

Comparing tillage and mulching for organic orchard performance



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Introduction

Weed control and nitrogen nutrition remain two major challenges for the rapidly expanding organic tree fruit sector in the state. Tillage has been the most common weed control practice, often with significant financial cost, and with potential soil quality degradation that conflicts with the National Organic Standards. We compared novel tillage, mulch, and cover crop techniques in two trials to examine their economic and environmental trade-offs. The first trial compared two tillage implements, tillage frequency, a wood chip mulch, and a mowed control in an established orchard. Because weed control is crucial for young tree establishment, a second trial tested the tillage and wood chip techniques, along with a "living mulch" cover crop with legume and nonlegume species, in a newly planted orchard.

Methods

Trial 1. This trial was initiated in April 2004 in an 8-yr old block of Gala/M26. Treatments included wood chip mulch (applied 6" thick, Figure 1), two cultivation implements (Wonder Weeder® and Weed Badger®), three tillage frequencies using the Wonder Weeder (Figure 2), and a mowed weed control. In Yr 3, tillage was simplified to 2 passes, as greater frequency did not significantly reduce weeds.

Trial 2. A new Piñata/M7 block was planted in April 2005 with two tillage techniques: clean cultivation (using Wonder Weeder) and Sandwich system (tillage on each side of the tree line with living mulch in the tree row, Figure 4). Living Mulch (LM) cover crops were planted in the entire 150-cm weed strip; Sandwich cover crops were planted in the 45-cm tree row only (Figure 4, Table 1). Tillage treatment plots (WW and SW) received four passes each season, and wood chips were applied yearly to a 6" depth. Two controls included a fertilized, undisturbed, weed-free treatment (CTL); and an unfertilized, undisturbed, weed-free treatment (CTL0), using manual weed control and organic herbicides. All treatments received the same rate of chicken compost each year (except CTL0). Vole presence was measured by a grid intersect method, but voles were not controlled in the trial.



Figure 1. Trial 1 wood chip mulch.



Figure 2. Trial 1 Wonder Weeder tillage.

Table 1. Trial 2 treatments.

Code	Treatment	Cover
CTL0	Unfertilized control	Undisturbed bare ground
CTL	Control	Undisturbed bare ground
SWL	Sandwich system tillage - legumes in tree row	Tree row with trefoil + bentgrass, sides tilled
SWNL	Sandwich system tillage - nonlegumes in tree row	Tree row with <i>Galium</i> (sweet woodruff), sides tilled
WC	Wood chip mulch	Wood chip mulch
LML	Living mulch legume in entire weed strip	Trefoil + bentgrass
LMNL	Living mulch nonlegume in entire weed strip	Bentgrass, thyme, alyssum (Yr1)
WW	Clean cultivated	Tilled - bare ground

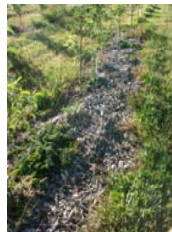


Figure 3. Trial 2 wood chips and weed encroachment.



Figure 4. Trial 2 Sandwich tillage with *Galium* planted in tree row.



Figure 5. Trial 2 tillage with leaning trees.

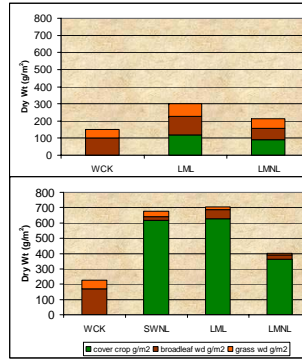


Figure 6. Trial 2 biomass Yrs 1 and 2. WCK=Weedy check.

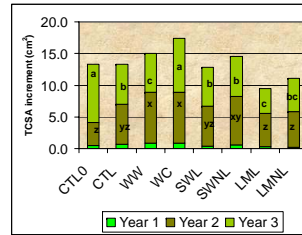


Figure 7. Trial 2 trunk growth. Letters a-c refer to Yr 3; x-z refer to Yr 2 data.

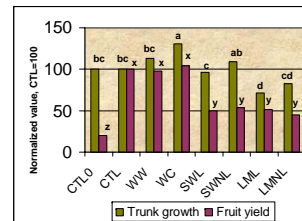


Figure 8. Trial 2 fruit yield and TCSA (normalized). Letters a-c refer to trunk growth, x-z to fruit yield.



Figure 9. *Thymus vulgaris* planted alone.

Results

Trial 1:

- Each tillage pass controlled existing weeds, but stimulated a flush of new weeds.
- Based on weed biomass data, living mulch reduced weed emergence over the 3-yr trial.
- Wonder Weeder speed 440 ft/min; Weed Badger 20 ft/min. Weed control was similar.
- Wood chip mulch provided excellent weed control, improved tree performance, and increased fruit value over the cost of mulch application (Table 2).
- One wood chip application lasted 3 years, and cost about \$900 per acre to apply.

Table 2. Trial 1 yield results.

	2005				2006			
	Fruit yield (kg/tree)	Fruit Size 80-88 (%)	Gross Fruit Value (\$/ac)	Fruit Yield (kg/tree)	Fruit Size 80-88 (%)	Gross Fruit Value (kg/tree)	TCSA increase (cm³)	Canopy Vol. (cu.ft.)
Wood chips	22.4	15.5 a	14,354	14.7	39.0	11,032	3.7 a	1531 a
Mowed Control	20.4	6.6 b	12,003	14.3	33.5	9,748	3.0 b	1286 ab
Wonder Weeder	17.6	7.0 b	9,556	13.3	22.0	10,162	2.3 c	1059 b
	p=	0.150	0.014	0.805	0.076	0.001	0.008	

Trial 2:

- Wood chip mulch did not provide acceptable weed control; increased tree growth and yield (Figure 8).
- Living mulch provided excellent weed control (Figures 6 & 10), but competed with trees.
- Trees with living mulch grew satisfactorily in Yrs 2 and 3, though less than other treatments; and had lower fruit yield in Yr 3 (Figure 8).
- Sandwich system tree growth similar to control; fruit yield similar to living mulch treatment (Figure 9).
- Birdsfoot trefoil (in LML, Figure 11) contributed 60 lb N/ac when grown alone.
- High vole presence in Yrs 1-2, but voles were nearly absent by Yr 3 due to natural decline. Living mulch had greater vole presence, except *Galium* (SWNL, Figures 4 & 10).

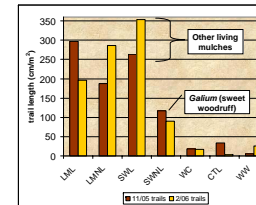


Figure 10. Trial 2 vole presence, years 1-2.



Figure 11. Harvesting LML biomass, trefoil.

Conclusions

Tillage:

- No clear effect on soil quality in Trial 1; Trial 2 tillage may have pruned roots.
- Wonder Weeder is faster, but shear bar on tool cannot be used on young trees.
- Sandwich system provided less competition with trees than full living mulch, with less tree leaning than full tillage.

Wood Chips:

- More effective and longer-lasting weed control in established orchard than in new trees.
- Improved tree performance in both trials.

Living Mulch:

- Clearly suppressed weeds, but competed with trees.
- Galium* was found to be less attractive to voles.
- Techniques to suppress competition still needed (e.g. organic herbicides, mowing).

Understory management had a major influence on tree growth, illustrating the trade-offs between tree performance and soil quality improvement. While wood chip mulch enhances tree growth, and living mulch enhances weed control, no treatment yet provides the optimum in tree performance, weed control, soil quality, and nutrient management.

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