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ZO- 351 PEST MANAGEMENT

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CHAPTER IV PEST MANAGEMENT USING BIOLOGICAL CONTROL

ECOLOGICAL CONSIDERATIONS

Ecological Pest Management (EPM) is an approach to increasing the strengths of natural systems to reinforce the natural processes of pest regulation and improve agricultural production. Also know as Integrated Pest Management (IPM), this practice can be "defined as the use of multiple tactics in a compatible manner to maintain pest populations at levels below those causing economic injury while providing protection against hazards to humans, animals, plants and the environment. IPM is thus ecologically based pest management that makes full use of natural and cultural processes and methods, including host resistance and biological control. IPM emphasises the growth of a healthy crop with the least possible disruption of agro-ecosystems, thereby encouraging natural pest control mechanisms. Chemical pesticides are used only where and when these natural methods fail to keep pests below damaging levels". Conventional, chemically based pest-management strategies encourage short-term solutions that can be harmful to the environment and to human health. Broad-spectrum chemicals also are ineffective against some pest problems.

EPM is based on a broad knowledge of the agro-ecosystem, the range of species of living organisms in the ecosystem, their interactions and the outcomes of those interactions. On any given farm, crops are interacting with all types of living organisms including bacteria, insects, nematodes, ruminants, which are also in dynamic interaction. The knowledge of these interactions constitutes the basis of EPM. The overall goal of EPM is to achieve ecological sustainability whilst maximizing the economic gains of agriculture. It comes with a conscious effort to maintain the equilibrium in the ecology of the agricultural or farming systems. The goal is achieved broadly on the principle of ensuring the generation and transfer of knowledge to the farmers on their respective ecological systems and promoting the application of such knowledge.

BIOLOGICAL CONTROL OF INSECTS

Biological control or biocontrol is a method of controlling pests such as insects, mites, weeds and plant diseases using other organisms. It relies on predation, parasitism, herbivory, or other natural mechanisms, but typically also involves an active human management role. It can be an important component of integrated pest management (IPM) programs.

There are three basic strategies for biological pest control: Classical (importation), where a natural enemy of a pest is introduced in the hope of achieving control; Inductive (augmentation), in which large populations of natural enemies are administered for quick pest control; and Inoculative (conservation), in which measures are taken to maintain natural enemies through regular reestablishment.

1. **Importation or classical biological control**

   Importation or classical biological control involves the introduction of a pest's natural enemies to a new locale where they do not occur naturally. Early instances were often unofficial and not based on research, and some introduced species became serious pests themselves.

2. **Augmentation**

   Augmentation involves the supplemental release of natural enemies that occur in a particular area, boosting the naturally occurring populations there. In inoculative release, small numbers of the control agents are released at intervals to allow them to reproduce, in the hope of setting up longer-term control and thus keeping the pest down to a low level, constituting prevention rather than cure. In inundative release, in contrast, large numbers are released in the hope of rapidly reducing a damaging pest population, correcting a problem that has already arisen. Augmentation can be effective, but is not guaranteed to work, and depends on the precise details of the interactions between each pest and control agent.

3. **Conservation**

The conservation of existing natural enemies in an environment is the third method of biological pest control. Natural enemies are already adapted to the habitat and to the target pest, and their conservation can be simple and cost-effective, as when nectar-producing crop plants are grown in the borders of rice fields. These provide nectar to support parasitoids and predators of planthopper pests and have been demonstrated to be so effective (reducing pest densities by 10- or even 100-fold) that farmers sprayed 70% less insecticides and enjoyed yields boosted by 5%. Predators of aphids were similarly found to be present in tussock grasses by field boundary hedges in England, but they spread too slowly to reach the centers of fields. Control was improved by planting a meter-wide strip of tussock grasses in field centers, enabling aphid predators to overwinter there.

Natural enemies of insect pests, also known as biological control agents, include predators, parasitoids, pathogens, and competitors. Biological control agents of plant diseases are most often referred to as antagonists. Biological control agents of weeds include seed predators, herbivores, and plant pathogens.

Biological control can have side-effects on biodiversity through attacks on non-target species by any of the above mechanisms, especially when a species is introduced without a thorough understanding of the possible consequences.

BIOLOGICAL CONTROL OF PLANT DISEASE

Biological control of plant diseases can be broadly defined as the use of one organism to influence the activities of a plant pathogen. Biocontrol organisms can be fungi, bacteria, or nematodes. Most are natural inhabitants of the soil and the environment and are not pathogenic to birds, mammals (including humans), and fish. They are not genetically modified and generally have short re-entry and days to harvest intervals. Biocontrol organisms work by competing with the pathogen for space and nutrients, by parasitism or predation, by inducing the plant's natural defense system, and/or by the production of antimicrobial substances (antibiotics like *streptomycin*). Often several mechanisms function together to make an organism effective. These products are living organisms or dried spore preparations and must be handled differently than conventional fungicides. They are sensitive to temperature extremes and must be applied immediately after mixing with water. They may also require special attention to pH, exposure to chlorine or UV light, and their shelf life may be limited.

Actinovate (*Streptomyces lydicus*) reduced root and seed rot severity in peas and resulted in significantly higher final emergence and significantly lower final disease in spinach challenged by *Pythium* and *Fusarium* (soil-borne fungi). No effect on *Phytophthora* fruit rots of pepper and pumpkin was obtained as well as no effect on Powdery Mildew on pumpkin. Compete Plus (Six species of *Bacillus*, *Streptomyces griseoviridis, Trichoderma harzianum* plus organic nutrients) significantly reduced incidence of potato tubers with both Black Scurf (*Rhizoctonia solani*) and common scab (*Streptomyces scabies*). Bio yield (plant growth promoting *rhizobacteria*) significantly reduced incidence of root rot (*Pythium, Rhizoctonia*) and wirestem (*Rhizoctonia*) on broccoli, resulted in significantly less post emergence disease on spinach (soil-borne fungi), but had no effect on tomato foliar diseases such as *Septoria, Alternaria* (Early Blight), and *Sclerotinia* (White Mold).

- Compost Tea significantly reduced potato tubers with both Black Scurf and Common Scab and reduced scab severity, while resulting in significantly lower final biomass and final emergence when applied to spinach to combat soil-borne diseases. Bi-nucleate *Rhizoctonia* are effective against diseases caused by *Rhizoctonia* and significantly reduced Black Scurf and stem canker on potatoes as well as root rot and wirestem incidence on broccoli.
- Serenade (*Bacillus subtilis*) failed to control the tomato diseases anthracnose, bacterial canker, and bacterial spot; had no effect on *Sclerotinia sclerotiorum* (White Mold) on lettuce or beans; and did not reduce Powdery Mildew on pumpkin or winter squash. Serenade did significantly increase yield and lower the incidence of root rot caused by *Rhizoctonia* on both beans and radish.

- SoilGard (*Trichoderma virens*) significantly reduced Black Scurf incidence and Common Scab severity on potato, resulted in significantly less post emergence disease on spinach from soil-borne disease, while having no effect on spinach and Pythium damping-off.

If one word could be used to describe research trials with these materials, that word would be inconsistent. The environment and application techniques have large impacts on their efficacy. Biocontrol organisms are only effective as preventive control and proper timing of application is critical. An unfavorable environment for their establishment or an environment too favorable for the pathogen can result in control failure. These organisms perform best at low pathogen populations; once disease is established, they will have little positive effect. Establishment of biocontrol organisms on foliar surfaces is difficult; most positive research results come against soil borne problems such as root, fruit, crown and seed rots. Combining these products with naturally resistant or tolerant cultivars is a promising avenue for their use. Biocontrol organisms can also be integrated with naturally suppressive composts, improved sanitation and other cultural controls, and with conventional fungicides to reduce disease control chemical applications.

BIOLOGICAL CONTROL OF WEEDS

Biological weed control involves using living organisms, such as insects, nematodes, bacteria, or fungi, to reduce weed populations. In nature, plants are controlled biologically by naturally occurring organisms. Plants become pests - and are labeled "weeds" - when they run rampant because their natural enemies become ineffective or are nonexistent. The natural cycle may be interrupted when a plant is introduced into a new environment, or when humans disrupt the ecological system. When we purposefully introduce biological control agents, we are attempting to restore or enhance nature's systems.

How does it work?

Roots provide plants with water and nutrients. Some biological control agents attach to roots and thereby stunt plant growth. Some bacteria live on root surfaces and release toxins that stunt root growth. Many fungi infect roots and disrupt the water transport system, which reduces leaf growth. Beneficial insects and nematodes feed directly on the weed roots causing injury which allows bacteria and fungi to penetrate.

Many weed species survive from year to year by producing seeds. Fungi or insects that attack seeds can reduce the number of weed seeds stored in the soil, which in turn can reduce the size of future weed populations. This lowers the effort needed to control the remaining emerging weeds.

Some bacteria and fungi applied as biological control agents do not survive from year to year. These organisms must be applied on an annual basis. This technique is called the "bioherbicide" strategy. With this tactic, biological agents are used a in manner similar to chemical herbicides.

Reference Books:

1. Biologically Based Technologies for Pest Control (1995), a 216-page report by the Office of Technology Assessment. Available for $14 from the Superintendent of Documents, P.O. Box 371954, Pittsburgh, PA 15250-7954. (Phone: 202-512-1800). Request document S/N 052-003-01449-1.
2. Ecologically Based Pest Management (1996), a 260-page book published in 1996 by the National Academy of Science; available for $37.95. Phone 1-800-624-6242 to order. National Biological Control Institute.
3. Emerging Technologies for Integrated Pest Management: Concepts, Research and Implementation (2000), G.G. Kennedy and T.B. Sutton, eds. APS Press, St. Paul, MN. 526 p.
4. Microbial Control of Weeds (1991), D.O. TeBeest, ed. Chapman and Hall. New York. 284 p.
5. Use of Plant Pathogens in Weed Control (1999), E.N. Rosskopf, R. Charudattan and J.B. Kadir. In: Handbook of Biological Control, Academic Press, San Diego, CA p. 891-918.
6. Biological Control of Weeds: A Handbook for Practitioners and Students (1992), K. Harley and I.W. Forno. Inkata Press, Melbourne, Australia. 74 p.
7. Biological Control of Weeds: Theory and Practical Application (1997), M. Julien and G. White. ACIAR Monograph No. 49, Australian Centre for International Ag. Research, Canberra, Australia. 192 p.

Reference Books -

1. Handbook of Pest Management in Agriculture by Pimentel.
2. Principles of Insect Pest Management by Dhaliewal and Arora.

3. Agricultural Pest of India & South East Asia by A. Satwal.
4. Pathological Problems of Economics Crop Plants & their Management by Paul Khurana, S. M., 1998.
5. Integrated Diseases Management and Plant Health by Gupta V. K. & Sharma R. C.
6. Diseases of Millets by Ramkrishnan T. S., I. C. A. R. Publ. New Delhi.
7. Fungal diseases of Rice in India by Padmanabhan S. Y., I. C. A. R. Publ., New Delhi.
8. Analysis of Pesticides Residues by H. A. Moye (JW)
9. Advance in Pest Control Research by R. L. Methcalf (JW)
10. Chemistry of pesticides by K. H. Buchel (JW).
11. Progress in Pesticides Biochemistry and Toxicology Vol. I, II & III by D. H. Hutsonand T. R. Robert.
12. Evaluation of Pesticides in Ground Water by W. Y. Garnett, R. C. Honeycatt and others.
13. Chemistry of Pesticides by Edward
14. Insecticide Biochemistry and Physiology by C. F. Wilkinson.

Journals:

1. Biological Control, Academic Press, San Diego, CA - http://www.elsevier.com/wps/find/journaldescription.cws_home/622791/description?navopenmenu=1
2. Biocontrol Science and Technology, Carifax Publishing Co., UK. - http://www.tandf.co.uk/journals/titles/09583157.asp

3. BioControl, Kluwer Academic Publishers, Dordrecht, The Netherlands - http://www.kluweronline.com/issn/1386-6141/contents
4. Plant Pathology - http://www.blackwellpublishing.com/toc.asp?ref=0032-0862&site=1
5. Molecular Plant Pathology - http://www.blackwellpublishing.com/toc.asp?ref=1464-6722
6. Weed Science - http://ws.allentrack.net/cgi-bin/main.plex
7. Weed Technology - http://wt.allentrack.net/cgi-bin/main.plex