Implementation of Strip Cultivation in Michigan Apple Orchards: *First Year Results*

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Introduction

Grower interest in alternatives to herbicide strips in perennial crops is increasing. The "Swiss Sandwich system" or strip cultivation, where growers cultivate within the drip line of trees is one such alternative. The potential advantages of this system include:

- Reduced herbicide application costs
- Reduced herbicide damage to crop plants
- Increased NPK availability within the tree rooting zone
- Increased soil organic matter within the tree rooting zone
- Increased habitat for beneficial insects and mites

Objectives:

- Demonstrate weed control efficacy using front mounted cultivation implements
- Determine impacts on soil nutrient levels, organic matter, tree growth (not presented), and beneficial arthropod communities
- Compare economic costs of floor management systems

Methods

Experiments were performed at 3 farm sites. Site one was near Flushing with mature trees where strip cultivation had been used for more than 5 years. Site two was outside of Pottersville with trees in their 5th leaf and ground cover management consisting of pre-emergent herbicide applications. Site three was near Sparta with trees in their 5th leaf and ground cover management consisting of repeated applications of Roundup® and 2,4d. Six rows, three of which were cultivated once a month and three of which received the grower's normal ground cover management practice, were selected at each sites. At site's one and three we used a Wonder Weeder® brand implement (Fig 1), while the implement at site two was fabricated by the grower (Fig 2). We measured: weed coverage, soil nutrition and organic matter, terminal growth measurements, and mite populations.

Freshly Cultivated Soil

Figure 1: Wonder Weeder® cultivation implement. Notice the flexible "shear bar" that works between trees. Implement is mounted using a front mount 3-point hitch with 3 cylinders allowing the operator to control both its height and pitch.

Figure 2: Grower built cultivation implement. This unit was fabricated from a salvaged Lilliston cultivator. Note that it lacks the "shear bar" present on the Wonder Weeder®. The 3-point hitch allows the operator to control both height and roll.

Weed Management

- Cultivation increased bare ground at the Flushing and Sparta sites but not at the Pottersville site (**Fig. 3**)
- Cultivation significantly decreased end of season dry weed biomass at Flushing but slightly increased dry weed biomass at Pottersville and Sparta (**Fig. 4**)

Figure 3: Percentage bare ground within drip line at the 3 sites

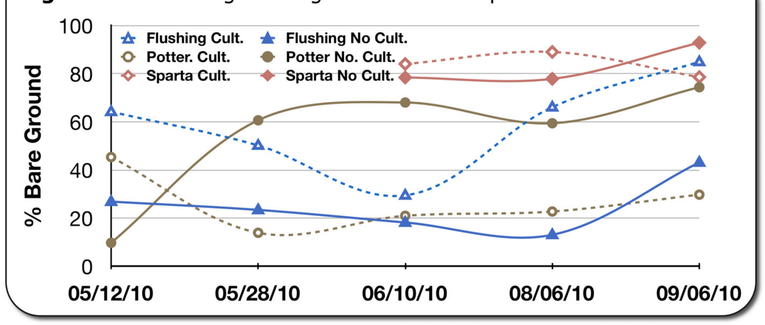
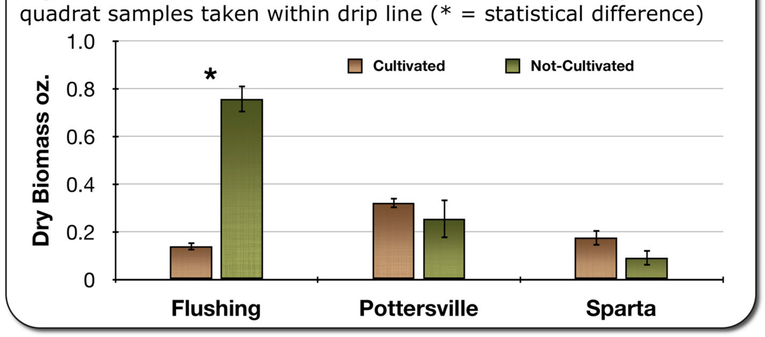


Figure 4: End of season mean dry weed biomass (±SEM) for quadrat samples taken within drip line (* = statistical difference)



Soil Ammonium and Organic Matter

- Cultivation significantly increased summer soil ammonium levels at two out (**Fig. 5**)
- Cultivation slightly increased end of season soil organic matter at all three sites (**Fig. 6**)

Figure 5: June soil ammonium (±SEM) (* = statistical difference)

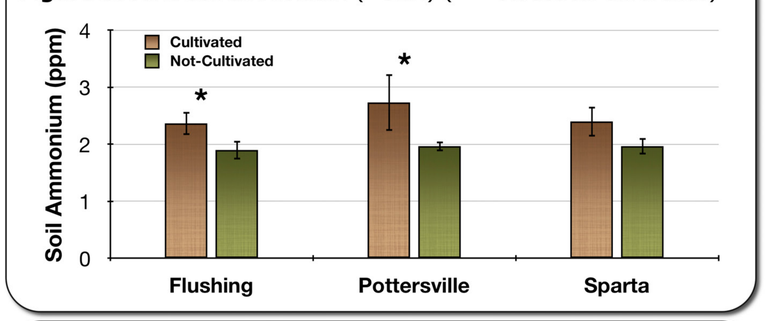
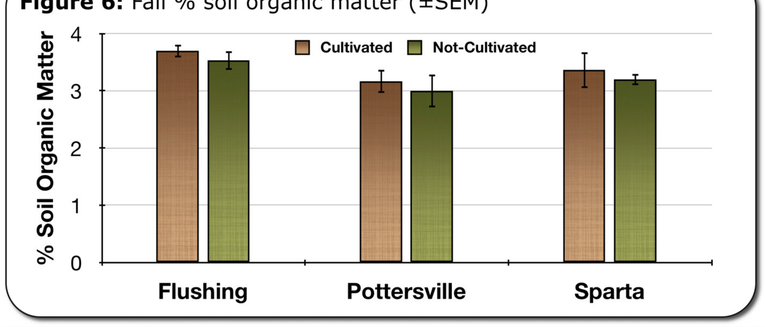


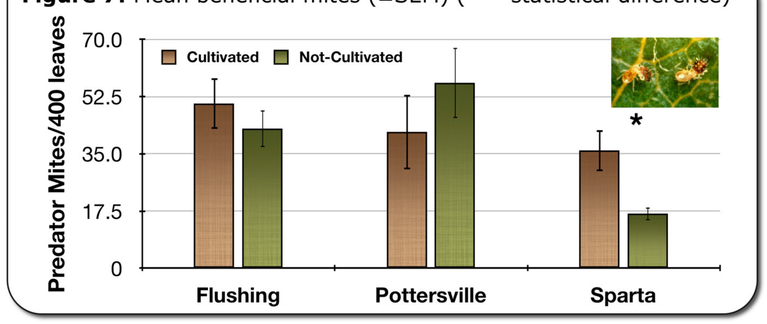
Figure 6: Fall % soil organic matter (±SEM)



Beneficial Mite Counts

- Cultivation significantly increased the number of beneficial mites at the sparta site and slightly increased them at the Flushing site (**Fig. 7**)
- Cultivation slightly decreased predatory mites at the Pottersville site

Figure 7: Mean beneficial mites (±SEM) (* = statistical difference)



Economics

- Cultivation using either of cultivation tools was considerably less expensive than projected herbicide application costs (**Table 1**).
- Savings over herbicide applications (assuming $50 per herbicide application) ranged from $58.26 per acre when a new Wonder Weeder® and 3 point hitch were purchased to $72.26 with the grower built implement. This translates to $5826 and $7226/100 acres/year.

Table 1: Estimated floor management costs based on 10 yr cost of ownership for a 100 acre orchard assuming: a 75 hp tractor, 10% yearly equipment maintenance and application rate of 0.26 acres/hour.

$$/Acre	Herbicide[1]	Wonder Weeder® + 3 Point[2]	Wonder Weeder®[3]	Grower Built Cultivator[4]
Tractor	$13.37	$13.37	$13.37	$13.37
Equipment	$2.50	$5.00	$3.25	$1.50
Herbicide	$50	NA	NA	NA
# Applications	2	4	4	4
Total	**$131.74**	**$73.48**	**$66.48**	**$59.48**
Savings	***NA***	***$58.26***	***$65.26***	***$72.26***

Equipment cost estimated at: [1]$2,500, [2]$10,000, [3]$6,500, and [4]$3000

Conclusions

- Cultivation had a definite impact on weed coverage and end of season dry biomass and did not result in as much bare ground as the two herbicide regimes. This was expected as the goal of strip cultivation is to set weeds back and maintain partial soil coverage.
- Numerical and significant increases in June soil ammonium and fall organic matter suggest that cultivation may help build soil and provide some "bonus" nitrogen to trees during a critical period of fruit growth and development. Increased organic matter leads to increased water holding capacity, increased nutrient cycling and improved plant health. However SOM changes slowly over time.
- Increased levels of beneficial mites in cultivated plots suggests that maintenance of some ground cover may provide biological control services for apple pests.
- The significant cost savings that may be expected with this system (over herbicide based programs) was the most exciting result, especially considering that costs might be further reduced for growers that integrate front mounted cultivation with rear mounted mowing or spraying operations. This would effectively halve tractor operation costs.