Methods of Weed Control

Section 3
Methods of Control

A. Eradication

• Complete kill or removal of a weed species from a defined geographical area; includes elimination of ungerminated seed and vegetative propagules

• Infers that the weed will not reappear unless introduced into the area.

• The ideal of weed control but rarely achieved
Why is Eradication of Weeds Not Common?

1. Very difficult, very expensive

2. Obstacles to eradication:
   - prolific seed production
   - long life of seed
   - numerous methods of dispersal
   - difficulty of avoiding reinfestation

3. Practical only in cases where there is a small isolated area and the weed is a serious threat.
   Examples: witchweed, itchgrass, tropical spiderwort.
Witchweed Eradication

- Weed found in 1956.
- Initially found in 39 counties in NC and SC; 425,000 acres
- USDA-APHIS began eradication program in 1957.
1960 Reported Survey of Witchweed, Striga asiatica

Data retrieved from National Agricultural Pest Information System 08/05/96

The Center for Environmental and Regulatory Information Systems does not certify to the accuracy or completeness of this map.
Witchweed Eradication

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- Eradication began in 1957.
- Initially found in 39 counties in NC and SC; 425,000 acres
- If reached Corn Belt, lose estimated at 10% of $20 billion crop (1957 dollars)
Witchweed Eradication Methodology

- Extensive surveys
- Herbicide programs
- Ethylene gas
- Quarantine

NC: 2,962 acres
SC: 393 acres
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   Examples: witchweed, itchgrass, tropical spiderwort.
If we can’t eradicate weeds, what can we do?

We manage them.
Weed Management

Limiting weed population to a level that will not cause economic damage or other loss of value
How Do We Manage Weeds?

What methods are at our disposal?
A. Prevention

steps taken to prevent introduction, establishment, and/or spread of a specified weed species into an area not currently infested with that species.
Examples of Prevention

1. Use of weed-free crop seed
2. Clean equipment before moving from infested to non-infested fields
3. Weed-free irrigation water
4. Avoid hay, livestock feed, or manure containing seed of species currently not on farm
5. Preventing introduced weeds from going to seed
6. Others in notes
Weed Control Methods

B. Mechanical Control

Use of a tool or machine to remove weeds
Weed Control Methods

B. Mechanical Control

1. Hand removal
   a. Limited use in agronomic crops; too expensive
   b. More use in high-value crops
   c. Widely used in developing countries
Weed Control Methods

B. Mechanical Control

1. Hand removal

Is it ever feasible in turf?
Weed Control Methods

B. Mechanical Control

1. Hand removal
2. Tillage
   Primary (seed bed preparation)
   Secondary (in-crop cultivation)
Cultivation

1. Works best on hot, dry soils

2. Cultivate shallow to avoid crop root damage, and to avoid bringing up untreated soil from below the herbicide-treated zone
Herbicide-treated zone

Weed seed
Problems with Cultivation

1. May not be effective on weeds in crop row
2. Weather may prevent timely use
3. May promote weed germination
4. Depletes soil moisture
5. Can cause physical damage to crop
6. May enhance disease problems; especially a problem in peanuts
Weed Control Methods

B. Mechanical Control

1. Hand removal
2. Tillage
3. Mowing
Mowing for Weed Control

1. More effective on tall-growing weeds.

2. For perennials, most effective when food reserves low. Continued mowing can deplete food reserves.

3. More effective on broadleaves than grasses; grasses have protected growing point.
B. Mechanical Control

1. Hand removal
2. Tillage
3. Mowing
4. Mulching
Mulching

• Goal is to exclude light

• Black plastic, sawdust, wood chips, paper, straw, grass clippings, etc.

• Used in vegetable crops, ornamentals, home gardens, etc.

• Cost of disposing of non-biodegradable materials

• Not practical in agronomic crops (except cover crop residue)
Weed Control Methods

B. Mechanical Control

1. Hand removal
2. Tillage
3. Mowing
4. Mulching
5. Burning, heat
Burning for Weed Control

1. Flaming
   a. Once used on railroads
   b. Flame cultivation
   c. Flaming sidewalk cracks
   d. Steaming sidewalk cracks
Burning for Weed Control

1. Flaming
   a. Once used on railroads
   b. Flame cultivation
   c. Flaming sidewalk cracks
   d. Steaming sidewalk cracks

2. Steam sterilization

3. Burning off wheat fields
Burning for Weed Control

1. Flaming
   a. Once used on railroads
   b. Flame cultivation
   c. Flaming sidewalk cracks
   d. Steaming sidewalk cracks

2. Steam sterilization

3. Burning off wheat fields

4. Soil solarization
Weed Control Methods

C. Cultural Control

practices that make conditions more favorable for crop, less favorable for weeds
Weed Control Methods

C. Cultural Control

1. Crop competition
2. Crop rotation
3. Cover crops
4. Water management
Using Crop Competition for Weed Control

Anything to give crop an edge over weeds, to get crop ahead of weeds, to promote shading by the crop

• Good seed, good seedbed, seeding rate, uniform stands

• Fertilization and liming

• Disease and nematode control

• Early season insect control

• Cultivar selection
Using Crop Competition for Weed Control

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• NARROW ROWS
Effect of Row Spacing on Weed Management

- Narrow rows have little effect on initial weed emergence
- Narrow rows give quicker canopy closure (i.e., shade), and shade impacts later weed emergence
Effect of soybean row spacing on weed resurgence following POST application of non-residual herbicide.

Weed Control Methods

C. Cultural Control

1. Crop competition
2. Crop rotation
3. Cover crops
4. Water management
Crop Rotation as a Weed Control Tool

• Good overall practice; results in healthier crops which in turn compete better with weeds

• Given weeds tend to be associated with given crops; rotation breaks that cycle

• CROP ROTATION HAS MAJOR IMPACT ON CHEMICAL CONTROL
Crop rotation allows herbicide rotation

- Broader spectrum, better long-term control
- Helps avoid weed population shifts
Weed Population Shift

- Change in species composition of a weed population over time
Weed Population Shift

• Change in species composition of a weed population over time

• Occurs in response to management practices, especially herbicide use
If a particular herbicide controls ♣ very well, but gives poor control of ♥, what happens over time if that herbicide is used annually?

Weed Population Shift

95% ♣
5% ♥
Weed Population Shift

95% ♣
5% ♠

95% ♠
5% ♣
Examples of Weed Population Shifts

- Fall panicum after extensive use of atrazine
- Broadleaf signalgrass after extensive use of Lasso
- Prickly sida after extensive use of Classic
- Morningglory and dayflower after extensive use of glyphosate in RR crops
Weed Population Shifts Due To:

- Herbicide programs
- Tillage practices
  (example: perennials in continuous no-till)
Impact of Crop Rotation on Chemical Weed Control

Crop rotation allows herbicide rotation

- Broader spectrum, better long-term control
- Helps avoid weed population shifts
- Helps avoid herbicide resistance
Weed Resistance

♥ susceptible biotype

♦ resistant biotype
Weed Control Methods

C. Cultural Control

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4. Water management
Cover Crops as a Weed Management Tool

- Small grains most common; some legumes also used
- Usually killed before planting crop of interest
- “Chokes” out weeds before planting crop of interest
- After cover crop killed, residue can exclude light, provide physical barrier, release allelochemicals
Effect of rye cover crop and herbicides on late-season weed biomass and grain yield of no-till corn.

Yenish, Worsham, York, 1996
Effect of rye cover crop and herbicides on late-season weed biomass and grain yield in no-till corn

Yenish, Worsham, York, 1996
Weed Control Methods

C. Cultural Control

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Water Management as a Weed Control Tool

- Flooding in rice; weeds deprived of oxygen
- Water deprivation on weeds
- Timely irrigation may make crop more competitive
Weed Control Methods

D. Biological Control

• Use of living organism to control weeds

• Examples: insects, fungi, animals such as geese, sheep, hogs, fish

see examples in your notes
Pathogens as Biocontrol Agents

1. Classical approach
   initial inoculation with self-sustaining pathogenic fungi

2. Mycoherbicide approach
   annual application of pathogenic fungi
Mycoherbicides

• Typically applied as foliar sprays
• Shelf life can be problem
• Use of fungicides on crop limits use of mycoherbicides
• May require specific environmental conditions
Weed Control Methods

D. Biological Control

- Use of living organism to control weeds
- Examples: insects, fungi, animals such as geese, sheep, hogs, fish
- Control agent must not harm crops and other beneficial organisms
- Fits best in non-intensive systems
Reality of Biological Control

• May fit well in low-input systems, such as rangeland

• Generally not practical in typical, intensively managed cropping systems; not a replacement for herbicides
Problems with Biological Control in Intensively Managed Areas

1. Narrow spectrum of control
2. Do not work fast enough to avoid early season weed competition
3. Difficult for biocontrol agent to survive in typical cropping systems
4. Require special handling; poor shelf life
5. Not compatible with other components of pest management required for profitable production
Weed Control Methods

E. Chemical Control

use of herbicides to control weeds
Herbicide Nomenclature

• Trade name
• Common name
• Chemical name
Example of Herbicide Nomenclature

Trade name: Scepter (agronomic crops)  
Image (turf)

Common name: imazaquin

Chemical name: 2-[4,5-dihydro-4-methyl -4(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-3-quinolinecarboxylic acid

![Chemical structure of imazaquin]
Categories of Herbicides
(terminology)
Broad Categories of Herbicides

A. Selective
B. Non-selective
Selective vs. Non-Selective Herbicides

- **Selective**: kills some species but not others; kills weeds, not the crop
- **Non-Selective**: kills or severely injures most species
Selectivity is usually rate dependent.

Selective herbicides can be made non-selective by increasing the rate.

Example:

Diuron can be applied preemergence to cotton at 1 to 2 lb a.i. (selective control)

Diuron can be applied at 5 to 15 lb a.i. in non-cropland areas for total vegetation control (non-selective)
Selectivity

• Through genetic engineering, a gene normally not present in a crop can be introduced. This gene can confer resistance to a herbicide that ordinarily would be non-selective on the crop.

• Example: Roundup Ready® crops
Broad Categories of Herbicides

A. Contacts
B. Systemics
Contact Herbicides

- very little translocation within the plant
- destroy only that plant tissue touched by chemical
- good spray coverage essential
- usually exhibit acute effects -- kill rapidly
- effective on annuals, usually ineffective on perennials
- can be selective or non-selective
Systemic Herbicides

- translocated (moved) within plant
- coverage less critical than for contacts (coverage is always important)
- usually exhibit chronic effects -- kill slowly
- more effective on perennials than contacts
- can be selective or non-selective
Broad Categories of Herbicides

A. Residual

B. Non-residual
Residual Herbicide

• Herbicide continues to have activity on weeds for some period of time after application

• Length of time it remains active depends primarily on the chemistry, and secondarily on the rate

• Preemergence or postemergence

• Selective or non-selective
Non-residual Herbicide

- Herbicide has activity only on weeds emerged at the time of application
- Postemergence only
- Can be selective or non-selective
Soil Sterilant

• Chemical applied to soil or soil plus foliage that controls essentially all vegetation for a given period of time
• Length of control varies, depending on chemistry and rate
• Total vegetation control (TVC)
• Nonselective
Methods of Herbicide Application

(terminology)
Methods of Herbicide Application

A. Early Preplant (EPP)
B. Preplant foliar (PPF)
C. Preplant incorporated (PPI)
D. Preemergence (PRE)
E. Postemergence overtop (POT)
F. Postemergence-directed (POST-DIR)
G. Postemergence with selective application equipment
Methods of Herbicide Application

A. Early Preplant (EPP)
  - applied a few weeks ahead of planting
  - typically for residual control of early germinating summer annuals
  - may control emerged weeds
  - not been common in NC, but now increasing
Early Preplant Application

**Advantages**

- Spread work load
- More time to receive rainfall for activation
- May reduce need for burndown in no-till or stale-bed systems
- May reduce carryover potential of long-residual herbicides
Early Preplant Application

Disadvantages

• Herbicide selection: need long-residual herbicide
• May require higher application rates to compensate for breakdown during time between application and planting
• May increase need for postemergence herbicides (compared to PRE)
• Spring weather conditions can limit application; compaction of wet soils
Methods of Herbicide Application

B. Preplant Foliar (PPF)

- Applied to control emerged weeds or cover crops ahead of planting in reduced-till systems; often called “burndown”
- Aid to tillage in conventional systems
- May or may not be residual
Methods of Herbicide Application

C. Preplant Incorporated (PPI)

- applied prior to planting, incorporated (physically mixed) into top few inches of soil

PTI = pretransplant incorporated
Reasons to Incorporate Herbicides

• Some herbicides very volatile; significant losses by volatility; incorporation greatly reduces volatilization losses
Reasons to Incorporate Herbicides

• Some herbicides very volatile; significant losses by volatility; incorporation greatly reduces volatilization losses

• Some herbicides subject to photodegradation; incorporation eliminates most of these losses

• Some herbicides have low water solubility; difficult to adequately activate* by rainfall; incorporation accomplishes activation

* refers to movement of surface-applied herbicide into weed seed germination zone by rainfall or irrigation
Preplant Incorporated Application

Advantages

• Reduces dependence on rainfall for activation
• Reduces volatilization losses
• Reduces photodecomposition
Preplant Incorporated Application

Disadvantages

- Requires additional labor and equipment
- Uniform incorporation may be difficult to achieve; problems associated with non-uniform incorporation
- May contribute to crusting or compaction
- Not possible in some conservation tillage systems
- Generally cannot band
Methods of Herbicide Application

D. Preemergence (PRE)

• applied to soil surface prior to crop or crop and weed emergence
Preemergence Application

Advantages

• Can plant and spray in same operation
• If activated timely, often perform better than PPI application
• Fit in any tillage system
• Can band to reduce costs
Preemergence Application

Disadvantages

• Dependent upon timely rainfall for activation. Generally need activation with 7 to 10 days or less after application

• On bedded land, herbicide may wash off shoulder of bed, leaving a streak of weeds

• May not move deep enough in soil to be effective on large-seeded weeds
Methods of Herbicide Application

E. Postemergence Overtop (POT)

• applied after crop or crop and weeds emerged
• no attempt to keep herbicide off crop
• can only use selective herbicides
Methods of Herbicide Application

E. Postemergence Overtop (POT)

- applied after crop or crop and weeds emerged
- can only use selective herbicides
- “at-cracking” is very early POT application
Postemergence Overtop Application

Advantages

• In most cases, soil does not impact on herbicide’s activity
• Fits IPM philosophy
• Can be used in any tillage system
• Can band to reduce costs
Postemergence Overtop Application

Disadvantages

• **TIMELY APPLICATION CRITICAL**
  Weather delays, equipment breakdown can be a problem.

• Environmental conditions affect efficacy
  – Drought
  – Washoff

• Many POT herbicides have little to no residual activity
Methods of Herbicide Application

F. Postemergence-directed (POST-DIR)

• applied after crop or crop and weeds emerged; use specialized equipment to prevent or limit spray contact with crop

• typically slower application than POT

• band or broadcast
Later Season Cultivator Mount

View From Rear
(Flat Fan Tips)
Methods of Herbicide Application

F. Postemergence-directed (POST-DIR)

- reasons to post-direct
  - use herbicides with limited crop tolerance
  - better coverage under crop foliage
What is “lay-by” application?

Basically a late POST-DIR application
Methods of Herbicide Application

F. Postemergence with Selective Application Equipment

- Specialized equipment designed to keep herbicide from contacting crop
- Allows use of non-selective herbicides
Methods of Herbicide Application

F. Postemergence Selective Application Equipment

• Recirculating sprayers
Methods of Herbicide Application

F. Postemergence Selective Application Equipment

• Recirculating sprayers
• Wiper applicators
Methods of Herbicide Application

F. Postemergence Selective Application Equipment

- Recirculating sprayers
- Wiper applicators
- Shielded sprayers, Hooded sprayers
Area of Herbicide Application

• Broadcast
• Banded
• Spot treatment
Area of Herbicide Application

- **Broadcast**: herbicide applied to all of planted area (over row and row middle)

- Can be EPP, PPF, PPI, PRE, POT, or POST-DIR
Area of Herbicide Application

- **Banded:** herbicide applied to only part of planted area, remainder of area untreated
- **Most common is a treated band** over the crop row
- **Usually PRE, POST, or POST-DIR**
Area of Herbicide Application

- Spot treatment: herbicide applied intermittently only as needed to specific target weeds
Spot Treatment

Advantages:

- Use relatively little herbicide, costs reduced
- If target weed confined to small percentage of crop area and grower willing to sacrifice part of crop, non-selective herbicides can be used

Disadvantages:

- Must know where target weed is located
- Often overlook weeds
Questions?