

Weed Management

in Organic Agriculture

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Weeds:

What are they?



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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)



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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.



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Broadleaf



Spiny amaranth



Spanish needle



Common purslane



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Legumes



Japanese tea



Sleeping grass



Legume nodules



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Grasses and Sedges



California grass



Guinea grass



Bristly foxtail



Purple nutsedge



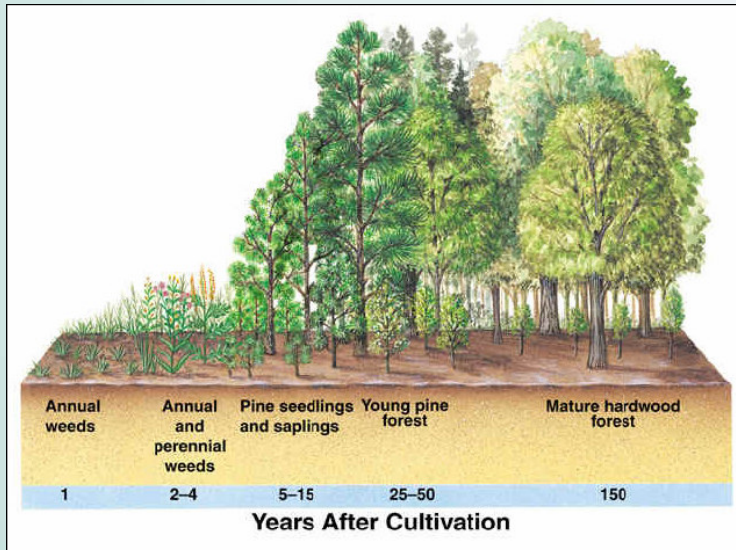
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Agricultural losses :

- 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



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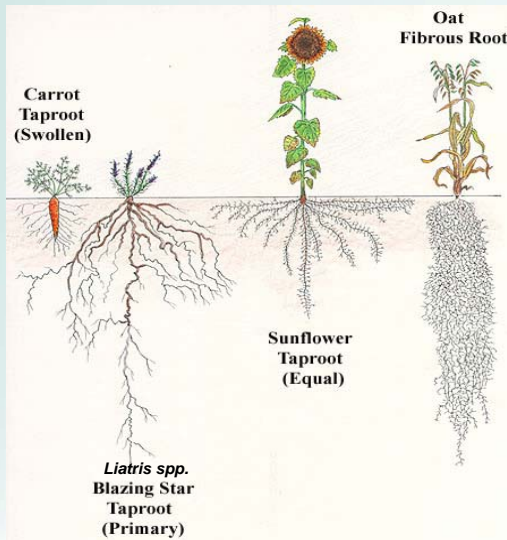
Superior light interception and use

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



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Superior Water and Nutrient Uptake



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Superior reproductive ability

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



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Alternate Hosts

Nutsedge (*Cyperus rotundus*) hosts *Fusarium oxysporium*



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Alternate Hosts

Amaranth spp. hosts *Meloidogyne incognita*



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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.

- Complex and controversial
- Difficult to distinguish from resource competition
- Stressful conditions enhance effectiveness



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**Come on, weeds
can't be all bad?**



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Weed Benefits

- Protect topsoil
- 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.
- Food and Shelter for beneficial organisms
- Food and Medicine for people
- Information about soil quality



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Food for Parasitoids

Parasitic wasps, hover flies (Surphids) control caterpillars, leaf miners and other insects.

Larvae feed on/develop in plant pests, but adults need pollen/nectar.



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Food and Medicine for People

Visit website for Weeds as Resources: An African Example

Plant	Use
Amaranth	Leafy vegetable, grain
Spanish needle	Leafy vegetable, tonic, anti-inflammatory
Purslane	Salad green, grain, high Omega-3
Galinsoga spp.	Sap a first-aid wound treatment



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Weeds as Indicators

Plant communities are a product of their environment.

Species composition of a weed community can be indicative of soil conditions.

Hans Ellenberg 1913-1998:
Ellenberg Indicator Value

Indicator values **MUST** be calibrated for local climate, species and biotypes.

Ellenberg, H., Weber, H.E., Düll, R., Wirth, V., Werner, W. & Paulißen, D. 1992. Zeigerwerte von Pflanzen in Mitteleuropa, 2nd ed. *Scr. Geobot.* 18: 1-258.



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Nitrogen fertility

Level	Indicator Value	Examples
Low	1-3	Bentgrass, Creeping Indigo
Moderate	4-6	Bentgrass, Plantain
High	7-9	Plantain, Amaranth, Bidens



www.hear.org



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Weeds: How do we manage them?



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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.



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Thresholds

- How do we define an “acceptable” density of weed populations?
- Weed densities that cause yield losses (~5-10%) that are equal to the cost of control.
- When taking into account seed production over the long term, the number is actually very small: <math><0.1 - 4.0 \text{ plants/m}^2</math>



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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.

Weed	Seed#/plant
<i>Amaranth</i>	235,000
<i>Lambsquarters</i>	100,000
<i>Crabgrass</i>	50,000
<i>Spurge</i>	3,000



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**“One year of seeding,
Seven years of weeding”**



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Thresholds

- **Generally 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.



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Management Strategies

- **Prevention**
- **Cultural**
- **Mechanical**
- **Biological**



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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.



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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, Crotonaria, 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>
- ***Managing Cover Crops Profitably***: Good survey of material available, seeding rates appear low for local conditions. www.sare.org/publications/covercrops/covercrops.pdf



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Cover Crops



Crotonaria
(Sunnhemp)



Ryegrass



Sudex



Buckwheat



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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.



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Cereal rye (*Secale cereale*)



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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.



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Mechanical Strategies

Cultivation Steel in the Field <http://www.sare.org/publications/steel/index.htm>

- 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.



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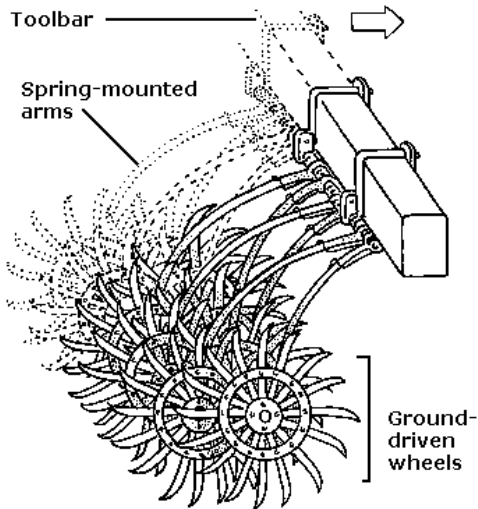
Mechanical Strategies

Cultivation



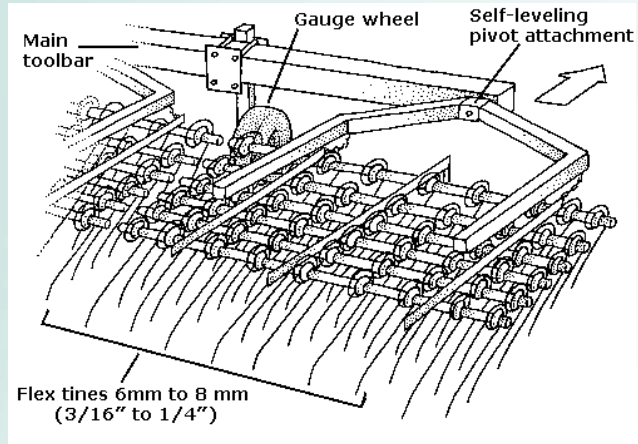
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Rotary Hoe



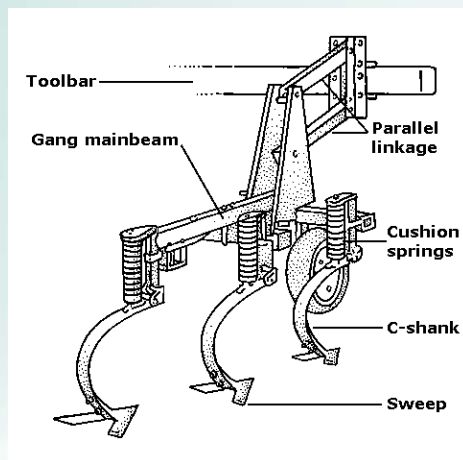
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Flex Tine



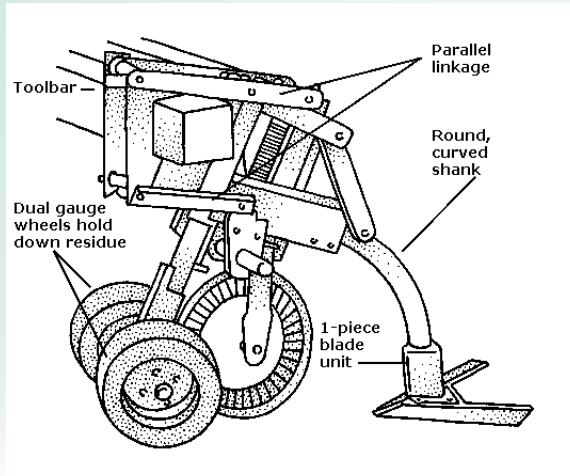
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Cultivator (low residue)



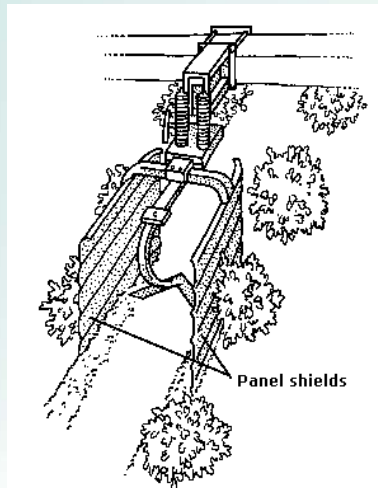
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Cultivator (high residue)



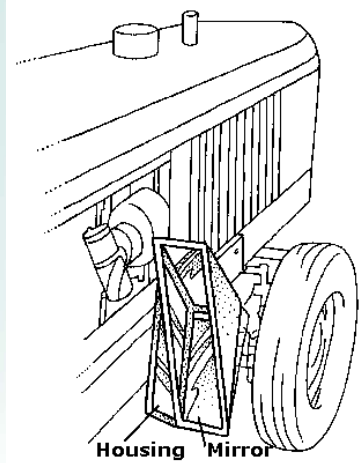
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Shields



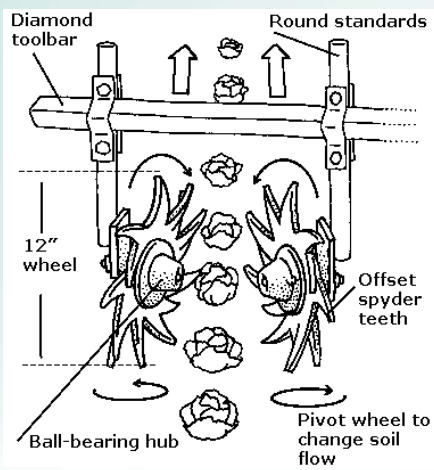
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Guidance mirror



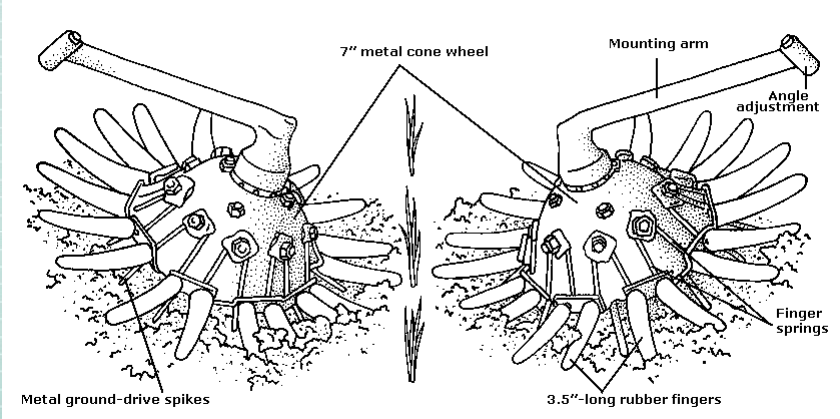
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Spyders



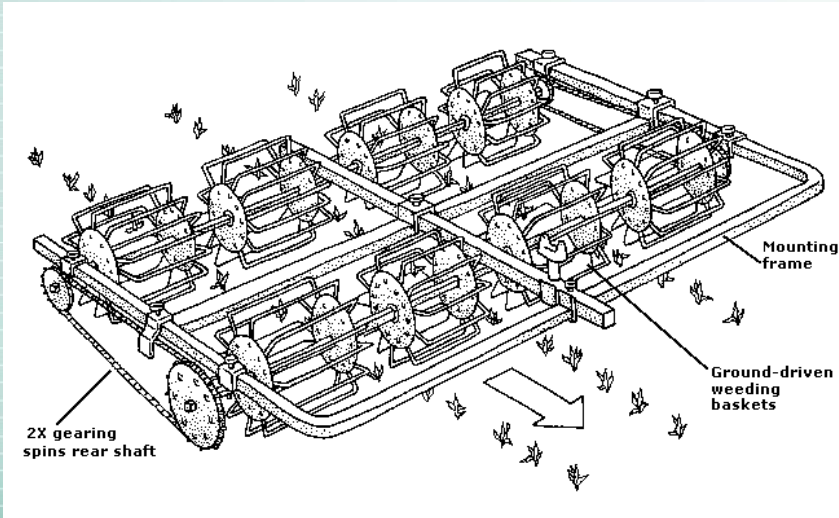
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Spyders



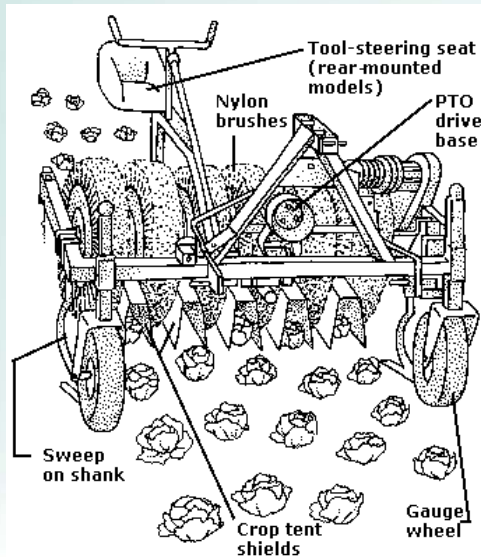
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Basket weeders



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Brush Weeder



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Mechanical Strategies

Flaming

- High temperatures burst cells (not burn plants).
- Weeds should be small (< 3").
- 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 handout and ATTRA document).

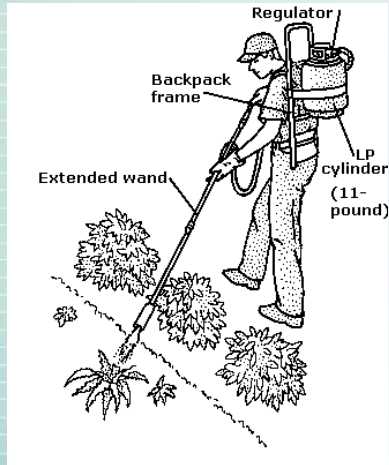
<http://www.attra.org/attra-pub/flameweedveg.html>



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Mechanical Strategies

Organic herbicides

- Active ingredients are usually essential oils and/or acids. The most common:
 - Clove oil
 - Acetic acid
 - Citric acid
- Scythe (Pelargonic acid) has no application pending with OMRI.
- 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>



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Mechanical Strategies

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.



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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>



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Mechanical Strategies

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)



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Mulch



Perennial peanut
in Waimanalo

Cover crop roller in Ohio



Sickle bar mower



Walk-behind mulch laying attachment



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Biological Control

- Insects
- Pathogens

See Biological Control article on Ted's resource page. <http://www2.hawaii.edu/~theodore/Links.htm>

- Domesticated Animals



Grazing cages by
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Thanks!



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