Farm Design to Enhance Ecological Pest Management: Successes and Challenges on Two Farms

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http://www.extension.org/organic_production

FARM DESIGN TO ENHANCE ECOLOGICAL PEST MANAGEMENT

Pinnacle Farm
Diverse Organic vegetable & fruit farm - 60 crops on 250 acres in both Juan Bautista and Hollister, CA.

METHODS AND DESIGN:
Cover crop of vetch and oats. Double seeded and tine weeded.

Minimal tillage:
Spader working ground
Spader tines

Compost: Modified Lubke method. Close-up of compost turner.

Spreading gypsum at Cabrillo farm

Flamer for weeds.

Insectary plants (Dhani-ya cilantro) between carrot and cabbage.

Hedgerow, vertebrate barrier, row cover, owl box
Lepidopteran damage on cabbage. Didn’t meet the threshold for BT due to biological control.

Planting east to west (upwind). Row cover on turnips for root maggots.

Planting east to west (upwind) to decrease aphids. Planting successional blocks upwind (East to West) for cabbage aphid. Brassicas

Thresholds. Example of sampling for estimating aphid infestation. 20 half heads.

Cucumber beetle and Septoria on celery

Amaranth trap crop for cucumber beetle. (Failed control method).
Insect vacuum (4 bed).

Hoophouses for season extension, some diseases and insects reduced. Some (powdery mildew, mites) increased.

Powdery mildew on tomato.

Pink root on onion.

Design error: hoop house and hedgerow sandwiching a narrow planting strip. Birds eat everything!

Design error: carrots planted next to broccoli. White crowned sparrows live in the broccoli (controlling lepidoterans) but use it for cover to eat the carrots.
Biodesign Farm, 1992 - present, Stevensville, MT:
30 acres organic vegetable and fruit production.
Legume Living Mulch, beetle banks, insectaries, hedge rows. Soil Covered All season, reduced tillage.

FARM DESIGN:
Increase Plant Diversity
Manage Complex Ecological Interrelationships

WEEDS:
Figuring out the ecological interrelationships: competition “thresholds” & timing in relation to soil fertility, crop nutrient need, water, light, and root architecture.

HABITAT FOR BENEFICIALS
And wind protection in the spring!
Yellow Sweet Clover "island" planted previous year blooming in mid June

In 1992-2004 Living mulch reduced tillage system including monthly mowing of LM. LM is water intensive, but increased SOM reduces irrigation.

Onion transplants compete with Alsike clover LM - high soil fertility & water

INCREASED PREDATOR AND PARASITE ACTIVITY
Wasp Parasitized Aphid
Predator fly larvae

Habitat for New Predators: birds
Butterfly count July 19, 2004: Cabbage Whites = 147, but little damage. And no Bt sprayed.

Habitat for pollinators = increased fruit set

LM plus crop residue habitat for insects, birds, and voles - crop damage from voles - keep LM mowed.

2004 New Design - 6 Ac. Field – Pasture for 50 yrs.

Minimum tillage & seeded to permanent red clover row middles.

30’ x 600’ beetle bank perennial grass strip center.

600’ native plant hedgerow right.

Spring 2006

Compost in row strips only 4/10

Chisel plow rows 4/14

Rototill rows 4/19
Perennial clover middles = less bare soil. Row middles covered all year = better habitat.

Perennial row middles and insectaries = earlier and increased numbers of predators and parasites.

New vole predator moves into the system…..

In 2006 received a SARE grant to study ICW – compared unsprayed (farm design control), sprayed bi-monthly with pyrethrum-rotenone (calendar), & sprayed with Bt when pest at IPM threshold.

Spraying some Organic Insecticides = Loss of lady bugs, spiders, & syrphid flies

Spraying “selective” Organic Insecticides, such as Bt, is better.
Farm Design System = increased ground dwelling predators.

<table>
<thead>
<tr>
<th>Carabids</th>
<th>Spiders</th>
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<tbody>
<tr>
<td></td>
<td>Threshold</td>
</tr>
<tr>
<td>7/5/06</td>
<td>2.75</td>
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<tr>
<td>8/2/06</td>
<td>2.5</td>
</tr>
<tr>
<td>8/30/06</td>
<td>2.5</td>
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<tr>
<td>9/27/06</td>
<td>3</td>
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</tbody>
</table>

Bt sprayed (THRESHOLD) = lowest foliar and B. sprouts damage (11.7% & 2.7%) 97% marketable. Bt sprayed 8 times.

Unsprayed (CONTROL) = more damage (27.3% and 11.5%), 88% marketable. Labor & material costs = 0.

Most foliar and crop damage = rotenone-pyrethrum (CALENDAR) plots – 80% marketable. Rotenone-pyrethrum sprayed 10 times.

**WEED STUDY 2007** – compared different types of in-row weed management. Yield lowest in no-till.

**Change in Weed Species’ Composition:**

general decrease in small-seeded annuals, increase in low-growing biennials and grasses.

Increased tillage and compost = more annual weeds.

**Monitored weed invasion. Results:**
Weeds came from manure-based compost and soil disturbance.

**Averages of all Harvests (Lbs)**

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<thead>
<tr>
<th>Treatments</th>
<th>Biomass</th>
<th>Yield</th>
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<tbody>
<tr>
<td>minimum till</td>
<td></td>
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<tr>
<td>Tillage</td>
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<tr>
<td>Paper</td>
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<tr>
<td>Vinegar</td>
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<tr>
<td>No-Till</td>
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**Numbers of Annual, Perennial, and Biennial Weeds per Treatment Sample**

<table>
<thead>
<tr>
<th>Treatments</th>
<th>TOTAL PERENNIALS</th>
<th>TOTAL ANNUALS</th>
<th>TOTAL BIENNIALS</th>
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</thead>
<tbody>
<tr>
<td>UNTILLED CONTROL</td>
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</tr>
<tr>
<td>MINIMUM TILL</td>
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<td></td>
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<tr>
<td>NO-TILL</td>
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<tr>
<td>COMPOST POTS</td>
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**Weed Study 2007**

- compared different types of in-row weed management.
- Yield lowest in no-till.
Mycorrhizae fungi (AMF) were highest in no-till plots and lower in all other treatments, indicating that any kind of soil disturbance, even minimum tillage and weed cultivation decreases population levels of these beneficial fungi, at least within a single growing season.

Lots of hand weeding necessary for seeded crops in LM system, ie., lettuce

Improved Habitat for Beneficial Microbes???

- **Antagonistic/Competitive/Mycoparasitic Fungi**
  - Trichoderma/Gliocladium
  - Pythium
  - Penicillium
  - Aspergillus

- **Antagonistic/Competitive Actinomycetes**
  - Streptomyces

- **Antagonistic/Competitive Bacteria**
  - Bacillus
  - Clostridium
  - Pseudomonas

- **Ectomycorrhizal Fungi**
  - Pisolithus
  - Thelephora
  - Suillus
  - Amanita
  - Scleroderma
  - Russula
  - Cenococcum
  - Boletus

- **Endomycorrhizal Fungi**
  - Glomus
  - Endogone
  - Rhizophagus

**RELATIONSHIP between NO3 LEVEL & WEEDS?**
Tilled-in 3 yr old red clover 4/6/07 = immediate NO3 release in <2 weeks 4/18 (except no-till treatment).

All till plots were statistically different from the no-till plots in April and in May, but no statistical differences except vinegar plots which had highest initial NO3 levels in April.

**Disease Suppression??? CMV 2004**

1995/1996 SARE Study Tillage decreased SOM, earthworms and Total Microbes.
All increased with regular additions of fresh, organic residue - clover mowed monthly.
CMV normally causes stunted plants and decreased yield.

Future Directions......

veganicpermaculture.com

General Results 1992 - 2011
IMPROVED YIELD AND QUALITY, fewer insects & diseases & decreased labor.

Find the slides and recording of this presentation at http://www.extension.org/pages/61953

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