Dr. Zach Miller
Protect your investment

- Main Objective:
  - Return of investment
  - Maximize growth
  - Minimize time to maturity/harvest
  - Site-Specific needs assessment and management plans
Orchard Planning makes dreams come true

- Fencing
- Bird Protection
- Weed Management
- Plant Selection
- Irrigation
- Potential Returns
Main threats to plant health/production

Weeds, Rodents/Deer, Birds, and Disease
Two major type of wildlife fencing

Woven wire

Electric
# Pros and Cons

<table>
<thead>
<tr>
<th>Fence Type</th>
<th>Cost</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Woven Wire</td>
<td>High: $4-6 per foot, $4700-7000/2 acres</td>
<td>Low- occasionally mowing</td>
</tr>
<tr>
<td>Electric</td>
<td>Low: $1.50-2.20, $1800-$3000/2 acres</td>
<td>High- must keep vegetation off fence.</td>
</tr>
</tbody>
</table>

http://agresearch.montana.edu/warc/guides/Orchard_Infrastructure.html
Bird Protection

- Can remove 50 to 99% of the crop
  - Aronia less attractive to birds
- Exclusion vs. Deterrents
- Two types
  - Row cover
  - Orchard Cover-Full Exclosure
Orchard Cover-Full Exclosure

- E.g. Smart Net System
  - Advantages:
    - Can work under net
    - Better for mixed orchards/U-pick
    - Better bird protection-can’t reach fruit
  - Disadvantages
    - Cost: need to add ~10 ft. tall posts every 50 ft.
    - ~$3,700 per acre

WWW.smart-net-systems.com
250-890-0841  Canada
Row cover

• Advantages:
  • Cost: $850-1,800/acre.
  • Netting: $800-1,200/ac
  • Support, stakes: $630/ac.
  • Allows mechanical harvest.
• Disadvantages
  • Less effective: birds can reach fruit
  • Can’t work under net- must remove to prune, spray, monitor, and harvest
Weed Impacts

- Direct:
  - Competition for water and nutrients:
    - Especially intense in establishment years
    - Lost returns on inputs/investment
    - Weeds can block irrigation -> water stress

- Indirect:
  - Provide food/habitat for rodents-winter browsing to roots and trunk
Weed Management

- Weed types
- Critical period for control
- Management tool kit:
  - Herbicide types
  - Application
- Orchard floor vegetation management planning
- Rodent control
- Take the Hard-easy approach:
  - Vigilant control early will make things easier in the end.

http://treefruit.wsu.edu/crop-protection/weed-control/
Know your enemy

- Scouting weeds:
  - Determine management
  - Monitor results

- Major weed types:
  - Growth form:
    - Grass
    - Broadleaf
  - Live span:
    - Annual (winter vs summer)
    - Biennial
    - Perennial
Weed Growth Forms

Monocot

Dicot-Broadleaf Weeds
Weed Life Span

- **Annuals**
  - Winter Annuals
  - Summer Annuals

- **Biennials**-2 year life cycle-often noticed too late to control
Spreading Perennial are the most difficult to control.

- E.g. Quack Grass, Canada Thistle, Field Bindweed
- Use Systemic Herbicide that will break down (i.e. glyphosate)
- Multiple applications-Fall most critical

REMOVE BEFORE PLANTING
Critical Period(s)

- Weed competition has greatest effects when:
  - **Orchard Establishment** - small root system, creates lag in growth
  - When plants need resources during the growing season
    - Flowering
    - Fruit set
    - Fruit enlargement (yield, size)
    - Growth (next years yield)
    - Flower bud initiation (next years yield)
  - **MAY-JULY**
    - Weed competition in fall can help plants harden off/prepare for winter
Increase in trunk cross sectional area – 1991

Trunk growth

Duration of weed-free period

Merwin-Cornell University
Early weed control is critical
Weed Management Tool Kit

Prevention: sanitation, stopping weed seed production

Biological: competition, bio-control

Chemical: tillage, mulches, mowing
### Table 4-14. Advantages and disadvantages of weed management tools

<table>
<thead>
<tr>
<th>Tool</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultivation/hoeing</td>
<td>- effective, especially on small weeds&lt;br&gt;- non-selective - controls all emerged growth&lt;br&gt;- equipment readily available</td>
<td>- may damage soil structure&lt;br&gt;- may spread perennial weeds&lt;br&gt;- may damage trees/roots&lt;br&gt;- provides only short-term control</td>
</tr>
<tr>
<td>Mulching</td>
<td>- effective if properly managed&lt;br&gt;- non-selective - suppresses all emerging weeds&lt;br&gt;- holds soil moisture as well&lt;br&gt;- provides long-term control</td>
<td>- availability of mulch&lt;br&gt;- cost of mulch/application&lt;br&gt;- attractive to rodents&lt;br&gt;- may affect tree nutrition&lt;br&gt;- must be free of weed seeds</td>
</tr>
<tr>
<td>Mowing</td>
<td>- rescue treatment&lt;br&gt;- quick suppression&lt;br&gt;- equipment available&lt;br&gt;- reduce seed spread</td>
<td>- weeds may still compete&lt;br&gt;- quick regrowth&lt;br&gt;- several mowings required&lt;br&gt;- may damage young trees</td>
</tr>
<tr>
<td>Herbicides</td>
<td>- effective&lt;br&gt;- easy to apply&lt;br&gt;- can be selective&lt;br&gt;- timely</td>
<td>- require 2% soil organic matter&lt;br&gt;- directed spray equipment&lt;br&gt;- effects on pest complex&lt;br&gt;- cost varies</td>
</tr>
</tbody>
</table>

$425/acre/year

$<100/acre/year

http://www.omafra.gov.on.ca/english/crops/facts/weedman.htm
Herbicide types

- **Pre-emergent: PRE**
  - Effects weed seeds (not established perennials)
  - Applied fall, early spring
  - Require incorporation (water, tillage)

- **Post-emergent: POST**
  - Contact: Not moved within plant
    - Effective on annual weeds
    - Less risk for crop damage
    - Paraquat, Glufosinate (Cheetah, Rely), Organic herbicides
  - Systemic: moved within the plant
    - Effective on annual and perennial weeds
    - Glyphosate (Roundup-many others)-no residual
    - 2,4-D, clopyralid (Stinger)-soil residual-can harm some cultivars if used mid season w/ irrigation

- Some herbicides are both PRE-POST
Herbicide types

- Selectivity: Based on mode of action (MOA)
  - Some MOA’s work on all plants - Non-Selective, Broad spectrum
  - Other MOA’s work on some plants - Selective
    - Often grass or broadleaf
    - But can be more selective.
    - Know weeds, Read labels.
### PREEMERGENCE WEED CONTROL

**Grasses**
- Barnyardgrass
- Crabgrass, large
- Foxtail, Giant
- Foxtail, Green
- Foxtail, Yellow
- Quickgrass
- Wheat, Volunteer

**Broadleaves**
- Chamomile, False
- Dandelion, common (seedling)
- Flibere, Redstem
- Fleabane, hairy
- Groundsel, common
- Herbit
- Kochia
- Mallow, common
- Marestail/horseweed
- Mustard, Birdsfoot
- Mustard, Black
- Pigweed, Redroot
- Pigweed, Smooth
- Puncturevine
- Purslane, Common
- Sperge, prostrate
- Sperge, spotted

### POSTEMERGENCE WEED CONTROL

**Grasses (1-2 inches)**
- Barley, Volunteer
- Barnyardgrass
- Bluegrass, Annual
- Crabgrass, large (1/2 inch)
- Foxtail, Brittle
- Foxtail, Giant
- Foxtail, Green
- Foxtail, Yellow
- Panicum, Fall
- Wheat, Volunteer

**Broadleaves (1-3 inches)**
- Chamomile, False
- Chickweed, common
- Herbit
- Kochia
- Mustard, Black
- Mustard, Wild
- Pigweed, Redroot
- Pigweed, Smooth
- Purslane, common
- Shepherd’s-purse
- Wild Radish

**POSTEMERGENCE PARTIAL WEED CONTROL**

**Grasses**
- Johnsongrass, seedling
- Millet, wild
- Oat, wild
- Quickgrass

**Broadleaves/Sedges**
- Cocklebur
- Dandelion, common (established)
- Lambquarters, common
- Nightshade, Black
- Nightshade, Hairy
- Nutsedge, yellow
- Pigweed, Prostrate
- Ragweed, Common
- Velvetleaf

### WATER SOLUBLE GRANULE

**For Weed Control In Citrus Fruit, Stone Fruit, Tree Nuts, Pome Fruit, Grapes, Potatoes, Potatoes grown for seed, and field grown Tomatoes**

**Grasses**
- Sorgghum halepense
- Panicum miliaceum
- Avena fatua
- Agropyron repens
- Eragrostis cilianensis

**Broadleaves/Sedges**
- Xanthium spp.
- Taraxacum officinale
- Chenopodium album
- Solanum nigrum
- Solanum sarrachoides
- Cyperus esculentus
- Amaranthus blitoides
- Ambrosia artemisiifolia
- Abutilon theophrasti

**Postemergence Partial Weed Control**

**Grasses**
- Johnsongrass, seedling
- Millet, wild
- Oat, wild
- Quickgrass

**Broadleaves/Sedges**
- Cocklebur
- Dandelion, common (6 inches in diameter)
- Lambquarters, common
- Mallow, common
- Nightshade, hairy
- Nutsedge, yellow
- Pigweed, prostrate
- Ragweed, common
- Smartweed, Pennsylvania
- Thistle, Giant

**Herbicide**

**Matrix® SG**

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- Nightshade, hairy
- Nutsedge, yellow
- Pigweed, prostrate
- Ragweed, common
- Smartweed, Pennsylvania
- Thistle, Giant
Maximizing Control

- Weed size/stage: smaller is more susceptible
- Weeds need to be actively growing
  - Water
  - Heat
- Herbicide must contact weeds
  - Dust
  - Hairs
- Adjuvants:
  - Hold herbicide on plant, prevent breakdown
  - Increase uptake
  - Nitrogen, surfactants, oils, penetrants, wetting agents, spreader-stickers
  - Follow labels
Other Considerations

- Soil factors- Organic Matter and temperature affect herbicide movement/breakdown
- Crop/Cultivar. E.g. Rose/Apple family more tolerant of synthetic auxins (clopyrlid)
- Age of plants:
  - younger plants have more tender bark and shallower root system.
    - Protect with careful application, guards.
    - Avoid root active PRE and POST products in new orchards.
  - Some products registered only for young, NON-BARING orchards.
- Weed shifts/Herbicide resistance
## Ten important herbicide modes of action

<table>
<thead>
<tr>
<th>Mode of action</th>
<th>WSSA group</th>
<th>Key herbicides</th>
<th>Number of resistant species</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACCase</td>
<td>Group 1</td>
<td>Poast, Select, Fusilade</td>
<td>44</td>
</tr>
<tr>
<td>ALS</td>
<td>Group 2</td>
<td>Sandea, Matrix, Solida, Pruvin</td>
<td>142</td>
</tr>
<tr>
<td>Shoot inhibitors</td>
<td>Group 3</td>
<td>Surflan, Prowl, Kerb</td>
<td>12</td>
</tr>
<tr>
<td>PGR</td>
<td>Group 4</td>
<td>2,4-D, Stinger</td>
<td>31</td>
</tr>
<tr>
<td>PS II</td>
<td>Group 5</td>
<td>Simazine, Sinbar</td>
<td>72</td>
</tr>
<tr>
<td>PSP</td>
<td>Group 9</td>
<td>Glyphosate, Roundup, many others</td>
<td>25</td>
</tr>
<tr>
<td>PS I</td>
<td>Group 22</td>
<td>Gramoxone</td>
<td>29</td>
</tr>
<tr>
<td>GS</td>
<td>Group 10</td>
<td>Rely, Finale</td>
<td>2</td>
</tr>
<tr>
<td>PPO</td>
<td>Group 14</td>
<td>Goal, Chateau, Treevix, Aim, Venue</td>
<td>6</td>
</tr>
<tr>
<td>Cellulose inhibitors</td>
<td>Group 20/29</td>
<td>Casoron, Gallery, Alion</td>
<td>1</td>
</tr>
</tbody>
</table>

### Cost

**Soil Active (preemergent) Herbicides for use in Orchards**

<table>
<thead>
<tr>
<th>Herbicide</th>
<th>Product</th>
<th>Cost per treated acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>diuron</td>
<td>Karmex</td>
<td>$4</td>
</tr>
<tr>
<td>dichlobenil</td>
<td>Casoron</td>
<td>$128</td>
</tr>
<tr>
<td>indaziflam</td>
<td>Alion</td>
<td>$21</td>
</tr>
<tr>
<td>norflurazon</td>
<td>Solicam</td>
<td>$30</td>
</tr>
<tr>
<td>oryzalin</td>
<td>Surflan</td>
<td>$10</td>
</tr>
<tr>
<td>pendimethalin</td>
<td>Prowl</td>
<td>$10</td>
</tr>
<tr>
<td>pronamide</td>
<td>Kerb</td>
<td>$57</td>
</tr>
<tr>
<td>simazine</td>
<td>Simazine 90DF</td>
<td>$6</td>
</tr>
<tr>
<td>terbacil</td>
<td>Sinbar</td>
<td>$41</td>
</tr>
</tbody>
</table>

*bold and italic recommended for new plantings*
Application

Granular applicators

Banded over row

Rotary spreader - broadcast

Drop spreader - broadcast
Integrated Weed Management

- Prior to Planting:
  - In row: build soil, reduce weeds
    - Wait for weeds to emerge-control, fall sprays to remove perennials
    - Cover crop
    - Tillage
    - Fall-control perennials with systemic herbicide (just after first frost)
  - Establish alleys:
    - Grass- sod forming, easy weed control
Integrated Weed Management

- Post planting first few years - critical period
  - Keep clean of weeds to drip line (2-4 ft.)
    - Chemical:
      - fall-early spring
        - Control winter annuals with contact herbicide
        - PRE-soil applied (8-12 weeks of weed control)
      - Clean up escapes with contact herbicide or hoeing.
      - Fall systemic if needed for perennials
    - Mechanical
      - Mulch (may need to remove for winter)
      - Tillage- applied every 3-4 weeks
      - Not effective for perennial weeds
Integrated Weed Management

- Established orchard
  - Will be more competitive (shade-deeper roots)
    - Control winter annuals, perennials in the fall
    - Fall or early Spring- apply broad spectrum contact herbicide followed by mulch or PRE herbicide
    - Control weeds as needed up to July (Critical period).
Small Mammals (Rodents)

Feed on bark of younger trees

Feed on tree roots
Rodent Control

- **Alter Habitat**
  - Reduce food and cover (vegetation/snow)
    - Remove vegetation around trunks
    - Mow or till alley and orchard border
    - Avoid plants favored by gophers
  - Encourage predators
    - Cats, Snakes, Raptors, Foxes

- **Protect Young Trees- tubes or paint**
- **Monitor (Apple slices-U of Illinois)**
  - 1 per 20-30 plants
  - 24 hrs
  - %apples w/ teeth =% trees damaged
  - Treatment threshold (20-25%) ITRPG
Bait/Trapping

- **Traps:**
  - Along runs/tunnels
  - Voles/mice: provide cover over traps

- **Baits/Poison**
  - **2 types**
    - Acute baits: Zinc phosphide
      - More effective for meadow voles
    - Anticoagulants (Chlorophacinone and Diphacinone)

- **Application:**
  - Broad cast
  - Bait stations
  - Hand
Disease Management

- Relatively minor concern due to our dry climate
- Recognize symptoms and treat early to limit damage.
- Saskatoon-Juniper rust (*Gymnosporangium* spp.) has been the most common disease
Saskatoons

- Common Diseases
  - Juniper rust
  - Entomosporium leaf and berry spot
  - Powdery Mildew
  - Fire Blight
Currants

- No disease seen in our trials
- Anthracnose (dark-brown to black dots on leaf surface-yellowing of leaves)
- Septoria leaf spot (in early stages looks similar to anthracnose, but spots expand and have light center and brown border)
- Powdery Mildew
Protect your investment

- Main Objective:

Weeds, Rodents/Deer, and Birds,
Table 1. Weed control options for organic orchards: Attributes and constraints.

<table>
<thead>
<tr>
<th></th>
<th>Attribute</th>
<th>Constraint</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tillage</td>
<td>Effective</td>
<td>Can degrade soil quality, organic matter depletion</td>
</tr>
<tr>
<td></td>
<td>Reduces rodent habitat</td>
<td>Costly in young orchards</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Can damage roots and trunks, irrigation system</td>
</tr>
<tr>
<td>Flaming</td>
<td>Can control weeds around trunk</td>
<td>Potential tree injury</td>
</tr>
<tr>
<td></td>
<td>Reduces rodent habitat</td>
<td>Not good for older weeds, perennials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Uses fossil fuels</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Irrigation system damage</td>
</tr>
<tr>
<td>Inert mulches</td>
<td>Effective for most weeds</td>
<td>Costly to apply</td>
</tr>
<tr>
<td></td>
<td>Can improve soil quality</td>
<td>Can tie up N</td>
</tr>
<tr>
<td></td>
<td>Conserves moisture</td>
<td>May be hard to source</td>
</tr>
<tr>
<td>Living mulches</td>
<td>Add biodiversity</td>
<td>Compete with trees</td>
</tr>
<tr>
<td></td>
<td>Benefit soil quality</td>
<td>Rodent habitat</td>
</tr>
<tr>
<td></td>
<td>Legumes can fix N</td>
<td>Variable persistence</td>
</tr>
<tr>
<td></td>
<td>Theoretically low maintenance</td>
<td>Variable ability to compete with weeds</td>
</tr>
<tr>
<td>Organic herbicides</td>
<td>Can control weeds around trunk</td>
<td>Expensive</td>
</tr>
<tr>
<td></td>
<td>No physical damage to tree, roots</td>
<td>Inconsistent effectiveness</td>
</tr>
<tr>
<td></td>
<td>Reduces rodent habitat</td>
<td>May need many applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Few registered products</td>
</tr>
</tbody>
</table>

Granatstein and Mullinix 2008