IPM from Cotton to Hydrilla

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• USDA APHIS PPQ
• USDA NIFA RAMP

Rachel Carson (1962)- *Silent Spring*
http://sweetnessorganic.com/Pesticides2.html
Outline

• Basic Concepts of IPM
• Specific Examples
  – Aquatic
  – Terrestrial
• Questions and Comments
Checking sticky traps for flight patterns of cotton insects, ca 1940s.
(Photo Credit: http://entohistory.tamu.edu/timeline/timeline.html)

Outline

• Basic Concepts of IPM

Cotton Boll Weevil, *Anthonomus grandis*
Integrated Pest Management

• IPM: Sustainable Approach to Managing Pests by Combining Appropriate Biological, Cultural, Physical & Chemical Tools;

• Control Methods Selected & Applied in Manner that Minimizes Risks to Human Health, Beneficial Non-target Organisms, & Environment

(USDA ERS Definition)
Invasive Plant Management - The Other IPM

Adkins (1997)
TACTICS OF INVASIVE PLANT MANAGEMENT

PREVENTION

BIOLOGICAL

CULTURAL

CHEMICAL

PHYSICAL

IMPORTATION

AUGMENTATION

FORTUITOUS

ORGANIC

INORGANIC

NATURAL

SYNTHESIZED

NATURAL

SYNTHESIZED

Relative Degree of Sustainability

PERMANENT

TEMPORARY
Rationale for IPM

• Reduces Invasive Plant Problems More Effectively by Saving $$ and Protecting the Environment

• How ??
  – Decreases Herbicide Use
  – Minimizes Resistance Problems
  – Promotes Successful Establishment & Impact of BioControl Agents
Biological Control

• Use of Living Organisms, Such as Insects, Nematodes, Bacteria, Viruses, or Fungi to Suppress Weed Populations

• Three Approaches:
  – Importation or Classical (Arthropods, Pathogens)
  – Augmentation (Arthropods, Pathogens, Grass Carp)
  – Fortuitous (Adventive Organisms)

• Importation or Classical Approach
  – Most Widely Used Method for Weeds
  – Highly Regulated
Importation (Classical) BioControl

- Introduction and Release of *Host Specific* Natural Enemies from the Weed’s Native Range to Reduce Its Population Density in the Adventive⁰ Range

⁰Arrived into a specified geographical region from elsewhere by ANY means.
Rationale for Importation BioControl

• Once Established, Non-Native Invasive Plants often develop High Populations in Florida

• Why?
  – Suitable Climate & Geography
  – ‘Enemy Release’ Hypothesis
    – Escape From Natural Enemies That Regulate Plants in Native Range
Goal of Importation BioControl

- Reunite Natural Enemies with their Hosts (Broad Sense)
- Natural Enemies Introduced to Suppress & Maintain the Density of the Pest at “ACCEPTABLE” Levels
- Important Caveat
  - Biological Control is *NOT* Eradication
  - Creates Opportunity to Combine w/ Other Tactics
How Does BioControl Work?

- Weed establishes equilibrium density (ED)* above economic / ecological injury level (EIL)**
- Natural enemy lowers ED & maintains it below EIL

*ED - Long term mean density
**EIL – Lowest density causing economic or ecological damage
Costs / Benefits of BioControl

(after Mentz 1987)
BioControl “Pipeline”

Credit: USA, COA
FL Quarantine Facilities

USDA-ARS Laboratory, Ft. Lauderdale

FL BioControl Lab, Gainesville

UF/DACS Laboratory, Ft. Pierce

UF Entomology Dept, Gainesville
Defining BioControl Success (in Operational Terms)

• Complete- No Other Control Methods Are Needed

• Substantial- Other Methods Needed But at Reduced Level
  * Goal of IPM

• Negligible- Other Methods are Required

(Hoffmann 1998)
Rationale for Integrating BioControl with Herbicides

- Biological Control is Not Immediate
- Unpredictable
  - Some Natural Enemies Fail to Establish
  - Some Natural Enemies are Ineffective
- Abiotic and Biotic Interference
Integrating BioControl Agents with Herbicides

• Must Be Sure That Herbicide (or BioHerbicide) Does Not Negatively Impact BioControl Agent
  – Directly- Causes Mortality
  – Indirectly- Herbicide Reduces Plant Density (= Food Source) Below Critical Level

• Consider Applying Herbicides to Maximize BioControl Agent Impact
  – Location
  – Timing
Tropical Soda Apple

Photo Credit: Jeff Mullahey
**Gratiana boliviana** (Chrysomelidae)

First insect approved in 2003 for Field Release in the USA

- **Adult**
- **Egg**
- **Larva**
- **Pupa**
TSA Beetle Releases in FL
Post Release Monitoring

Five years after release, statewide surveys conducted to monitor the establishment and impact of beetles.

38 counties with a total 113 of random sites

Plant and beetle variables collected
Adults are reproductive from April to October and migrate to the ground during winter.
The beetle is established below the 29°N latitude ONLY

G. boliviana absent
G. boliviana present
Solution?

- Cold-Tolerant Biological Control Agent Identified
  - Screening of a New Gratiana Beetle Completed in 2010

HOST SPECIFICITY TESTS OF GRATIANA GRAMINEA (COLEOPTERA: CHRYSomELIDAE), A POTENTIAL BIOLOGICAL CONTROL AGENT OF TROPICAL SODA APPLE, SOLANUM VIARUM (SOLANACEAE)

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Herbicide Escape Mechanisms
Brazilian Peppertree Seed Wasp

Megastigmus
(Hym: Torymidae)
Herbicide Escape Mechanisms
Chinese Privet Seed Weevil

*Ligustrum sinense*
Photo by Fred Nation

*Ochyromera*
(Col: Curculionidae)
Outline

• Basic Concepts of IPM
• Specific Examples
  – Aquatic
Waterhyacinth

*Neochetina* spp.  
(Col: Curculionidae)
Water Hyacinth Fungus
*Cercospora piaropi*

(Courtesy of R. Charudattan)
Integrating BC with Other Tactics

- *Neochetina* Weevils with *Cercospora* Fungus

(Courtesy of R. Charudattan)
Augmentative Hydrilla BioControl

- Sterile (Triploid) Grass Carp Used to Manage Hydrilla
  - Diploid Grass Carp in Suwannee River (Jaggers et al. 2011)
- BUT- They Are Not Selective Feeders
- Can Only be Used in Closed Water Bodies
Integrating Fish with Herbicide

GRASS CARP

FLURIDONE

Hydrilla
Hydrilla verticillata
Photo by Vic Ramsey
Copyright 2000 Univ. Florida

Kracko and Noble (1993)
Hydrilla Bioherbicide

Mycoleptodiscus terrestris (Native Fungal Pathogen)
Integrating Fungus w/ Herbicide

- Combined fungus *Mycroleptodiscus terrestris* (Mt) with fluridone
- Hydrilla control > 90%
  - 2 ppb fluridone + 100 cfu ml\(^{-1}\) Mt
  - Rapid biomass reduction
  - Long-term control
  - Reduced contact time – approximately by 50%
- Mt compatible with many herbicides

Netherland and Shearer (1996)
Integrating Mt with Herbicide

Dry weight hydilla shoot biomass/g

- Control
- Fluridone 21 day
- Fluridone 35 day
- Mt liquid
- Mt dry
- Mt liq + 35 day Fluridone
- Mt liq + 21 day Fluridone
- Mt dry + 35 day Fluridone
- Mt dry + 21 day Fluridone

Legend:
- Red: Control
- Green: Fluridone 21 day
- Yellow: Fluridone 35 day
- Blue: Mt liquid
- Pink: Mt dry
- Cyan: Mt liq + 35 day Fluridone
- Grey: Mt liq + 21 day Fluridone
- Brown: Mt dry + 35 day Fluridone
- Black: Mt dry + 21 day Fluridone
Fortuitous (Adventive) BioControl

- Regulation of a Weed Population by a Natural Enemy that Has Arrived from Elsewhere *Without* Deliberate Introduction
- No Active Human Involvement
The Hydrilla Miner - *Cricotopus lebetis*

- Tip- mining Midge
  - Larvae Feed on Living Plant Tissue
  - Rare Occurrence
- Prevents “topping out”
- Naturalized in Florida
  - No Swarms
  - Low Dispersal Distance
  - Easily Mass Reared
Integrating Herbicide w/ Miner

Imazamox

Hydrilla

Hydrilla Miner
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Tropical Soda Apple

Tropical soda apple (TSA), “The Plant From Hell”

- A member of the Solanaceae
- Noxious weed (under both federal and state designations)
- Originally from South America
- Invasive weed in Florida and seven southeastern states and spreading
- Primarily a problem in pastures, but also in sod-production, citrus, and natural areas

TSA’s needle sharp prickles pose a serious danger to cattle and humans
Augmentative BioControl

- Release of Large Numbers of a Biological Control Agent to Achieve a Rapid Effect
- There is No Expectation the Biological Control Agent will Establish a Permanent (= Reproducing) Population
The use of TMGMV as a bioherbicide for TSA has been patented by the University of Florida (U.S. Patent No. 6,689,718 B2, issued Feb. 10, 2004).

*BioProdex, Inc.*, has licensed this technology from the University of Florida Research Foundation (UFRF) to develop and register the virus as a bioherbicide.

The proposed name of the bioherbicide is *SolviNix* (*Solvi* = *Solanum viarum*; *Nix* = to put an end to)
SolviNix™ Bioherbicide

- SolviNix™ effective at concentrations as low as 200 mg / acre
- TSA plants of all ages highly susceptible & die within 3 weeks post-treatment
- Two formulations: liquid concentrate & wettable powder
Chemical Control

Response of TSA with 2.0 and 2.6 pt/acre of GrazonNext alone and 2 pints/acre of GrazonNext plus 2,4-D amine, WeedMaster, Pasturegard, or Vista. Herbicide prices shown are approximate and do not include application costs.
Cultural Control

• Prevent Seed Movement / Dispersal
  – Clean All Equipment & Clothing When Leaving TSA-Infested Pastures
  • Vehicles, Mowers, Tractors, & Even Shoes
Cultural Control

• BMPs for Shipping & Holding Cattle
  – Ship Cattle ONLY From Areas w/o TSA or is TSA-Fruit Free
    • Mow TSA-Infested Pastures Prior to Stocking
  – When Buying Cattle, Hold in ONE Area for a Week to Avoid Spreading Seeds
    • TSA Seeds Remain Viable in Gut for ~ 6 Days
Components of Melaleuca IPM Program

• Mechanical Removal - Immediate Effect
• Herbicidal Control - Temporary Effect
• Biological Control - Sustained Effect
Mechanical Removal
Herbicidal Control
Biological Control
Summary

• Integrated Systems Result in More Rapid and Economical Weed Control

• More Complete Control than with Any Method Used Alone

• Difficult to Control Invasive Weeds with Only One Tool
Web Sites

http://plants.ifas.ufl.edu/guide/contents_by_category.html

http://ipm.ifas.ufl.edu/
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