

## **Progress Report: Organic Cropping Research for the Northwest**

**TITLE:** Integrated Multiple Mulch Trial

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**DATE** (period which report covers): Apr. 2005- Apr. 2006 (Initial Year)

**KEYWORDS:** mulch, living mulch, cover crop, legumes, sandwich system, mechanical weed control, apple, first year orchard, meadow vole, clove oil herbicide, Brassica meal herbicide

### **ABSTRACT:**

Weed control and fertility management have been identified as priority research needs by Washington organic orchardists, especially techniques for the establishment years. Mechanical weed control has been the standard practice, often with high cost and potential degradation of soil quality. Cultivation yields better tree growth during the first years of growth, but clean tillage has been shown to leach significant amounts of NO<sub>3</sub> into the water table (Wiedenfeld 1999). Mulches have been shown to control weeds and improve tree growth and yield (Neilsen et al. 2003). Living mulches show promise for weed control, soil quality, and fertility benefits, but can compete with trees and increase rodent populations. Balancing nutrient management, rodent and weed control while maintaining soil quality is a complex undertaking for organic apple growers. This trial investigates the following treatments in the first two years of orchard establishment: clean tillage, Swiss "Sandwich" system tillage planted with a legume or nonlegume mix in the tree line, living mulch cover crops with a legume or nonlegume mix in the entire weed strip, a Brassica meal treatment, an undisturbed bare ground control, and a wood chip mulch. A "Wonder Weeder" cultivator has been found to provide low cost weed control (Granatstein 2004), so this was used for the clean-tilled and Sandwich system treatment. The Swiss Sandwich system treatment is tilled on both sides of the tree line with a living mulch planting in the tree line. Weed control was measured using biomass and percent cover of all treatments, and various other soil quality and rodent measures were assessed. Wood chips did not control weeds well in this trial, and the chips may have brought in new weed species. Clean-tilled and wood chip treatments were significantly greater in tree TCSA, suggesting the living mulch treatments severely competed with the trees for nutrients. In general, all treatments yielded poor tree growth, possibly due to replant disease or substandard tree quality. Since meadow vole (*Microtus pennsylvanicus*) damage to young trees is a concern in organic orchard systems, vole usage was measured in fall 2005 and winter 2006, and more vole usage was observed with the living mulch legume treatment relative to the other treatments. An organic herbicide with clove oil did control broadleaf weeds, but was not as effective on grass weeds. An additional treatment using Brassica meal as an herbicide was initially promising, but did not result

in significantly reduced weeds by peak season. A higher rate of Brassica meal will be tested in year 2, as well as a new formulation of clove oil herbicide.

**OBJECTIVES:**

1. Evaluate the effectiveness of various weed management strategies for organic orchards during the first two years of tree establishment.
2. Evaluate 'living mulch' species for their establishment, vigor, rodent usage, and competitiveness with weeds.

**PROCEDURES:**

A new Pinata/M7 block was planted in April 2005 with the following understory treatments: bare ground control, bare ground with Brassica meal, wood chip mulch, cultivation (using Wonder Weeder), Sandwich system (tillage each side of the tree line and a 45 cm strip of living mulch in the tree line, see Photo 1), and a Living Mulch (LM) treatment filling the 150 cm wide tree row. Both LM and Sandwich legume treatments are a species mix of Mt. Barker subclover (*Trifolium subulata*), black medic (*Medicago lupulina*), burr medic (*Medicago polymorpha*), birdsfoot trefoil (*Lotus corniculatus*), and bentgrass (*Agrostis tenuis*). The Sandwich non-legume treatment is transplanted sweet woodruff (*Galium odoratum*) and Corsican mint (*Mentha requiennii*), while the living mulch non-legume mix contains sweet alyssum (*Lobularia maritima*), five spot (*Nemophila maculata*), mother of thyme (*Thymus serpyllum*) and bentgrass. Pelleted chicken manure was broadcast and incorporated in the tree row at a 1x rate of 93 lb N/ac. Tilled plots and LM non-legume plots have 0.5x, 1x, and 1.5x treatments, and wood chip and LM legume plots have 1x and 1.5x treatments. An unfertilized bare ground control (0x) was maintained to provide a baseline for the nutrient analysis. Trees were supplemented with foliar sprays (2.4 lb N/ac), but because of poor growth, an organically-approved liquid fertilizer was injected around the base of each tree in August (32 lb N/ac). Experimental design is a Randomized Complete Block with 5 replicates. Measurements included living mulch and weed biomass, % mulch cover, % weed cover, emergence count, tree TCSA increase, leaf SPAD, and soil measures of moisture, resistance, nutrients, and microfaunal communities. Vole sign was subsampled using a grid of 36 intersection points three times in each plot; number of intersections that coincided with a vole runway, hole, or other sign was counted, and length of all runways were measured for each grid area (Hansson 1979). Pocket gopher (*Thomomys talpoides*) traps were used throughout the spring and summer to protect the young trees (Sullivan 2001).

**PROGRESS TOWARDS OBJECTIVES:**

**Weed Control and Vole Usage.** All cover crop species established well and showed minimal weed pressure in the early season. Warm season annual weeds infested the site by mid July, severely competing with both cover crops and trees (Table 1). Both the legume and non-legume cover crop mixes did provide some early season weed suppression, but also competed with the trees. Overall, we observed the trend that higher fertility rates produce more weeds. Weeds come in from surrounding seed sources, and we found that the replicate closest to a neighboring orchard had significantly more grass weeds. Also, the wood chip mulch brought in some weeds from the source of the wood

chips, and these were difficult to control. There were no significant differences in stand biomass for all the LM species mixes (Figure 1). As warm season weeds came on, the living mulches may have differed in weed suppression, but this was not well described by such an early season measure. However, a later season biomass measure was complicated by weed seed management activities, but will be collected in year 2. The most vigorous LM legume species in this trial included birdsfoot trefoil, Afghan black medic, and Mt. Barker subclover. The living mulch legume cover crop mix tended to have more broadleaf and grass weeds than the nonlegume mix, but the differences were not significant (Figure 1). There was an effect of Brassica meal in reducing weed % cover (Figure 2). These data also show an increase in weeds with increasing applied fertility. An earlier and shorter mowing of the cover crops may enhance their competitiveness with the weeds. We anticipate a reduction in annual weed pressure in year 2 with cover crop equilibration, and lack of initial tillage disturbance. Vole sign was abundant in the trial, despite a late season short mowing to reduce habitat. Overall, our data suggests a cover crop effect, in that voles preferentially used the legume mixes significantly more than nonlegume treatments (Table 2) and avoided the cultivated treatment. However, relatively little damage to trees was observed in late winter 2006. Vole usage was higher adjacent to a mature block of Fuji trees that provided greater cover or habitat. Physical protection provided by the cover, rather than species composition of the cover crop, seems to be more important to voles in winter. In winter 2006, Sandwich legume and living mulch nonlegume treatments had similar vole usage measures (Table 2).

**Tree Growth.** Total per cent cover of understory vegetation showed a negative relationship with tree growth ( $R^2=0.84$ , Figure 4), suggesting the cover crops adversely affected trees in their first year. The clean-tilled treatment (WW) had better tree growth and higher SPAD readings than the cover crop (LM and Sandwich) treatments. SPAD readings in living mulch treatments in both late August and September were below that of the control. Fertility level had no effect on TCASA measures in the first year of growth, which could suggest that our levels of fertilizer may have been inadequate, or affected by the high irrigation needed to establish seeded cover crops. Supplemental fertilizer by injection in late August stimulated cover crop growth, but also weed growth, usurping nitrogen from the trees in the living mulch and Sandwich treatments (see Photo 3). In the non-cover crop treatments, however, the trees gained much new growth after this injection (Figure 3). While both legume and nonlegume cover crop led to less tree growth in terms of trunk cross sectional area, the Sandwich treatment was similar to the control. Thus, this treatment may be a compromise between adequate young tree growth with some of the additional soil benefits of cover crops (Figure 3, Table 3). Trees in the Sandwich plots are expected to improve next year when roots are able to move under the tilled area. In winter 2006, root lesion nematodes (*Pratylenchus pentrans*) were found to have infested root samples from trees in the trial, as well as various pathogenic fungi of genera *Pythium* and *Phytophthora*. A more extensive root sampling is planned in 2006 to determine if replant disease is affecting the trial.

**Soil Quality.** Wood chip mulch did not adequately control weeds in this trial, but did show the lowest soil penetration resistance of all treatments. At 15mm and 30 mm depth, soil resistance was significantly lower in the wood chip and LML plots than the control

and WW plots. Volumetric water content analyses showed that soil moisture was similar for all treatments regardless of cover or tillage.

Tests for soil nutrients and microbial status will be conducted in early 2006 by Lori Hoagland.

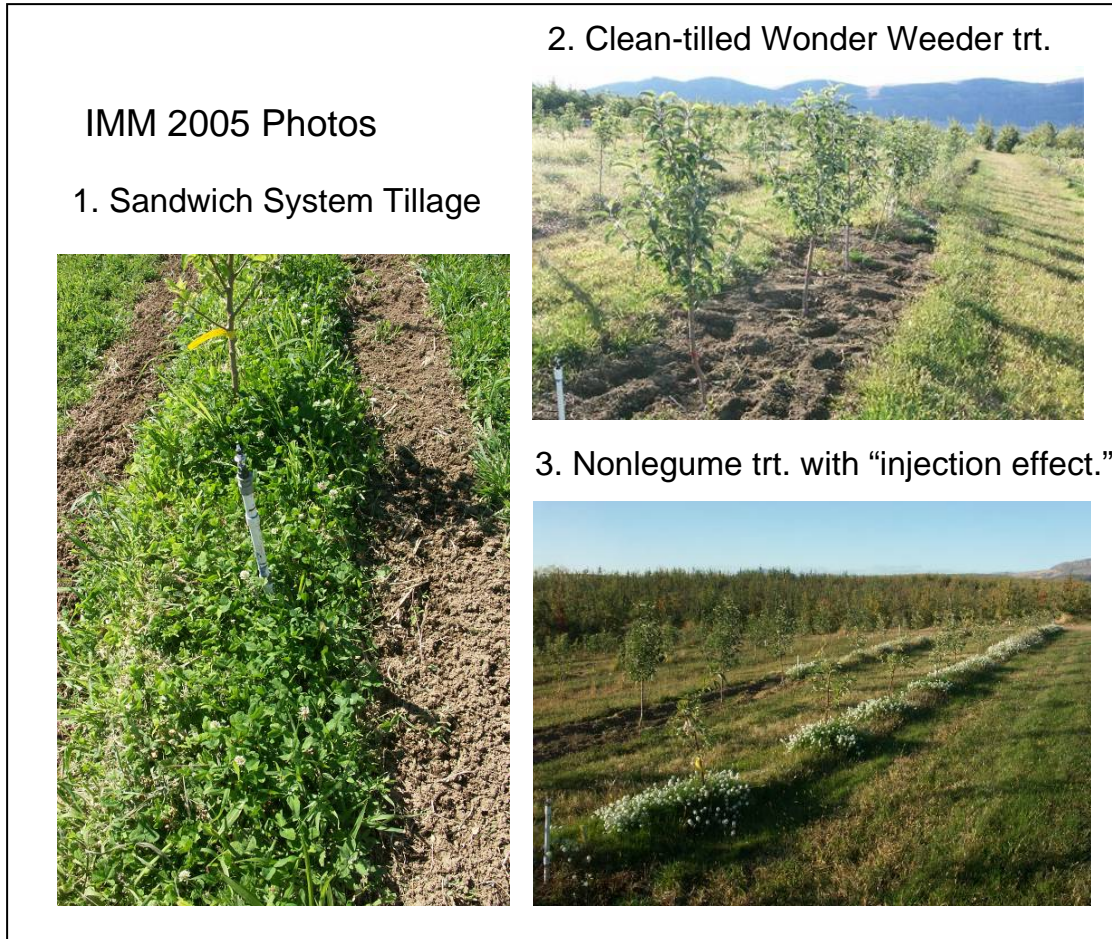


Table 1. Predominant Weed Species observed in IMM 2005

Common name	Latin	Life Cycle
<b>Broadleaf Weeds</b>		
Common Lamsquarters	<i>Chenopodium album</i>	summer annual
Shepard's Purse	<i>Capsella bursa-pastoris</i>	annual or winter annual
Redroot Pigweed	<i>Amaranthus retroflexus</i>	annual
Dandelion	<i>Taraxcum officinale</i>	Perennial
Ladysthumb	<i>Polygonum persicaria</i>	annual
<b>Grass Weeds</b>		
Large crabgrass	<i>Digitaria sanguinalis</i>	summer annual
barnyardgrass	<i>Echinochloa crusgalli</i>	summer annual
green foxtail	<i>Setaria viridis</i>	summer annual

Figure 1. 2005 Weed and cover crop biomass. July 5 2005.

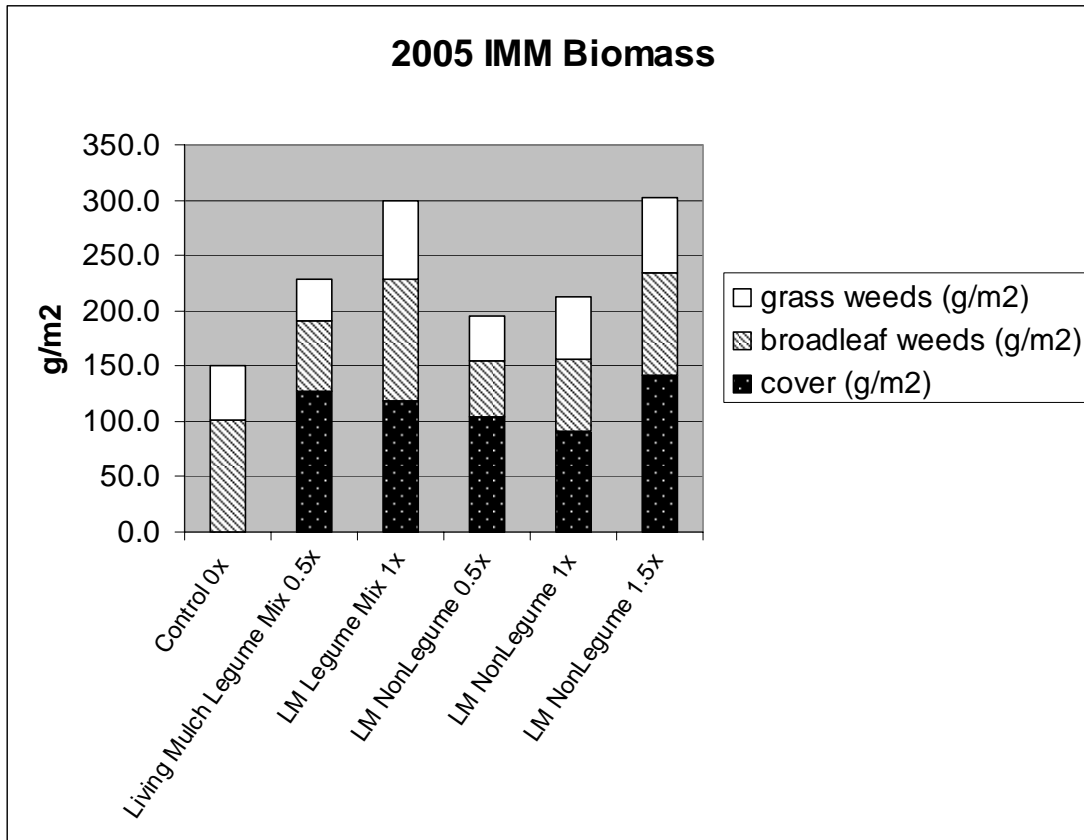


Figure 2. Percent cover data separated by weeds, cover crop, and bare ground. July 8 05.

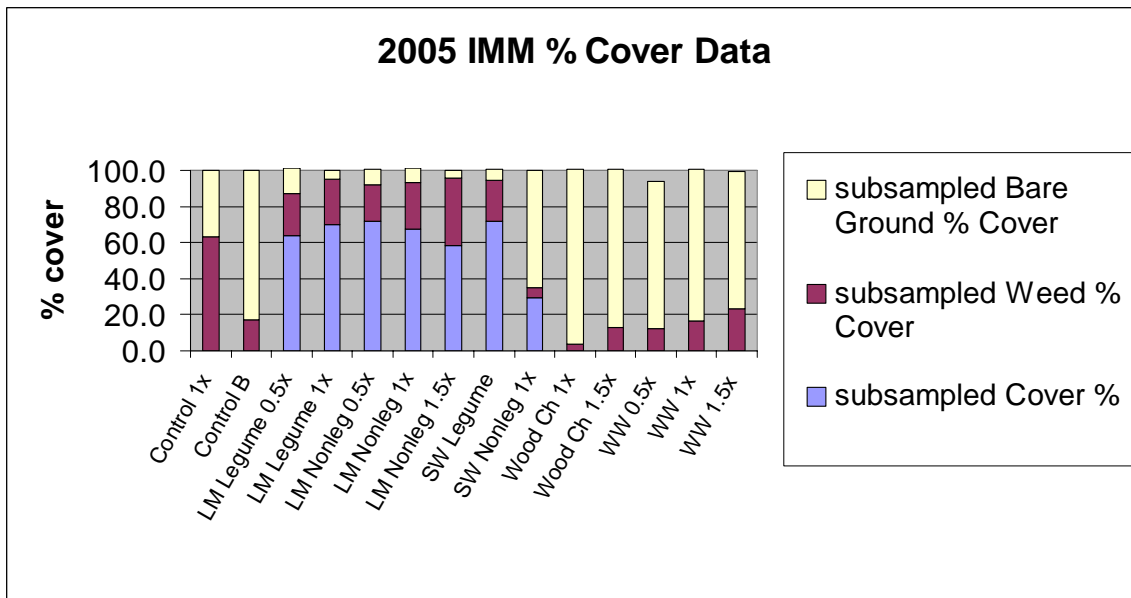


Figure 3. Correlation of Sept. 2005 leaf SPAD with new tree growth observations, IMM.

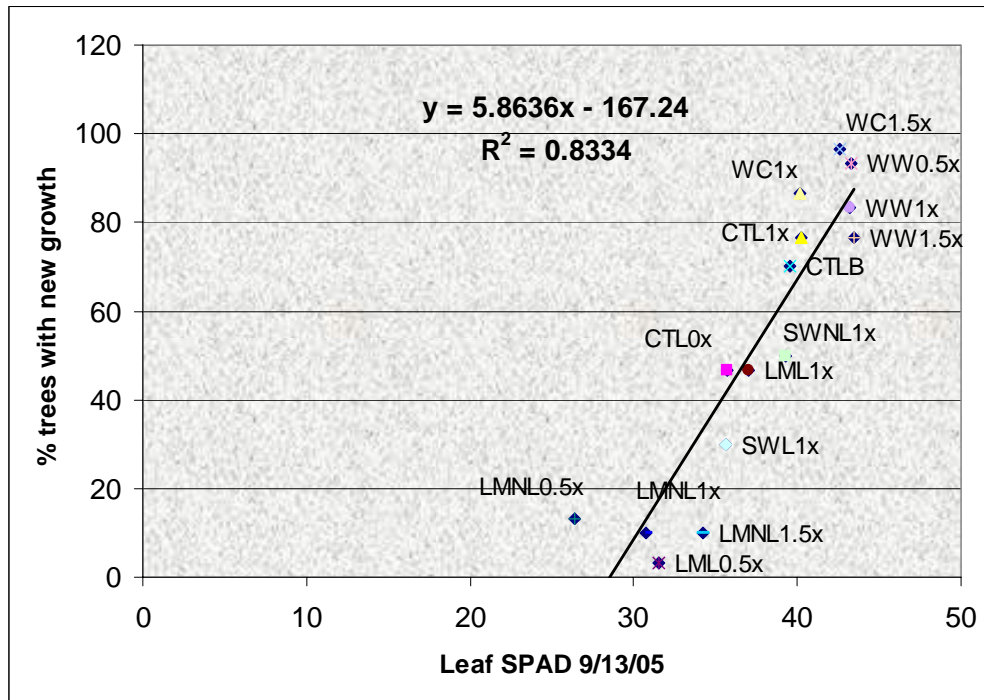


Figure 4. Correlation of tree TCSA growth increment ( $\text{cm}^2$ ) and total understory competition (total % cover of weeds and cover crop).

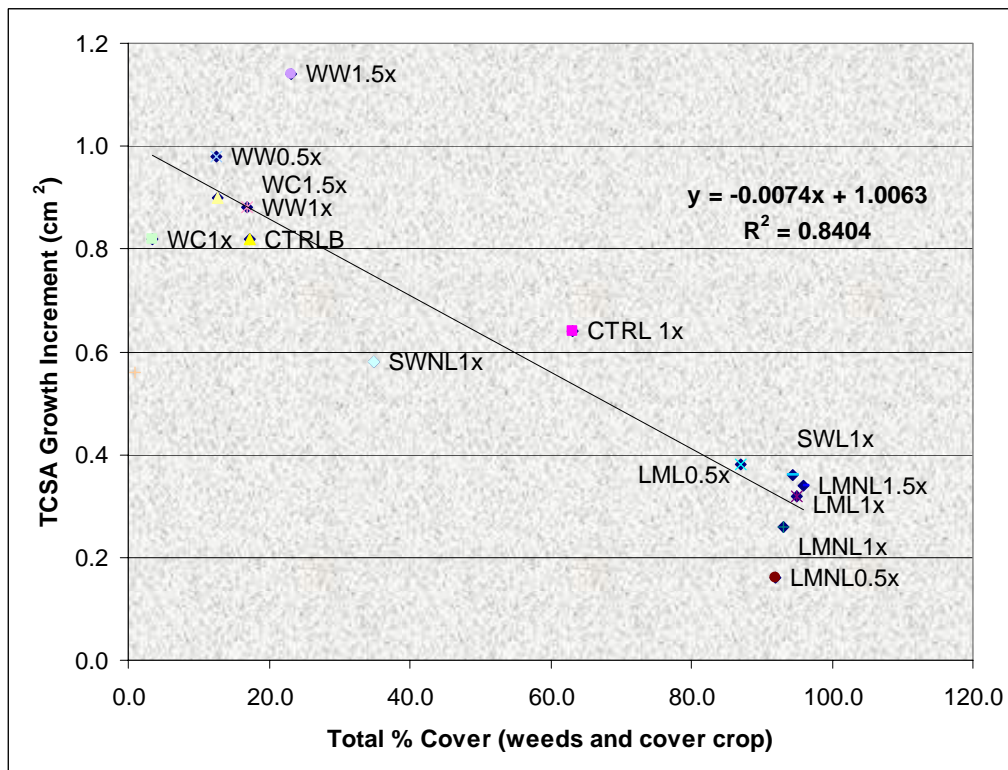


Table 2. 2005 Vole usage, years 1 & 2.

TRT	November 2005 Sampling			February 2006 sampling		
	Intersect Count	Count as % of total	Run Length (cm/m <sup>2</sup> )	Intersect Count	Count as % of total	Run length (cm/m <sup>2</sup> )
Sandwich Legume	11.7 a	32.6	354.0 a	11.3 a	31.3	264.0 ab
Living Mulch Nonleg.	10.0 ab	27.8	286.0 ab	9.5 a	26.3	188.0 c
Living Mulch Legume	7.9 b	22.0	196.7 b	11.7 a	32.6	297.3 a
Sandwich Nonlegume	3.1 c	8.7	90.0 c	2.8 b	7.8	117.3 c
Wonder Weeder	0.8 c	2.2	26.0 c	1.3 b	3.5	5.3 d
Wood Chip	0.5 c	1.5	17.3 c	1.5 b	4.3	18.7 d
Control	0.2 c	0.6	4.0 c	1.7 b	4.6	33.3 d
	<b>p= &lt;0.0001</b>		<b>&lt;0.0001</b>	<b>&lt; 0.0001</b>		<b>0.0179</b>

Table 3. 2005 TCSA growth increment, % increase and tree leaf SPAD.

TRT	TCSA growth increment (cm <sup>2</sup> )	TCSA % increase	Leaf SPAD 08/02/2005	Leaf SPAD 08/24/2005	Leaf SPAD 09/13/2005
Wonder Weeder 1.5	1.1 a	35.9	34.5 ab	40.3 a	43.5 a
Wonder Weeder 0.5	1.0 ab	31.5	32.5 abcd	40.3 a	43.3 a
Wood Chip 1.5	0.9 abc	27.6	33.7 abc	39.3 a	42.6 a
Wonder Weeder 1	0.9 abc	28.1	35.4 a	39.7 a	43.2 a
Wood Chip 1	0.8 bdc	28.1	31.4 abcde	35.9 abc	40.2 ab
Brassica	0.8 bdc	24.8	34.0 abc	36.7 ab	39.6 ab
Control 1*	0.6 cde	20.2	32.0 abcde	36.4 ab	40.3 ab
Sandwich NonLeg 1	0.6 def	19.7	33.3 abc	36.4 ab	39.3 abc
Control 0*	0.6 efg	18.0	29.9 bcde	33.1 bcd	35.7 bcd
Living Mulch Leg. 0.5	0.4 efg	10.9	27.1 de	27.0 e	31.5 de
Sandwich Leg 1	0.4 efg	10.9	29.7 cde	30.7 ed	35.6 bcd
Living Mulch NonLeg 1.5	0.3 fg	10.8	30.0 bcde	31.2 cde	34.2 cd
Living Mulch Legume 1	0.3 fg	10.6	30.6 bcde	33.8 bcd	37.0 bc
Living Mulch NonLeg 1	0.3 g	7.3	30.6 bcde	27.9 e	30.7 de
Living Mulch NonLeg 0.5	0.2 g	4.7	27.9 de	26.2 e	26.4 e
	<b>p= &lt;0.0001</b>		<b>0.0100</b>	<b>&lt;0.0001</b>	<b>0.0045</b>

\* A non-weeded control yielded an average TCSA growth increment of 0.6cm<sup>2</sup>, and 14.7 % inc.

**REFERENCES:**

Granatstein, David G., E. Kirby, et al. 2004. Evaluating the Effectiveness of Weed Control Strategies for Organic Orchards in Central Washington. <http://organic.tfrec.wsu.edu/OrganicIFP/OrchardFloorManagement/WeedControlReport04.pdf>

Hansson, Lennart. 1979. Field signs as indicators of vole abundance. *Journal of Applied Ecology* 16: 339-347.

Neilsen, G.H., E.J. Hogue, et al. 2003. Mulches and biosolids affect vigor, yield, and leaf nutrition of fertigated high density apple. *HortScience* 38:41-45.

Sullivan, Thomas P., D. S. Sullivan, E. J. Hogue. Reinvasion dynamics of northern pocket gopher (*Thomomys talpoides*) populations in removal areas. *Crop Protection* 20: 189-198.

Weidenfeld, Bob, L. B. Fenn, et al. 1999. Using sod to manage nitrogen in orchard floors. *Commun. Soil Sci. Plant Anal*, 30(3&4): 353-363.

**OUTPUTS:**

2005 - Progress Report: Understory Management in Organic Tree Fruits. Progress Report: Organic Cropping Research for the Northwest. David Granatstein, Kent Mullinix, Lerry Lacey, Elizabeth Kirby, Michel Brockington

**IMPACT:**

There have been 11 grower inquiries about the weed control and cover crops being tested.

**INSTITUTION:** Washington State University, Wenatchee Valley College, USDA-ARS,  
**STATE:** WA

**FUNDING SOURCE(S):** USDA CSREES special grant, Wenatchee Valley College Institute for Rural Innovation and Stewardship; Herbicide donated by G.S.Long Co. and EcoSmart Technologies; Seed or inoculant donated by Kamprath Seed Co., Nitragin Co., Big Sky Wholesale Seeds, USDA ARS Plant Germplasm

**FUNDING AMOUNT(S):** \$31,489 USDA, \$10,000 WVC.

ORGANIC RESEARCH LAND (indicate number of acres on all that apply):

Station	_____ non-organic	_____ transitional	_____ certified
On-farm	_____ non-organic	__2.5 transitional	_____ certified

FARMER COOPERATOR(S): Number\_1\_\_  
Name(s): Amos Kukes