that can be divided into three categories: those that create barriers that keep pests from plant tissues and/or impact water supply; those that deliver physical impacts such as smothering or abrasion; and those that act as an inert carrier for companion biopesticides.

Plant-Incorporated Protectants

Plant-incorporated-protectants, also known as genetically modified crops, are pesticidal substances that plants produce from genetic material that has been added to the plant, such as corn and cotton.

Challenges and Opportunities for Dealers

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Biopesticide products present several significant opportunities for dealers, including:

- Stocking biopesticides increases overall inventory and meets the needs of a wider audience of growers, including growers from larger operations, who tend to be the most avid users of biopesticide products, and organic growers.
- Dealers who stock biopesticide products today are considered progressive and will be more likely to attract progressive growers. This builds long-term customer base and strengthens reputation.
- The use of biopesticides requires training and related information services. Dealers have the opportunity to sell agronomic services, from technical support to application to assessment, along with products.
- Biopesticides designed for use in conjunction with certain traditional chemical pesticides may be used to spur sales of those chemistries.
- As new biopesticide products are released, dealers may establish and/or strengthen working relations with both large and small-medium manufacturers.

However, there are several significant challenges for dealers, including:

- Biopesticides are relatively new to the market and work in different ways than traditional chemical pesticides. Some growers may be reluctant to alter a program that relies on well-known and affordable traditional chemicals.

- The effectiveness of biopesticides is measured differently than traditional chemicals. Growers are familiar with standard field trial results and may not understand biopesticide success measures.
- There are some common misconceptions about biopesticides, including that they are more expensive to use and less effective than traditional chemicals, that they are only for organic production and that they are difficult to use.

Challenges and Opportunities for Consultants

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Biopesticide products present several significant opportunities for consultants, including:

- Biopesticides operate differently than traditional products. Growers need assistance when adopting these new technologies. Consultants may advise growers on such things as proper application timing and frequency; the most effective application methods to ensure thorough crop coverage; target pest identification; and pest/disease pressure and life cycle dynamics.



- Biopesticides provide different benefits depending on the product used and the crop. Consultants may help growers plan for the proper use of biopesticides within an IPM program, monitor pests in-season and evaluate the effectiveness of the product through field performance trials and marketable yield and quality data.

Biopesticides present several significant challenges for consultants, including:

- Biopesticides are relatively new to the market and the need for education of growers is significant. Some growers may be reluctant to be advised on new systems.
- The effectiveness of biopesticides is measured differently than traditional chemicals. Growers may not understand or accept the new measures provided by consultants.



Market and Technology Overview

Significant Growth Expected in the Global Pesticide Market

While estimates on the size of the biopesticide market can vary widely, some market studies indicate that during the past five years, the global biopesticide market has grown by nearly 10% per year, from more than \$670 million in 2005 to \$1 billion in 2010.⁸ (For the purposes of this document, plant-incorporated protectants (PIPs) are treated as a separate class of biopesticides.) Given the increasing consumer demand for chemical-free crops and the increasing number of registered biopesticide products, industry models indicate that the annual biopesticide market could exceed \$2.5 billion by 2015.⁷

This recent growth has occurred despite a stagnating overall market for pesticides. Since the early 2000s, in markets where biopesticides are sold, growth rates for biopesticides are generally higher than for traditional chemicals, sometimes by a factor of two.⁵ Industry models indicate that sales of traditional chemical pesticides will either increase at a negligible rate along with inflation and commodity prices — or decline slightly — through 2015.

Presently, biopesticides represent 2-6% of the approximately \$40 billion global pesticide market. That share is expected to increase significantly through 2015 and beyond.

In terms of geography, North America and Western Europe are the leading consumers of biopesticides worldwide, having purchased approximately \$600 million of biopesticide products in 2008.³ According to market reports, that figure could exceed \$1 billion by 2015. Asia-Pacific represents another fast-growing biopesticide market, with sales in that region projected to top \$350 million by 2012.

In terms of crops, an estimated 55% of all current biopesticide sales are for use on orchard crops.³ Overall, biopesticides are most widely used on specialty crops, although these technologies are being used to an increasing extent on corn, soybeans, forage crops, and applications in the areas of public health and forestry.

Biopesticide Regulation and Legislation

In the United States, biopesticides are regulated by the same laws and regulations as traditional chemical pesticides. All biopesticide product registrants must submit data to the Biopesticides and Pollution Prevention Division (BPPD) of the Office of Pesticide Programs (OPP) regarding the composition, toxicity, degradation, and other characteristics of the product.²³ This information is reviewed to ensure that a product will not adversely affect human health or the environment.

The EPA regulates three major classes of biopesticides: biochemical pesticides, microbial pesticides, and plant-incorporated protectants.

Given that biopesticides tend to pose fewer risks than chemical pesticides, the EPA generally requires less data to register a biopesticide than to register a chemical pesticide. As a result, new biopesticides are often registered in less than a year, compared with an average of more than three years for chemical pesticides.¹

Although the registration process for biopesticides may be less costly than for chemical pesticides, field testing of biopesticides on high-value specialty crops can be disproportionately expensive for small biopesticide manufacturers who may realize only a modest return on investment for a product with limited usage. The United States Department of Agriculture's (USDA) Interregional Research Project Number 4 (IR-4) was established to assist these minor acreage, specialty crop producers in obtaining EPA tolerances and new registered uses for biopesticide products.

In the European Union (EU), recent legislation has synchronized with political will to both reduce traditional chemical usage in agriculture and increase the use of biopesticides.⁶ The Sustainable Use Directive, signed in 2009, calls for EU governments to introduce national action plans by 2012 for the significant reduction of chemical usage in agriculture.

France, Denmark, and Sweden already have aggressively reduced overall agricultural chemical use by more than 30%. Through its Ecophyto 2018 plan, which includes a robust grower-education component, France intends to reduce its agricultural chemical usage by 50% by 2018 without affecting yield or rev-

"...the agriculture industry must be more productive than ever before, while decreasing its negative impact. Biopesticide products meet the demands of sustainability."

enues.¹² Overall, the number of conventional pesticides approved for agricultural use in the EU has been reduced from an all-time high of about 1,000 to a current list of 300.

As of 2008, the EU had 77 active substances registered as biopesticides, compared with 279 registered in the United States. Biopesticides are regulated in the EU in the same manner as chemical pesticides. The Organisation for Economic Co-operation and Development (OECD), a 34-country group headquartered in Paris, France, assists EU governments in quickly and thoroughly assessing biopesticide risks to humans and the environment.

Population Growth, Increasing Environmental Awareness Fuel Demand for Biopesticides

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Several key factors have spurred the significant recent increase in demand for biopesticide products.

From a macro perspective, the agriculture industry is undergoing rapid change. As world population continues to increase — from 6 billion in 2000 to 6.8 billion in 2010 to a projected 9 billion by 2050¹¹ — and nutritional habits change, more food must be produced. Some estimate that current food production levels must be doubled by 2050 to satisfy demand. At the same time, arable land, water, and other natural resources are limited. Therefore, the agriculture industry must be more productive than ever before, while decreasing its

negative environmental impact. Biopesticide products meet the demands of sustainability.

From the perspective of the general public — the end-consumer of food products — chemical pesticides have been associated, fairly or unfairly, with the potential for pollution and health hazards. This perception is strongest in areas where urban and suburban hous-

"Once solely the domain of smaller manufacturing companies, the biopesticide market is now being considered by leading agrochemical companies."

ing abuts agricultural land. Many consider produce grown with less chemical inputs as healthier, safer, and friendlier for the environment. Although a significant number of these end-consumers may not be intimately familiar with biopesticides, they do perceive biopesticides to be a generally agreeable alternative to chemicals in a sustainable, integrated approach to agriculture.

The European model relies on engagement from the entire food production chain to spur new product acceptance.⁶ Under that system, all sectors, including produce buyers, retailers, and food processors, support a product to drive it forward. Currently, in Europe, all sectors perceive positive benefits from biopesticides, and those perceptions — along with legislative mandates for 2012 — are contributing to rapid acceptance and use of biopesticide products by growers.

In the United States, demand is being driven, in part, through the financial influence of large retailers such as Wal-Mart and McDonald's Corporation, who, in response to shareholder demand, are authorizing their growers to

reduce use of chemical pesticides and to increase use of alternative crop protection such as biopesticides.

New Technologies Create New Markets

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One of the most important factors in the recent growth of the biopesticide market is innovation in biopesticide technology itself. During the decades of the 1990s and 2000s, significant progress was made in microbial and biochemical research. Manufacturers made advances in the mass production of biopesticides, increased the storage and shelf life of their products, and improved application methods. These successes caused an overall increase in investment in biopesticide research and development.

Once solely the domain of smaller manufacturing companies, the biopesticide market is now an investment area for leading agrochemical companies. Given the increasing demand for biopesticides, these companies are including biopesticides in their portfolios either by acquiring products from or forming licensing agreements with smaller companies or by investing in their own new research and development.

In the EU, the systematic review of chemical pesticides that thinned the approved products list from about 1,000 to 300, effectively instigated research into alternative products with new modes of action. The potential for further new product discoveries will have a significant impact on the industry going forward. To date, only a small percentage of species have been considered for biopesticide usage.¹¹ Many potential biopesticides remain undiscovered.

Summary and Sources

Biopesticides are an important tool for managing the increasing concern over pesticide residues on food and the always-present problem of pest resistance. Significant lowering of MRLs by regulators in many countries is a trend that is expected to continue. Biopesticides offer dealers and consultants additional options for services and products as they assist growers dealing with these issues. Additionally, biopesticides are a valuable option because of their sustainability, crop quality and harvest flexibility benefits.

For More Information

Visit the Biopesticide Industry Alliance at <http://www.biopesticideindustryalliance.org/>

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