Biological control

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Definition

Biological control is a component of an integrated pest management strategy. It is defined as the reduction of pest populations by natural enemies and typically involves an active human role. Keep in mind that all insect species are also suppressed by naturally occurring organisms and environmental factors, with no human input. This is frequently referred to as natural control. This guide emphasizes the biological control of insects but biological control of weeds and plant diseases is also included. Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids, and pathogens. Biological control of weeds includes insects and pathogens. Biological control agents of plant diseases are most often referred to as antagonists (Shelton, 2016).

Predators, such as lady beetles and lacewings, are mainly free-living species that consume a large number of prey during their lifetime. Parasitoids are species whose immature stage develops on or within a single insect host, ultimately killing the host. Many species of wasps and some flies are parasitoids. Pathogens are disease-causing organisms including bacteria, fungi, and viruses. They kill or debilitate their host and are relatively specific to certain insect groups. Each of these natural enemy groups is discussed in much greater detail in following sections (Shelton, 2016).

Conservation

The conservation of natural enemies is probably the most important and readily available biological control practice available to growers. Natural enemies occur in all production systems, from the backyard garden to the commercial field. They are adapted to the local environment and to the target pest, and their conservation is generally simple and cost-effective. With relatively little effort the activity of these natural enemies can be observed. Lacewings, lady beetles, hover fly larvae, and parasitized aphid mummies are almost always present in aphid colonies. Fungus-infected adult flies are often common following periods of high humidity. These natural controls are important and need to be conserved and considered when making pest management decisions. In many instances the importance of natural enemies has not been adequately studied or does not become apparent until insecticide use is stopped or reduced. Often the best we can do is to recognize that these factors are present and minimize negative impacts on them. If an insecticide is needed, every effort should be made to use a selective material in a selective manner (Shelton, 2019).

With the advent of synthetic insecticides in the 1950s, easy control of insect pests appeared at hand. However, it soon became obvious that there were problems associated with the use of insecticides. Some insect pests became resistant, and some nontarget organisms were adversely affected, and pest resurgence occurred. Additionally, environmental and health concerns arose (Shelton, 2019).

Today, the protection of food and fiber crops from insect, mite, disease, and weed pests in conventional agricultural systems still relies primarily on the use of chemical pesticides. However, continued reliance solely on conventional pesticides has drawbacks. The integrated pest management strategy described in this guide promotes nonchemical pest control tactics such as use of pest-resistant plants, cultural control methods, and biological control. Pesticides should be used only to prevent an economic loss and rarely should be used in a prophylactic manner (Shelton, 2019).

The need to develop alternatives to conventional pesticides may be more acute in some commodities than in others. For example, vegetables and fruits are considered minor crops in many areas, and new insecticides are less likely to be registered or existing ones re-registered. Populations of many major vegetable and fruit insect pests possess resistance to insecticides. Also, vegetable and fruit growers, especially fresh market producers with small and diverse operations and roadside stands, are highly visible to the public. The application of pesticides is frequently obvious and may result in conflicts with urban neighbors. Alternatives that would reduce the need for pesticide use could help alleviate some of these conflicts (Shelton, 2019).

All insect pests have natural enemies. The use of these organisms to manage pests is known as biological control. Conservation of natural enemies is probably the most important biological control practice readily available. Through the use of selective insecticides and the judicious use of broader spectrum materials, natural enemies can exist and exert their impact on pest populations. The future of biological control is promising, but this tactic will constitute just one of many pest management options. Many obstacles will need to be overcome before biological control can reach its full potential (Shelton, 2019).

Before biological control will advance, much more emphasis needs to be placed on investigating indigenous natural enemies and their impact on the pests they attack. With this information it may be possible to foster or enhance the efficacy of natural enemies through manipulation of the crop habitat, changes in cultural practices, or changes in pesticide application practices. In addition, the introduction of new natural enemies through classical biological control programs holds much promise. The development of successful biological control programs will be challenging, but holds great potential (Shelton, 2019).

Agricultural Entomology in Brazil started with a strong influence of pesticides, and since then the "culture of applying agrochemicals" has been widely accepted and adopted by Brazilian growers. In 1921, 32 years after the first successful case of BC, the first natural enemy was imported into Brazil from the USA. This attempt to use *Encarsia erlesei* Howard (Hymenoptera Aphelinidae), previously called *Prospaltella berlesei* to control white peach scale, *Pseudaulacaspis pentagona* (Targioni) (Hemiptera: Diaspididae) ,was, unfortunately, not completely successful. Other cases using imported natural enemies are mentioned in the section "History of Biological Control in Brazil." Despite the progress made in the use of BC (Biological Control)., the "Culture of Chemical Control" prevailed and reached a peak with the synthesis of DDT (Dichlorodiphenyltrichloroethane) in 1939, which won Paul Müller the Nobel Prize and prompted the massive use of chemicals until the early 1960s. In 1962, Rachel Carson published "Silent Spring," alerting the general public to problems associated with the abusive use of pesticides. As a result, people became more aware of problems related to the indiscriminate use of chemicals, including ecological imbalances; the development of insect and mite resistance to agrochemicals (to date, more than 500 resistant pests have been identified); outbreak of secondary pests; resurgence of pests; harmful effects on human beings, natural enemies of pests, fish and other non-target animals, in addition to persistent chemical residues in food, water and soil (Carson, 1962 *apud* Parra, 2014).

The so-called "dark age of pest control" from 1940 to 1960 (Kogan, 1998) motivated the scientific community to propose a novel philosophy of Pest Control based on not only economic, but also ecological and social considerations. IPM (Integrated Pest Management) has arisen as a response of the scientific community to solve problems originating from the abusive use of chemicals. The IPM approach is defined as a combination of control tactics with the aim of keeping pest population densities below the economic threshold, taking into account economic, ecological and social criteria

(Parra, 2014).

Brazil, a leader in the development of tropical agriculture, will have to create a BC model adapted to the local conditions, extensive farmlands, and dynamic features of its agricultural system. This dynamism leads to continual changes in beneficial and pest populations because of the different farming systems used, such as no-tillage, continuity of crops, crop succession and rotation, irrigation, new varieties, large-scale use of transgenic plants, emergence of new pests, etc. Additionally, Brazil is progressively becoming an exporting country and, therefore, must adapt to international market requirements for chemical residues, which create difficulties in achieving a sustainable agriculture, an urgent issue in modern times (Parra, 2014).

BC must be implemented as one contributive component of IPM, since it is difficult to control pest populations using BC alone. Irrespective of whether natural enemies are released in an inoculative way (Classical Biological Control) or inundative (Applied or Augmentative Biological Control), BC must conform to the basic principles of IPM. In the case of crops that have numerous pests, when agrochemicals are necessary, selective products, as well as rotation of active ingredients, should be employed in order to prevent pests from developing resistance (Parra, 2014).

The current extensive use of chemicals in citrus, soybean and cotton crops in Brazil results in unbalanced systems, where BC cannot be established. In order to enhance BC in Brazil, production systems must be planned in the context of the enormous climatic and edaphic diversity of our country, so as to take advantage of our biodiversity in BC programs in tropical regions. It is important not to restrict programs to mimic the technology used in countries with different characteristics and conditions because such methods have proved, on the whole, to be inefficient in Brazil (Parra, 2014).

Three forms of applied biocontrol are generally recognized based on how the natural enemies are manipulated. In classical biocontrol, exotic natural enemy species are imported and released in the region where the pest occurs. If the introduced natural enemy survives and adapts to its new habitat, it may increase in numbers, disperse throughout the pest region over the course of several years, and suppress the pest population. Often, no natural enemy releases beyond those used to initially establish and spread the natural enemy are needed. Classical biocontrol is often practiced against exotic pest species because these pests usually invade their new habitats without the natural enemies that suppress their populations in their native range. However, classical biocontrol is also practiced against native pests when it is thought that an exotic natural enemy species may be able to suppress the pest better than native natural enemies (Parra, 2014).

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