

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

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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 tined 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.

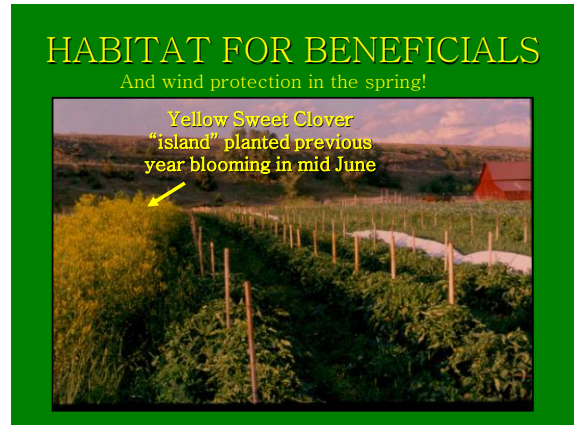
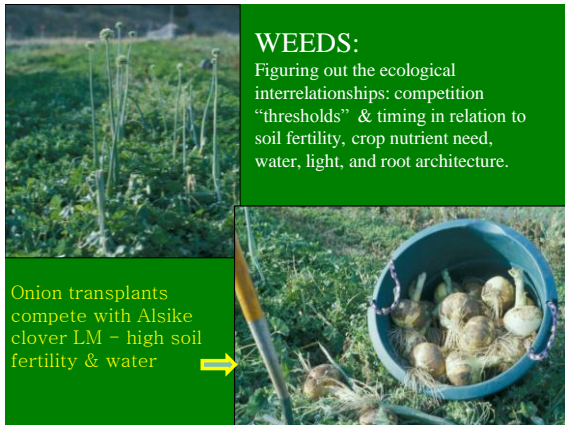


Design error: hoop house and hedgerow sandwiching a narrow planting strip. Birds eat everything!



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.





Butterfly count July 19, 2004: Cabbage Whites = 147, but little damage .

And no Bt sprayed.



More habitat = new predators, such as predaceous stink bugs preying on potato beetle larva.



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.

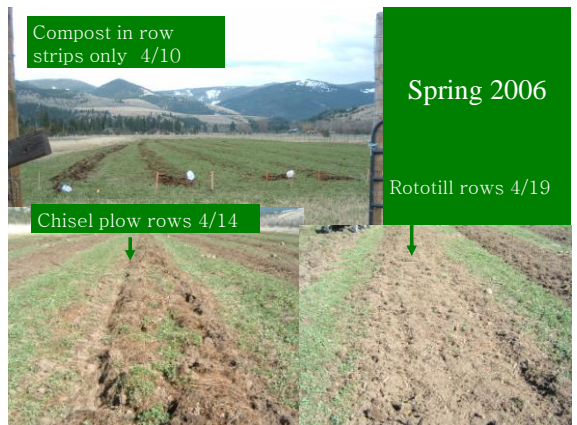


Compost in row strips only 4/10

Spring 2006

Rototill rows 4/19

Chisel plow rows 4/14



Perennial clover middles = less bare soil. Row middles covered all year = better habitat.

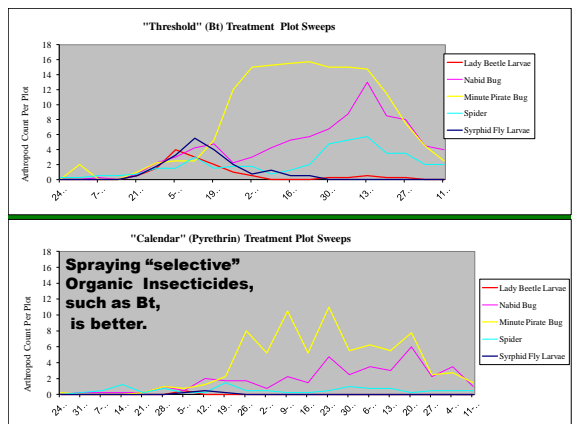
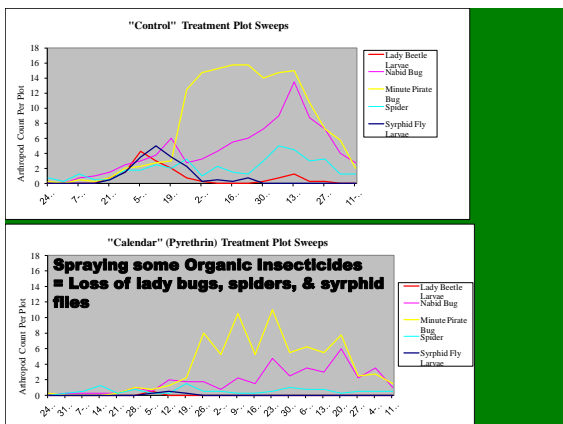


Perennial row middles and insectaries = earlier and increased numbers of predators and parasites.



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.



Farm Design System = increased ground dwelling predators.

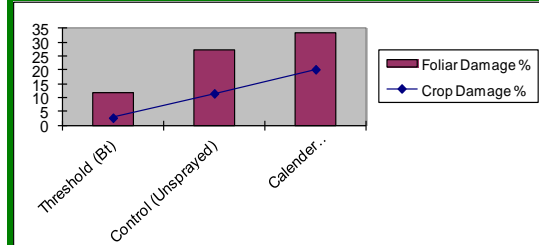
	Carabids			Spiders		
	Threshold	Control	Calendar	Threshold	Control	Calendar
7/5/06	2.75	3	0.25	7.75	8.25	2.5
8/2/06	2.5	2.5	0.25	7.5	9.5	2.5
8/30/06	2.5	2.25	0.25	8.25	9.75	2.5
9/27/06	3	2.75	0.25	9	9.5	1.25



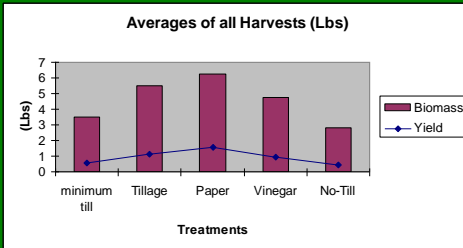
Bt sprayed (THRESHOLD) = lowest foliar and B. sprouts damage (11.7% & 2.7%) - 97% marketable. Bt sprayed 8 times.

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.

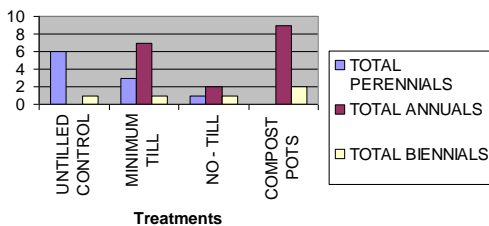


Monitored weed invasion. Results: Weeds came from manure-based compost and soil disturbance.



Increased tillage and compost = more annual weeds.

Numbers of Annual, Perennial, and Biennial Weeds per Treatment Sample

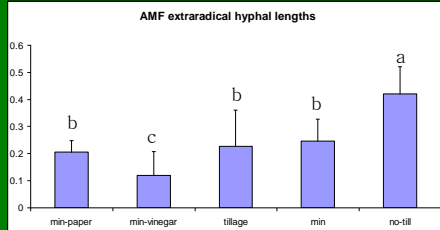


Change in Weed Species' Composition:

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

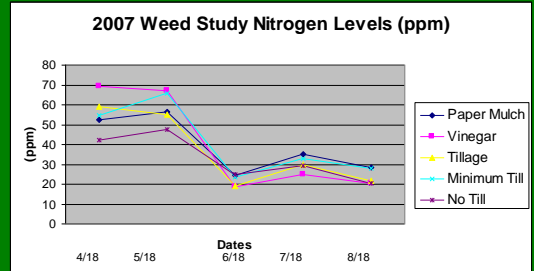


Mycorrhizae fungi (AMF) were highest in no-till plots and lower in all other treatments, indicating that any kind of soil disturbance, even minimum tillage and weed cultivation decreases population levels of these beneficial fungi, at least within a single growing season.



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 tilled 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.

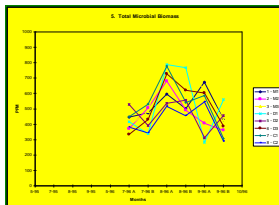
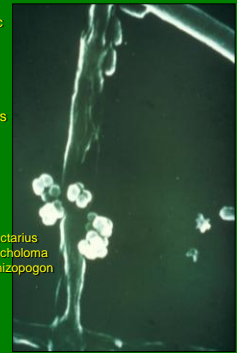


Lots of hand weeding necessary for seeded crops in LM system, i.e., lettuce

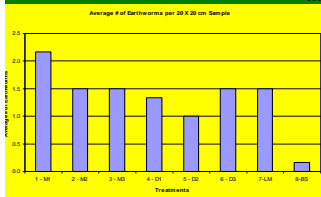


Improved **Habitat** for Beneficial Microbes???

- 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
 - Lactarius
 - Tricholoma
 - Rhizopogon
- Endomycorrhizal Fungi
 - Glomus
 - Endogone
 - Rhizophagus
 - Sclerocystis
 - Gigaspora



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



Disease Suppression??? CMV 2004



CMV normally causes stunted plants and decreased yield.



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



Future Directions.....

veganicpermaculture.com

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