

**UNIVERSITY OF PUERTO RICO
MAYAGUEZ CAMPUS
COLLEGE OF AGRICULTURAL SCIENCES
DEPARTMENT OF CROP PROTECTION**

**PROC 6645
BIOLOGICAL CONTROL**

Syllabus

Three hours credit. Two hours credit. Two hours of lecture (AP-103) and a three-hour laboratory weekly (AP-103).

Description:

Introduction to the biological control of plant pathogens, nematodes, insects and weeds. Topics on ecological theories that study the use of biological system in order to prevent or reduce agronomic loss caused by pathogens, nematodes, insects or weeds.

Objectives:

The course's purpose is to introduce students to the biological control agents used to control plant pathogens, plant-parasitic nematodes, insects and weeds. Also, study the interactions of these biological control agents with their target, host plant, and environment. It will discuss the feasibility of utilizing these control agents in a real and practical way. Other topics will include: Optimization of naturally occurring biological control, mass production and application of biological control agents, and the integration into IPM and Sustainable Agriculture systems.

Course outline:

1. Biological control of plant pathogens:
2. Definitions, history, and importance of biological control (1 lecture)
3. Biological control of bacterial pathogens on aerial surfaces (1 lecture):
 - (a) Bacterial pathogens of blossoms
eg. *Erwinia amylovora*; russet-inducing bacteria
 - (b) Bacterial pathogens of leaves
eg. *Pseudomonas syringae* and the INA concept; *Xanthomonas campestris*
4. Biological control of fungal pathogens on aerial surfaces (1-2 lectures):
 - (a) Ecology in the leaf surface
 - (b) Necrotrophic fungal pathogens

- eg. *Botrytis cinerea* - bacterial biocontrol agents and *Trichoderma*
 - Sclerotinia sclerotiorum* - bacterial biocontrol agents and *Sporidesmium*
 - (c) Biotrophic fungal pathogens
 - eg. Rusts - bacterial biocontrol agents
 - Powdery mildews - bacterial biocontrol agents and *Ampelomyces*
 - (d) Virus and induced systemic resistance
4. Biological control of soil - borne pathogens and concepts of biotechnology (1-2 lectures):
- (a) Bacterial pathogens
 - eg. *Agrobacterium tumefaciens* - *A. radiobacter* K84 and K1026 and *Ralstonia* (= *Pseudomonas*) *solanacearum* - an example of plectropism and the transference of resistant gene
 - (b) Fungal pathogens
 - eg. *Fusarium* spp. - bacterial biocontrol agents and nonpathogenic fusaria
 - Rhizoctonia solani* - bacterial agents and nonpathogenic *Rhizoctonia*
 - Pythium* spp. - bacterial biocontrol agents and hyperparasitic *Pythium* spp.
5. Biological control of post-harvest pathogens (1 lecture):
- (a) Bacterial pathogens
 - eg. *Erwinia carotovora* soft-rots
 - (b) Fungal pathogens
 - eg. *Penicillium* spp. on citrus
 - Monilinia* on peaches
 - Mucor* and *Rhizopus* on apple and pear
6. Mechanisms of biological control of plant pathogens (2-3 lectures):
- (a) Competition for nutrients
 - eg. competition between pathogenic and nonpathogenic fungi
 - (b) Competition for iron and the role of siderophores
 - (c) Competition for fungal germination stimulants
 - (d) Antibiosis
 - (e) Lytic enzymes
 - (f) Induced systemic resistance
 - (g) Cross protection
 - (h) Hyperparasitism
 - (i) Hypovirulence

Biological control of nematodes using microorganisms:

- (a) Bacterial parasites and Rhizobacteria (PGPR or YIB)
 - eg. *Pasteuria penetrans*, *Ralstonia* (= *Burkholderia*) *cepacia*
- (b) Fungal parasites
 - eg. *Paecilomyces lilacinus* and *Verticillium clamydosporum*, etc.
- (c) Nematode trapping fungi
 - eg. *Arthrobotrys oligospora*

- (d) Mycorrhiza and endophytic bacteria
- (f) Trap and antagonistic crops, organic amendments and rotations

Biological control of insects:

1. Definitions and importance
6. Parasitoids definitions and examples (2 lectures):
eg. *Trichogramma*; *Apanteles*
7. Predators (2 lectures):
eg. *Chrysopa*, *Hippodamia*, etc.
4. Biology, ecology, and population dynamics (1-2 lectures)
8. Microbial Control (2-3 lectures)
 - 1) Bacteria: eg. *Bacillus thuringiensis*; *B. popilliae*
 - 2) Viruses: eg. Nucleopolyhedrosis and granulosis viruses
 - 3) Fungi: eg. *Entomophthora*, *Beauveria*

Biological control using entomopathogenic nematodes (1-2 lectures):

1. Introduction: *Steinenema*, *Heterorhabditis*
2. Mode of action
3. Production and formulation
4. Application and commercialization

Biological weed control using plant pathogens:

5. Introduction to strategies of weed control
6. Use of foliar fungal pathogens
eg. *Colletotrichum* (COLLEGO) to control Northern Joint Vetch
Alternaria cassiae (CAST) to control sicklepod
Phytophthora palmivora (DIVINE) to control *Morrenia*
7. Nematodes: *Anguina*
8. Production, formulation and application of biological control agents (1-2 lectures)
 - (a) Aerial surfaces
eg. Lyophilized cells - survival problems with Gram negatives and vectoring of *Gliocladium*
 - (b) Seed treatment
 - (c) Soil application

Biological control of weed using insects:

- (a) Use of insects to control weeds in agronomic lands
eg. *Cactoblastis cactorum* on prickly pear cactus
Chrysolina quadrigemina on Klamath weed
- (b) Use of insects/fish to control aquatic weeds
eg. *Agasicles hygrophila* on alligatorweed

Ctenopharyngodon idella on many aquatic weed species

Industry and commercialization:

1. Technology transfer
2. Market size and marketability
3. Timely availability and shelf-life
- d. Consumer acceptance of produce protected by non-engineered and engineered biocontrol agents: Cost/benefit ratio.

Laboratory topics:

1. Introduction: General tools, materials, and equipment
2. Sampling methods
3. Isolation and purification of biological control agents
4. Antibiosis assays in vitro and tests of antagonisms
5. Assays with biological control agents I
6. Assays with biological control agents II
7. Natural enemies of nematodes
8. Tests with organic extracts
9. Sampling and observations of natural enemies of insects
10. Parasites, parasitoids, and predators of insects
11. Functional response
12. Entomopathogenic nematodes
13. Attractions and repellence of organic exudates
14. Biocontrol products and commercialization.

Course textbooks and references:

Due to the broad nature of the course outline, no textbook will be required. For the first offering of this course, handouts will be presented throughout the quarter.

Cook, R.J. y Baker, K.F. 1983. The nature and practice of biological control of plant pathogens. APS Press, St. Paul, Mn. 539 pp.

Debach, P. y Rosen, D. 1991. Biological control by natural enemies. 2nd. Ed. Cambridge Univ. Press, Cambridge, N.Y. 440 pp.

Hall, R. 1996. Principles and Practice of Managing Soilborne Plant Pathogens. APS Press. St. Paul, Mn. 330 pp.

Mahr, D.L. and Ridgway, N.M. 1993. Biological Control of Insects and Mites: An Introduction to beneficial natural enemies and their use in pest management. North Central Regional Publication 481. 91 pp.

Stirling, G.R. 1991. Biological control of plant parasitic nematodes. C.A.B. International, Oxon, UK.

282 pp.

Tananada, Y. and Kaya, H.K. 1993. *Insect Pathology*. Academic Press, Inc. San Diego, Ca. 666 pp.

TeBeest, D.O. 1991. *Microbial control of weeds*. Chapman & Hall, N.Y., N.Y. 284 pp.

Van Driesche, R.G. and Bellows, T.S., Jr. 1996. *Biological Control*. Chapman and Hall. N.Y., N.Y. 539 pp.