Reduced Tillage in Organic Vegetable Production

Helen Atthowe

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http://www.extension.org/organic_production

Can we model a productive Organic vegetable production system on no-till natural systems?

Increase Plant Diversity?
Reduce Tillage?
Manage Complex Ecological Interrelationships?

WHY REDUCE TILLAGE?

Reduced tillage increases soil microbes & soil-microbe-plant-insect interrelationships

1986 NJ:
200 acres Organic Vegetable and fruit production:
Mulch creates habitat for beneficial insects & reduces exposed bare soil.

1989 NJ:
25 acres organic vegetable production - Living Mulch

weeds between crop rows

1980 - 1983 Georgia
189 acres grain successions, vegetables & fruits.

Soil covered year round.
Biodesign Farm 1992 - 2010:
30 acres
Organic vegetables and fruit

**Legume Living Mulches**
Parabinga medic

**Living Mulch Reduced Tillage:**
*Soil covered most of the year*

**LIGHT TILLAGE IN SPRING (late May):**
*LOTS OF RESIDUE LEFT*

Reseed living mulch each spring.
Alsike clover recruits from previous year still present.

Leave “islands” or strips of no-till areas

*Soil covered by early June*

White Clover
1995–1996 Living Mulch Experiment:
How to manage lots of plant residue?
Compared mowing and light tillage at different times (fall, summer, or spring) to monthly tillage between crop rows.

Tillage decreased SOM, earthworms and Total Microbes. All increased with regular additions of fresh, organic residue – Clover mowed monthly.

1995 – 2004 farmed with living mulch reduced tillage system, tweaking eco-system design pieces.

Yellow sweet clover "island" planted previous year blooming in mid June

Results: IMPROVED YIELD AND QUALITY

IMPROVED COLD TOLERANCE

HABITAT FOR BENEFICIALS
And wind protection in the spring!
INCREASED PREDATOR AND PARASITE ACTIVITY

Wasp Parasitized Aphid

INCREASED PREDATOR AND PARASITE ACTIVITY

Butterfly count July 19, 2004: Cabbage Whites = 147, but little damage. And no Bt sprayed.

Winter-dormant LM = habitat for over wintering spiders and ground beetles

Habitat for New Predators: birds

Habitat for pollinators = increased fruit set

More habitat = new predators, such as predaceous stink bugs preying on potato beetle larva.
LM plus broccoli residue = habitat for insects, birds, and voles & garter snakes

Improved Habitat for Beneficial Microbes
- Antagonistic/Competitive Mycoparasitic Fungi
  - Trichoderma
  - Gliocladium
  - Pythium
  - Penicillium
  - Aspergillus
- Antagonistic/Competitive Actinomycetes
  - Streptomycetes
- Antagonistic/Competitive Bacteria
  - Bacillus
  - Clostridium
  - Pseudomonas

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Disease Suppression? CMV 2004
CMV normally causes stunted plants and decreased yield.

Long-term soil health improved with Living Mulch system

Cover Crop Biomass or Regular Additions of “Quality” Residue?

MONTHLY AVERAGE
Nutrient Content of Living Mulch

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Cover Crop Biomass or Regular Additions of “Quality” Residue?
2004 -
Can we move towards more:
plant diversity?
complex interrelationships?
reduced tillage?

New 6 Ac. Field – Pasture for 50 yrs.

Minimum Tillage April 2005 –
Significant decrease in SOM after 2 weeks; Significant increase in Nitrate.

St Dev (T/U) 0.3064

Organic Matter in Tilled and Untilled Soil

Untilled Average 3.83%
Tilled Average 3.4%

Tillage causes release of available Nitrate-N from SOM and organic residue.

3 – Pass Seeding May 2005
(Eric Brennan USDA, Salinas, CA)

Untilled       33.33
Average
Tilled          61.33
Average
St Dev. 19.79899

Nitrate in Tilled and Untilled Soils

Red Clover – Triticale Cover Crop – August 2005

Red Clover dominant in October 2005
Soil covered in winter to avoid frost heave & provide habitat for soil microbes and predators. Soil covered all year round? How much can we reduce tillage?

Soil covered all year round? How much can we reduce tillage?

Tilling, bed making and planting plastic-mulched minimum-till beds to warm soils.

UNDISTURBED CLOVER IN ROW MIDDLES LATE MAY and JUNE

No-till Experiment - flaming

Spring 2006 rototilled on 4/19/06

Compost in row strips on 4/10.

Chisel plowed on 4/14/06

No-till Brussels sprouts: 36% yield reduction.

There are better choices than red clover! Annuals that winter kill.....
Good yield & quality in minimum tillage beds

SOIL DATA – SOM. Highest in untiled and No-till plots. The difference between treatments was significant (P=0.01) only on 4/05 and 8/06.

SOIL DATA – NITRATE. Highest in clover minimum-till.

N is released quickly by minimal tillage of clover. N not avail. in no-till until early July. N low in untiled grass & clover & mowed clover but lowest in grass. N lower in mowed vs. unmowed clover

SOIL DATA – NITRATE. Highest in clover minimum-till.

Average Nitrogen ppm

Treatments differences were significant (P<0.01) at all dates except 4/05 and 4/06.

NO-TILL BRUSSELS SPROUTS YIELD DOWN 36%.

Probably due to lower soil temperatures and slow release of N compared to minimum-till broccoli/cabbage plots.

Average Organic Matter

SOM added by tilling in clover, but highest SOM in flamed, no-till.

Average Number Per Plot

Earlier and increased numbers of predators and parasites and….

more diversity of species. Stopped spraying in 2000.
WEED STUDY 2007 – compared different types of in-row weed management. Yield lowest in no-till.

Monitored weed invasion.
Results:
Weeds came from compost source and soil disturbance.

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.

SUMMARY
Slightly lower yield, excellent quality, reduced labor, increased profitability (No off-farm fertilizer, no spraying, little weeding).

Challenges:
Grasses moving into LM Vole & Bird damage Seeeded crops

Biodesign April 2011

Reduced Tillage Possible on a Larger Scale?
Experiments in CO on a 2000 acre organic vegetable farm with a 5000 member CSA in 2011– potato & spinach interplanting
Future Directions......

veganpermaculture.com

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