International Journal of Biotechnology and Bioengineering Research.
ISSN 2231-1238, Volume 4, Number 3 (2013), pp. 175-180

http://www.ripublication.com/ ijbbr.htm

Biological Control and its Important in Agriculture

Anchal Sharma*, V.D. Diwevidi[1], Smita Singh[2], Khsitiz Kumar Pawar[3], Mahesh Jerman[4], L.B. Singh[5], Satish Singh[6] and Deepak Srivastawa[7]

[*]Research Associate, MPWSRP, Department of Horticulture, COA,Rewa, JNKVV, Jabalpur, INDIA.
[1,2]Department of Agronomy, COA, Rewa, JNKVV, Jabalpur, INDIA.
[3]Department of Plant Breeding and Genetics, COA,Rewa, JNKVV, Jabalpur, INDIA.
[5,6]Department of Horticulture,COA ,Rewa, JNKVV, Jabalpur, INDIA.
[4]Department of Plant Breeding and Genetics, COA, Rewa, JNKVV, Jabalpur, INDIA.
[7]PG, Student,Department of Agronomy, COA, JNKVV,Jabalpur, INDIA.

Abstract

Biological control is defined broadly as the "use of natural or modified organisms, genes, or gene products” to reduce the effects of pests and diseases. Physical control is the use of tillage, open-field burning, heat-treatment (pasteurization), and other physical methods, usually to eliminate pests or separate them from the crop. Chemical control is the use of synthetic chemical pesticides to eliminate pests or reduce their effects. The many approaches to biological control can be categorized conventionally into (1) regulation of the pest population (the classical approach), (2) exclusionary systems of protection (a living barrier of microorganisms on the plant or animal that deters infection or pest attack) and (3) systems of self-defense (resistance and immunization). The agents of biological control include the pest- or disease-agent itself (sterile males or a virulent strain of pathogens), antagonists or natural enemies, or the plant or animal managed or manipulated (immunized) to defend itself. Principles of plant health care are offered, know the production limits of the agro-ecosystem, rotate the crops, maintain soil organic master, use clean planting material, plant well-adapted, pest-resistant cultivars, minimize environmental and nutritional stresses, maximize the effects of beneficial organisms and protect with pesticides as necessary. Mode of action of bio-control agents-Competition, Antibiosis, Mycoparasitism / Hyperparasitism, Lytic enzymes, Hydrogen cyanide, Induced Systemic Resistance (ISR) and Plant growth promotion.

Keywords: plant diseases, fungi, bacteria, plant breeding, non-pathogens, bio-control agents.

1. Introduction

In considering the contributions of biological pest control to a sustainable agriculture, it may be useful first to examine briefly some of the advantages and disadvantages of each of the major methods by which pests can be controlled. The major methods of pest control can be grouped into three categories of (1) physical control, (2) chemical control and (3) biological control. These broad categories, in turn, can be combined into integrated pest management (IPM), integrated crop and pest management (ICPM), or, as will be used in this article. Biological control is the control of one organism by another (Beirner, 1967). This control may be expressed as either a longer population of the pest (DeBach, 1964) or as a restriction or prevention of the severity or incidence of pest damage without regard to the pest population (Cook and Baker, 1983). Biological control depends on knowledge of biological interactions at the ecosystem, organism, cellular, and molecular levers and often is more complicated to manage compared with physical and chemical methods. Biological control is also likely to be less spectacular than most physical or chemical controls but is usually also more stable and longer lasting (Baker and Cook, 1974). In spite of biological controls having been used in agriculture for centuries, as an industry biological control is still in its infancy. Biological control is now being considered for an increasing number of crops and managed ecosystems as the primary method of pest control. One reason for its growing popularity is its record of safety during the past 100 years considered as the era of modem biological control (Waage and Greathead, 1988). No microorganism or beneficial insect deliberately introduced or manipulated for biological control purposes has, itself, become a pest so far as can be determined, and there is no evidence so far of measurable or even negligible negative effects of biocontrol agents on the environment (in Cook, Chairman; 1987). The new tools of recombinant DNA technology, mathematical modeling, and computer technology combined with a continuation of the more classical approaches such as importation and release of natural enemies and improved germplasm, breeding, and field testing should quickly move bio-control research and technology into a new era.

2. Biological Control

Biological control was discovered by trial and error and then practiced in agriculture long before the term itself came into use (Baker and Cook, 1974). One example is the ancient practice of not growing the same crop species in the same field more frequently than every second or third year or even longer. Such crop rotation allows time for the pest or pathogen population in soil to decrease below some economic threshold because of the predatory, competitive, and other antagonistic effects imposed by the associated microflora and fauna. In other words, crop rotation allows time for the natural soil microbiota to sanitize the soil, especially with regard to the more specialized plant parasites and insect pests that are highly dependent on their host crop to maintain their populations.

The era of modern biological control, involving the deliberate transfer and introduction of natural enemies of insect pests, was launched 100 years ego with the highly successful introduction of the vadalia beetle from Australia to California in 1888 to control the cottony cushion scale of citrus. In 1914, the German plant pathologist C. F. von Tubuef wrote a somewhat speculative article entitled "Biologische Bekampfung von Pilzkrankheiten der Pflanzen." This is apparently the first reference in the scientific literature to the term "Biologische Bekampfung" or "biological control" (Baker, 1987).

DeBach (1964) defined biological control as "the action of parasites, predators, or pathogens in maintaining another organism's population density at a longer average than would occur in their absence." This definition covers some highly successful biological controls of insect pests with natural enemies, but it does not accommodate some other highly successful controls accepted in other disciplines as examples of biological control. For example, citrus tristeza virus is controlled in Brazil by inoculating the citrus trees with a mild virus, which then protects the trees against the more severe strains (Costa and Muller, 1980). "Cross protection" was first shown by H. H. McKinney in 1929 to have potential for biological control of plant viruses. Plant pathologists refer to cross protection for control of plant viruses as biological control.

3. Need for Biological Control in India

The production of food grain should increase to 250 million tones by the year 2020 in order to meet the needs of the growing population. Beyond good agronomic and horticultural practices, growers often rely heavily on chemical fertilizers and pesticides. However, the environmental pollution caused by excessive use and misuse of agrochemicals, as well as fear mongering by some opponents of pesticides, has led to considerable changes in people’s attitudes towards the use of pesticides in agriculture. A concomitant increase in the proportion of pests and diseases resulted in the increased use of toxic chemical for their management. The number of species resistant to pesticides and fungicides is increased. In recent years after signing of the general agreement of trade and tariff of world trade organization more emphasis is given to the use of ecofriendly pesticide for crop production in view of their least toxic nature, low levels of disease resistance and low residue problems. However, Biological controls should be integrated with other control measures because different methods are effective at different times and locations under varying conditions.

4. Merits of Biocontrol Agents

(1) Biological control is less costly and cheaper than any other methods.
(2) Biocontrol agents give protection to the crop throughout the crop period.
(3) They do not cause toxicity to the plants.
(4) Application of biocontrol agents is safer to the environment and to the person who applies them.
(5) They multiply easily in the soil and leave no residual problem.
(6) Biocontrol agents not only control the disease but also enhance the root and plant growth by way of encouraging the beneficial soil micro flora. It increases the crop yield also.
(7) Biocontrol agents are very easy to handle and apply to the target.
(8) Biocontrol agent can be combined with bio-fertilizers.
(9) They are easy to manufacture.
(10) It is harmless to human beings and animals (Environmentally safe.)

5. Mode of Action of Biocontrol Agents

Competition: Microorganism competes for space, minerals and organic nutrients to proliferate and survive in their natural habitats. This has been reported in both rhizosphere as well as phyllosphere. Competition has been suggested to a play a role in the biocontrol of species of *Fusarium* and *Pythium* by some strains of fluorescent pseudomonas. Competition for substrates is the most important factor for heterotrophic soil fungi. Success in saprophytic ability (CSA) and inoculums potential of that species. Those fungi with highest number of propagules or the greatest mass of mycelia growth have the greatest competitive advantage. Competitive saprophytic ability is the summation of physiological characteristics that make for success in competitive colonization of dead organic substrates.

Antibiosis: Antibiosis is defined as antagonism mediated by specific or non – specific metabolites of microbial origin, by lytic agents, enzymes, volatile compounds or other toxic substances. Antibiosis plays an important role in biological control. Antibiosis is a situation where the metabolites are secreted by underground parts of plants, soil microorganism, plant residues etc. It occurs when the pathogen is inhibited or killed by metabolic products of the antagonists. The products include the lyric agents, enzymes, volatile compounds and other toxic substances.

Mycoparasitism / Hyperparasitism: Mycoparasitism or hyperparasitism occurs when the antagonist invades the pathogens by secreting enzymes such as chitinases, celluloses, glucanases and other lytic enzymes. Mycoparasitism is the phenomenon of one fungus being parasitic on another fungus. The parasiting fungus is called hyperparasite and the parasitized fungus as hypoparasite. In mycoparasitism, two mechanisms operate among involved species of fungi. This may be hyphal of inter-fungus interaction i.e., fungus-fungus interaction, several events take place which lead to predation viz., coiling, penetration, branching and sporulation, resting body production, barrier formation and lyses.

Lytic enzymes: Lysis is the complete or partial destruction of a cell by enzymes. Lysis may be distinguished into two types, endolysis and exolysis. Endolysis (autolysis) is the breakdown of the cytoplasm of a cell by the cell's own enzymes following death, which may be caused by nutrient starvation or by antibiosis or other toxins. Endolysis does not usually involve the destruction of the cell wall. Exolysis (heterolysis) is the destruction of cell by the enzymes another organism. Typically exolysis is the destruction of the walls of an organism by chitinases, cellulases etc. and this frequently results in the death of the attacked cell.

Hydrogen cyanide: Many rhizobacteria produce hydrogen cyanide and this has been shown to play direct as well as indirect role in biological control of plant diseases and increasing the yields. The florescent pseudomonas themselves produce HCN and are able to suppress the pathogens.

Induced Systemic Resistance (ISR): ISR is the ability of an agent (a fungus, bacteria, virus, chemical etc.) to induce plant defense mechanisms that lead to systemic resistance to a number of pathogens. Inoculation of plants with weak pathogens or non- pathogens leads to induced systemic plant resistance against subsequent challenge by pathogens. The mechanisms remain largely unknown but typically the induced resistance operates against a wide range of pathogens and can persist for 3-6 weeks. The biocontrol agents bring about induced systemic resistance (ISR) through fortifying the physical and mechanical strength of cell wall as well as changing physiological and biochemical reaction of host leading to the synthesis of defense chemicals against challenge inoculation of pathogens. Defense reaction occurs due to accumulation of PR proteins (chitinase, B-1, 3 glucanse), chalcone synthase, phenylalanine ammonia lyase, peroxidase, phenolics, callose, lignin and phytoalexins.

Plant growth promotion: Biocontrol agents also produce growth hormones like, Auxins, Cytokinin, Gibberellins etc. These hormones suppress the deleterious pathogens and promote the growth of plants and simultaneously increase the yield. The studies on mechanism of growth promotion indicated that PGPR promotes plant growth directly by production of plant growth regulators or indirectly by stimulating nutrient uptake, by producing siderophores or antibiotics to protect plant from soil borne pathogens or deleterious rhizosphere organisms. Pseudomonas spp. May increase plant growth by producing gibberellins- like substances, mineralizing phosphates.

6. Conclusion

For growth of agricultural production has led several new challenges, making further growth possible only if these challenges are met appropriately and timely. Increase in crop production from the modern farming techniques reaching a plateau is the most of the countries including India and the environmental problems due to excessive use of chemical fertilizers and pesticides becoming a matter of concern. So, the biological control can be alternate system, which may play an important role in achieving the goal of agriculture.

References

[1] Baker, K. F. 1987. Evolving concepts of biological control of plant pathogens. Ann. Rev. Phytopathol. 25:67-85.

[2] Baker, K. F., and R. J. Cook. 1974. Biological Control of Plant Pathogens, W. H. Freeman and Co, San Francisco, California. 433 pp. (Book, reprinted in 1982, Amer. Phytopathol. Soc., St. Paul, Minnesota).

[3] Beirner, B. P. 1967. Biological control and its potential. World Rev. Pest Control 6(1):7-20.

[4] Cook, R. J., and K. F. Baker. 1983. The Nature and Practice of Biological Control of Plant Pathogens. Amer. Phytopathol. Soc., St. Paul, Minnesota. 539 pp.

[5] Cook, R. J., and D. M. Weller. 1987. Management of take-all in consecutive crops of wheat or barley. In I. Chet (ed.). Innovative Approaches to Plant Disease Control. John Wiley& Sons, Inc. pp. 41-76.

[6] Costa, A. S., and G. W. Muller. 1980. Tristeza control by cross protection: A U.S.-Brazil cooperative success. Plant Disease 64:538-541.

[7] De Bach, P., ed. 1964. Biological Control of Insect Pests and Weeds. Reinhold, New York, New York. 844 pp.

[8] Waage, J., and D. J. Greathead. 1988. Biological control: challenges and opportunities. In R. K. S. Wood and M. J. Way (eds.). Biological Control of Pests, Pathogens, a Weeds: Developments and Prospects. The Royal Soc., London., pp 1-18.