

# What's next in the Tool Box?

Methods of weed control

Today's topics:

- Weed control methods
- Cultural control
- Biological control



# Weed Control Methods

## Mechanical and physical control

- ▶ Hand pulling and hoeing
- ▶ Tillage
- ▶ Mowing
- ▶ Mulches
- ▶ Living mulch & cover crops
- ▶ Flooding
- ▶ Fire and heat

## Cultural Control

- Competitive crops
- Crop rotations
- Allelopathic/cover crops

## Biological Control

- Classical
- Bioherbicides

## Chemical control

# Cultural Weed Control

1. Crop management
2. Competitive crops
3. Cover crops
4. Intercropping
5. Crop rotations

# Crop management

Manipulation of the crop to increase competitiveness

Proper cultural considerations:

- Crop variety
- Planting date and density
- Fertilization
- Irrigation
- Control of diseases and pests

# Competitive crops

Certain crops are themselves able to form dense stands that suppress growth of weeds

- |           |                |
|-----------|----------------|
| alfalfa   | foxtail millet |
| buckwheat | rye            |
| sorghum   | clovers        |
| sunflower | Turfgrasses    |

In these crops 70% or more of weed control can be achieved through cultural methods

# Competitive crops

Factors to consider:

- ▶ Time of crop emergence relative to weeds
- ▶ Rate of crop growth
- ▶ Leaf area, leaf orientation, and time of canopy closure
- ▶ Spacing

Row spacing (cm)	Weeks of weed control needed
105	14
77	10
52	6

Gaps in stand -- Weeds will invade any break in the crop canopy

## Effect of row spacing



## Competitive/Allelopathic crops

Use of crops with allelopathic properties

- Crop itself may be allelopathic
- Crop residue with allelopathic chemicals
  - o From a previous crop (e.g., wheat from the previous year)
  - o From a cover crop (e.g., rye sown in fall and killed prior to planting)

Considerations

- ▶ Avoid allelochemical toxicity to new crop
- ▶ Must minimize disturbance of the allelopathic residue

## Truth or Science fiction?

Crops will be genetically engineered for greater competitive ability... growth form, nutrient uptake, and/or photosynthetic efficiency.

## Enhanced competitiveness: Prospects

Rice height influenced by sucrose phosphate synthase (SPS) gene.



Transgenic plants overexpressing a maize SPS gene were up to 1.3 times taller than wild-types.

Differences attributed to greater sucrose transport, rather than differences in synthesis.

No differences in heading date or yield observed.

Nipponbare NIL6

(Ishimaru et al. 2004)

## Cover crop objectives

- ▶ Cover crops are highly competitive (allelopathic?) crops grown for weed control:

- o Goal: Replace unmanageable weed population with manageable cover crop species.

- o Used in:

- Orchards and vineyards
- Between seasons in annual crops
- Off season winter annual cover crops



- o Increasing amount of cover crop residue generally leads to decreasing number of weeds.

## Cover crops

- ▶ Cover crops control weeds with intense competition  
Very effective at limiting light from hitting the soil and competitive against weeds that emerge



Buckwheat between rows of potatoes

## Cover crops – related terms

- ▶ "Living mulch":
  - Two crops are grown simultaneously, with one usually more economically important and the other suppressing weeds (*crop and legumes*)
  - Both can be harvested, and the combination of two crops reduces the resources available for weeds
- ▶ "Green manure":
  - Cover crop grown specifically to build soil organic matter and fertility
  - Include legumes species

## Cover crop management

Need to kill cover crop to avoid competition with primary crop:

- ▶ Mowing
- ▶ Rolling
- ▶ Tilling
- ▶ Herbicides

Plant into residue



Soybeans emerging in rye

## Popular cover crops – Grasses

- ▶ Annual ryegrass
- ▶ Barley
- ▶ Millet
- ▶ Oats
- ▶ Rye
- ▶ Sorghum
- ▶ Triticale
- ▶ Wheat



## Popular cover crops – Legumes

- ▶ Alfalfa
- ▶ Cowpea
- ▶ Crimson clover
- ▶ Field peas
- ▶ Hairy vetch
- ▶ Medics
- ▶ Mung beans
- ▶ Red clover
- ▶ Soybean
- ▶ Subterranean clover
- ▶ Sweetclovers
- ▶ White clover



## Popular cover crops – Brassicas

- ▶ Black mustard
- ▶ Field mustard
- ▶ Kale
- ▶ Oilseed radish
- ▶ Rapeseed
- ▶ Turnip
- ▶ Winter canola



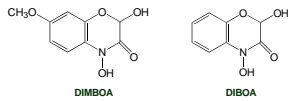
## Popular cover crops – Other

- ▶ Buckwheat
- ▶ Flax
- ▶ Malabar spinach
- ▶ Marigolds
- ▶ Spinach



## Allelopathy in cover crops

Hydroxamic acids in wheat, rye, and maize



Rye/vetch cover



No cover



Wheat/vetch cover

## Advantages

- ▶ reduced soil erosion
- ▶ improved soil structure
- ▶ reduced compaction
- ▶ reduced weed numbers
- ▶ may reduce pests
- ▶ may be harvested for forage
- ▶ legumes may supply nitrogen
  
- ▶ VIDEO

## Disadvantages

- ▶ Must avoid competition between cover crop and the primary crop.
- ▶ Herbicides may be needed to stunt or kill cover crops to prevent competition with main crop.

Cover crops form an effective component of a weed control system in no-till situations, but generally require herbicides or other inputs to completely control weeds

## Crop rotations

–Any continuous practices selects for a certain spectrum of weeds. Rotations disrupt this selection process

Factors to consider:

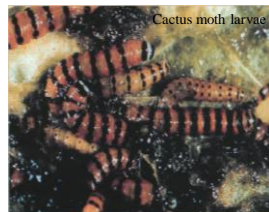
- Crop growing conditions (different is better)
- Weed control options for different crops
  - Herbicide rotations
- Crop rotations may require additional equipment (large capital investments)
- Crop rotations may mean growing lower value crops.

## Biological Control

The use of living organisms to lower the population level or competitive ability of a weed species



Alligatorweed flea beetle



Cactus moth larvae

## Classical Biological Control

Classical biological control

A biological agent, *usually an insect*, is released and allowed to reproduce and spread naturally through the weed infested-area

Economical and relatively permanent solution for controlling a single weed species

<http://www.youtube.com/watch?v=1k0F4NmWvcl>

## Model of classical control

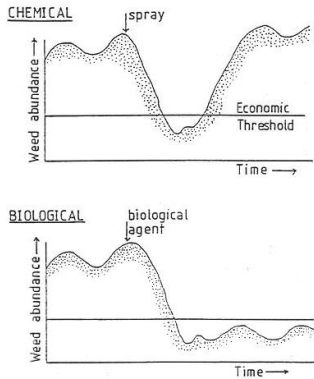
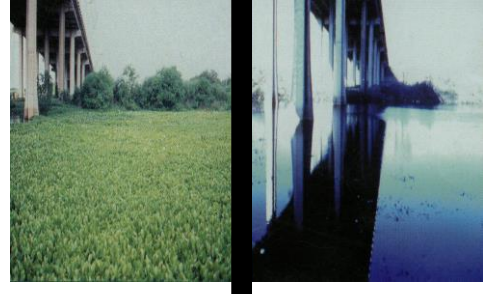


FIGURE 8.33 Diagram showing the weed suppression over time from biological and chemical control methods. Note that successful biological control results in an equilibrium of weed abundance below an economic threshold through time. (From Kilgus, 1995.)

## Success



Water hyacinth in Mississippi

## Requirements for a classical control organism

- ▶ Thrive on the target weed and propagate naturally.
- ▶ Tolerate occasionally low levels of the target weed
- ▶ Not harm non-target plants.
- ▶ Reproduce rapidly enough to keep up with the weed populations.
- ▶ Maintain an equilibrium with the target weed that keeps the weed population below threshold levels.
- ▶ Adapted to the environment of its host.
- ▶ Not decimated by other predators or pathogens.

## Environmental factors favoring classical biological control

- ▶ Relatively undisturbed
- ▶ Abundant target weed
- ▶ Usually not supporting high value crops
- ▶ Large areas that do not justify herbicidal and mechanical control measures.

## Manipulated agents

- Disease organisms, *usually bacteria or fungi*, that are grown on artificial media in large quantities and subsequently applied to weeds almost like a chemical=bioherbicide
- ▶ Apply organism itself or its propagules (spores)
  - ▶ Manipulated agents do not have to be exotic introductions

## Example of manipulated agents

Some bioherbicides have made it to the market

- ▶ COLLEGO: Spores of the fungus *Colletotrichum gloeosporioides* f. sp. *aeschynomene*
  - Control of northern jointvetch in rice and soybean
  - Best with relative humidity above 80%
  - Aerial application
  - Lesions form on plant stem, with death occurring in 4 to 5 weeks



## Collego example



Northern jointvetch in rice fields before and after treatment with Collego®

## Charateristics of manipulated agents

- ▶ Applied to emerged weeds
- ▶ Very sensitive to environmental conditions
- ▶ work best under high humidity conditions
- ▶ Relatively slow acting
- ▶ Very safe to nontarget organisms–high selectivity!
- ▶ Storage conditions critical

## Animals:

<http://www.youtube.com/watch?v=tkpmkaGTRAE>

### Grazing animals

Geese  
Goats  
Sheep  
Cows  
Fish



Goats have been used for controlling weeds in a variety of settings

Geese will selectively eat grass in a variety of settings

## Fish

### Grazing animals

Geese  
Goats  
Sheep  
Cows  
Fish



Herbivorous fish (tilapia and grass carp) can be effective on algae and submersed weeds.

## Limitations of animals

- ▶ They must prefer to eat the weedy vegetation.
- ▶ They need to be tended to keep them in the area of weed infestation.
- ▶ They may need supplemental food containing nutrients not found in the weeds.
- ▶ They must be sheltered and maintained as with any other livestock.

## Summary

- ▶ Understand the principles of cultural and biological control methods.
- ▶ Be able define and cite examples for each type of control.
- ▶ Be able to describe the pros and cons of these methods.