Weed Management
in Organic Agriculture

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Web Resources

CTAHR COVER CROP DATABASE
http://www2.ctahr.hawaii.edu/sustainag/Database.asp

MANAGING COVER CROPS PROFITABLY (book)
www.sare.org/publications/covercrops/covercrops.pdf

STEEL IN THE FIELD (book)

FLAMING
http://www.attra.org/attra-pub/flameweedveg.html

LIVING MULCH IN HAWAII
http://www2.hawaii.edu/~leary/a.htm

WEED BIOCONTROL IN HAWAII & WEEDS AS RESOURCES
http://www2.hawaii.edu/~theodore/Links.htm
Suppliers

**Koolau Seed and Supply, Inc.**, 48-373G Kamehameha. Hwy, Kaneohe, HI 96744, 808-239-1280. *Cover crop seeds.*

**United Agri Products (UAP)** 96-1345 Waihona St. 808-454-0041  
*Various products*

**BEI** 311 Pacific Street, Honolulu, HI 96817, 808.532.7400. *Various.*

**Airgas/Gaspro** Airgas Gaspro 2305 Kamehameha Hwy., Honolulu, HI 96819, (808) 842-2222.

**Peaceful Valley Farm Supply**, P.O. Box 2209, 125 Clydesdale Court, Grass Valley, CA 95945, (530) 272-4769. [http://www.groworganic.com](http://www.groworganic.com)

**Flame Engineering, Inc.**, P.O. Box 577, LaCrosse, Kansas 67548, 1-888-388-6724, [http://www.flameengineering.com](http://www.flameengineering.com)

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**A Weed is…**

*Any plant that interferes with human welfare or activity, or is otherwise objectionable.*

**Plants Out Of Place (P.O.O.P Rule)**
Classification of Weeds

**Broadleaf**
Many of our annual weeds, growing points high above the ground, succulent growth more tender than grasses.

**Legumes**
Annual or perennial broadleaf plants that fix N gas from the air, and are more tolerant to poor soil conditions.

**Grasses/Sedges**
Often strong perennials, growing points close to or below the ground, tough foliage with high silica content.

**Broadleaf**

- Spiny amaranth
- Spanish needle
- Common purslane
Agricultural losses:

- Direct competition with crop
- Hosts to crop pathogens, nematodes
- Clog irrigation water
- Contaminate crop with seeds/parts
- Reduce access to field or pasture
- Poison livestock

Superior light interception and use

- Rapid expansion of tall foliar canopy
- Climbing habit
- Rapid response to shading
Superior reproductive ability

- Germinates under wide range of conditions
- Germination variable over time
- Rapidly reaches reproductive stage
- Self compatible
- Seed production high

Alternate Hosts

Amaranth spp. hosts *Meloidogyne incognita*
Allelopathy

Beneficial or harmful effects of one plant on another plant by the release of chemicals from plant parts by leaching, root exudation, volatilization, residue decomposition and other processes.

Come on, weeds can’t be all bad?
Weed Benefits

• Protect topsoil
• Conserve moisture

• Extensive root systems penetrate deep into the subsoil.
  • Improve crop root growth
  • Drainage
  • Accumulate nutrients from the subsoil, particularly trace elements, and transport them to the soil surface.

• Nurse crop
• Food and Shelter for beneficial organisms
• Food and Medicine for people
• Information about soil quality

Food and Medicine for People

Visit website for Weeds as Resources: An African Example

<table>
<thead>
<tr>
<th>Plant</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranth</td>
<td>Leafy vegetable, grain</td>
</tr>
<tr>
<td>Spanish needle</td>
<td>Leafy vegetable, tonic, anti-inflammatory</td>
</tr>
<tr>
<td>Purslane</td>
<td>Salad green, grain, high Omega-3</td>
</tr>
<tr>
<td>Galinsoga spp.</td>
<td>Sap a first-aid wound treatment</td>
</tr>
</tbody>
</table>
Weeds:
How do we manage them?

Integrated weed management

Basic Elements:
• Focus on reducing populations below levels that cause damage.

• Multiple tactics employed in a compatible manner.

• Focus on multiple bottom line: economic, environmental and social sustainability.
Management Strategies

• Prevention
• Cultural
• Mechanical
• Biological
• Benign neglect

Weed Prevention Strategies

1. Don’t allow weeds to go to seed.
Weed Seed Production

Weed Seed Bank
• Average number of seeds in soil is 30,000-350,000 weed seeds/m²
• 120 million-1.4 billion per acre.

<table>
<thead>
<tr>
<th>Weed</th>
<th>Seed#/plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amaranth</td>
<td>235,000</td>
</tr>
<tr>
<td>Lambsquarters</td>
<td>100,000</td>
</tr>
<tr>
<td>Crabgrass</td>
<td>50,000</td>
</tr>
<tr>
<td>Spurge</td>
<td>3,000</td>
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</tbody>
</table>

“One year of seeding,
Seven years of weeding”
Critical period

• Generally vegetable crops are kept weed free during a critical weed-free period early in development.

• Critical periods:

  ~3-5 weeks for transplants and grains.

  > 5 weeks for direct seed veggies and veggies with small canopies or wide spacing.

  Onions are kept weed free throughout growth.

Weed Prevention Strategies

1. Don’t allow weeds to go to seed.

2. Clean equipment before moving from infested field.

3. Buy uncontaminated crop seed from a reputable source.

4. Thoroughly compost (131 F for 3 days) manure and other residues that might contain seeds. Almost no seeds survive in chicken manure.

5. Filter surface water if possible.

6. Apply fertilizer and irrigation directly to the crop row if possible.

7. Work with your neighbors.
Cultural Strategies

Crop selection and rotation

- Rotate weed-susceptible crops (carrots, onions, widely spaced crops) with suppressive crops such as sweet corn, pumpkin, sweet potatoes.

- Weed suppressive cover crops should be used in problem areas. Sudex, Buckwheat, Crotolaria, Cereal rye, Rape.

- Ground cover critical for weed suppression. Pay attention to cover crop pest problems and requirements. See CTAHR cover crop database: http://www2.ctahr.hawaii.edu/sustainag/Database.asp


Cover Crops

Crotolaria (Sunnhemp)  Ryegrass
Sudex  Buckwheat
Cover Crops

Brassica mix

Oats

Trial, N. Shore O’ahu (McHugh and Constantinides, 2007)

- Three locations
- Sept ’06-Jan ’07
- 20-300 ft elevation
- pH 6-8
- Seeding rate:
  - 40 lbs/ac SH
  - 70 lbs/ac Oats
- Seed cost:
  - $118 lb/ac
  - $28 Oats

<table>
<thead>
<tr>
<th>Suppression Rating</th>
<th>% Cover</th>
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<tbody>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td></td>
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<tr>
<td>6</td>
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<tr>
<td>9</td>
<td></td>
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<tr>
<td>9.5</td>
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</tbody>
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- S. Hemp + Oats
- S. Hemp
- Oats
Cultural Strategies

Variety selection and spacing

- Choose crop varieties that are well adapted to your area.
- Plant at the best time of year for vegetative growth.
- Choose crop varieties with vigorous canopy development.
- Purchase high quality seed.
- Use transplants where possible.
- Space plants at the higher end of recommended density ranges.

Cultural Strategies

Cover Crop Allelopathy

- Allelopathy is controversial as an effective weed suppressive strategy.
- Most consistently demonstrated with rye and correlated with DIBOA (2,4-dihydroxy-1,4-benzoxazin-3-one)
- Suggested strategy: seed at high density, irrigate until good cover established, drought-stress plants to increase DIBOA, kill early in development when DIBOA highest, do not incorporate residue.
Cereal rye (Secale cereale)

Mechanical Strategies

Cultivation

- Very important strategy relied on by many growers.
- Plant very straight, uniformly spaced rows to allow for close cultivation to the plants.
- Keep cultivation shallow to minimize weed seed germination.
- Cultivate weeds early (< 1 inch ideally) at ~50% field capacity.
- Push dirt into rows of long-stemmed plants to cover small weeds.

Mechanical Strategies

Cultivation

Flex Tine

- Main toolbar
- Gauge wheel
- Self-leveling pivot attachment

Flex tines 6mm to 8 mm
(3/16” to 1/4”)
Cultivator (high residue)

Spyders

Metal ground-drive spikes

3.5" long rubber fingers
Basket weeders

Brush Weeder
Mechanical Strategies

Flaming

- High temperatures burst cells (not burn plants).
- Weeds should be small (< 3”).
- Weeds should be well-watered, but with dry leaf surface.
- Flaming at night increases efficacy.

Mechanical Strategies

Flaming

- Most effective on broadleaf weeds.
- Grasses more resistant.
- Can be done before (1-2 days) and after crop emergence.
- Tolerance of crops to flaming varies with species and size (see ATTRA document).
Mechanical Strategies

Flaming

• Recommended rate = 18-27 pounds propane per acre.

• 1 gallon liquid propane = 4 pounds.

• 5-7 gallons of liquid propane per acre.
Chemical Strategies
Organic herbicides

- Active ingredients are usually essential oils and/or acids. The most common:
  - Clove oil
  - Acetic acid
  - Citric acid

- These are contact herbicides, effective only on small weeds, and more effective on broadleaves than grasses.

- So far the economics are poor in the few studies done.

- Corn gluten meal is also used, primarily in turf
  http://wihort.uwex.edu/turf/CornGluten.htm

Clove Oil Based Herbicides

Photo courtesy Jari Sugano
Stale seed bed technique

- This technique is used to exhaust the active seed bank in the first several inches of soil.

- The area is tilled, fertilized and irrigated to promote weed germination.

- Young weeds are killed mechanically.

- Weeds are allowed to flush again and killed.

- Seeds or transplants are placed in the field with minimal or no tillage.

Mechanical Strategies

Mulch

- Plastic and organic mulches may be used.

- With organic mulches, light exclusion and persistence most important.

- In general, grasses persist the longest, legumes the shortest.

- Living mulches, if controlled properly, can increase soil moisture and bioactivity, reduce pest pressure and weed competition. See: http://www2.hawaii.edu/~leary/a.htm
Mulch

- Black plastic mulch extremely effective, and warms soil.
- Solarization to kill weed propagules with clear mulch is tricky: 1) Smooth bed; 2) Film must be against soil; 3) air temperatures > 90 F; 4) Plastic left for 4-6 weeks; 5) do not till more than 3 inches afterward.
- Solarization most effective when combined with other strategies.
- Other mulch colors may improve crop photosynthesis (Red) or disorient pests (Reflective)

Mechanical Strategies
**Mulch**

- **Walk-behind mulch laying attachment**
- **Woven mat in Kula**

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**Biological Control**

- **Insects**
- **Pathogens**

See Biological Control article on Ted’s resource page. [http://www2.hawaii.edu/~theodore/Links.htm](http://www2.hawaii.edu/~theodore/Links.htm)

- **Domesticated Animals**

Grazing cages by Glenn Fukumoto

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