

Implementation of Strip Cultivation in Michigan Apple Orchards: An Organic Alternative to Herbicide Strips



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Introduction

In recent years, strip cultivation (the Swiss Sandwich System) has received attention as a primary weed management strategy in orchards.

Previous studies have shown that frequent cultivation can be detrimental to soil organic matter, structure, and nutrient content over the long term. However, most of these studies have been done using heavily disruptive, PTO-driven cultivation equipment. We are testing ground driven implements run at a shallow depth, allowing weeds to rebound more quickly and act as a potential cover crop.

Objectives:

- Demonstrate effectiveness of strip cultivation as a weed management strategy
- Assess effect of strip cultivation on soil organic matter and nutrients
- Assess effect of strip cultivation on pest insect populations and insect damage to crop
- Calculate monetary costs of using cultivation as ground management.

Methods

Experiments were performed at 2 farm sites. Site one was near Flushing, MI with mature trees where strip cultivation had been used for more than 5 years. Site two was outside of Pottersville, MI with mature trees and existing ground cover management consisting of pre- and post-emergent herbicide applications. At the Flushing site, we monitored 6 rows, 3 of which were cultivated once a month and three of which not. At the Pottersville site we established 6, 2 acre plots with half receiving cultivation and half receiving herbicide. We used a Wonder Weeder® brand implement (Fig 1), at both sites. The implement used at the flushing site had two additional gangs of tillers added and was used to flail mow the orchards while cultivating (Fig 2). We measured: weed coverage and biomass, soil nutrition and organic matter.



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: Modified WonderWeeder®. This unit was modified to till either side of the drive row. Note that the tractor is pulling a flail mower. This allows the grower to perform two operations—drive row mowing and strip cultivation—in one pass.



Weed Management

- Cultivation resulted in decreased weed coverage at Flushing (compared with no ground management) and **comparable weed coverage** at Pottersville (compared with herbicide application) (Fig. 3)
- Cultivation significantly decreased end of season dry weed biomass at at Pottersville (Fig. 4)

Figure 3: Percentage bare ground within drip line

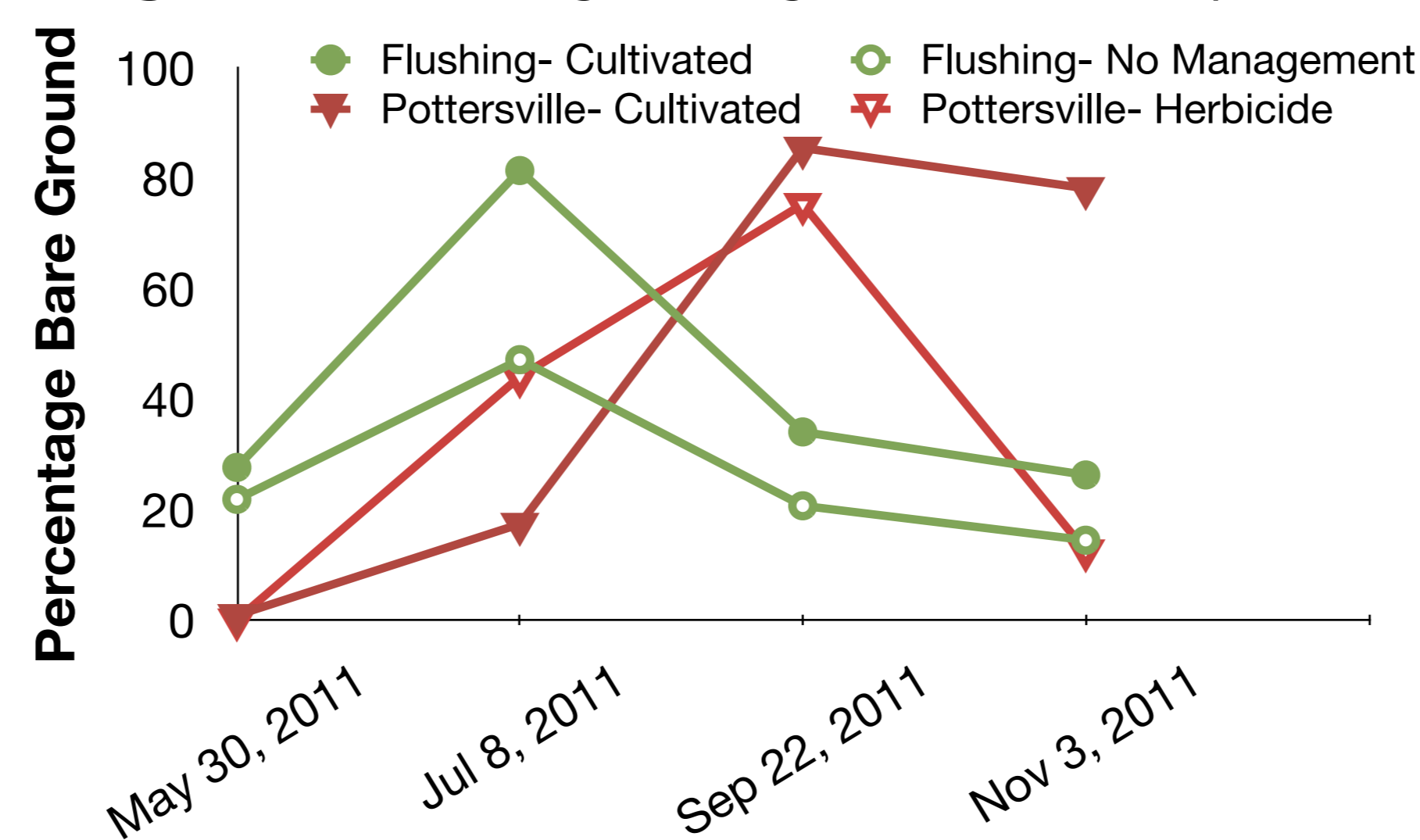
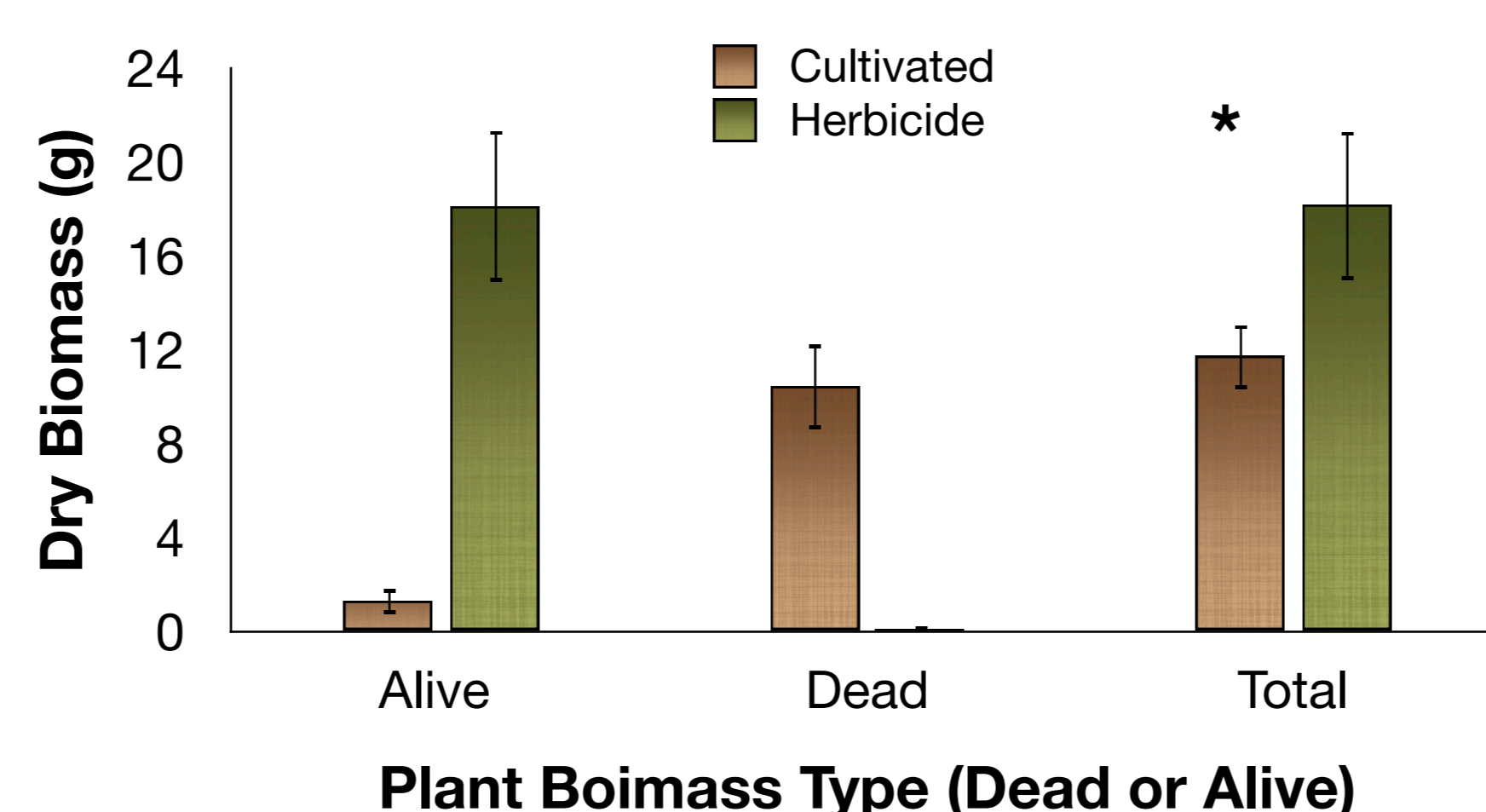


Figure 4: End of season mean dry live, dead, and total weed biomass (±SEM) for quadrat samples taken within drip line



Soil Nitrogen and Organic Matter

- Cultivation **significantly increased** summer soil nitrate and ammonium levels at the Pottersville site (Fig. 5)
- Cultivation did not affect soil organic matter at the Pottersville site (Fig. 6)

Figure 5: July soil nitrate and ammonium (±SEM)

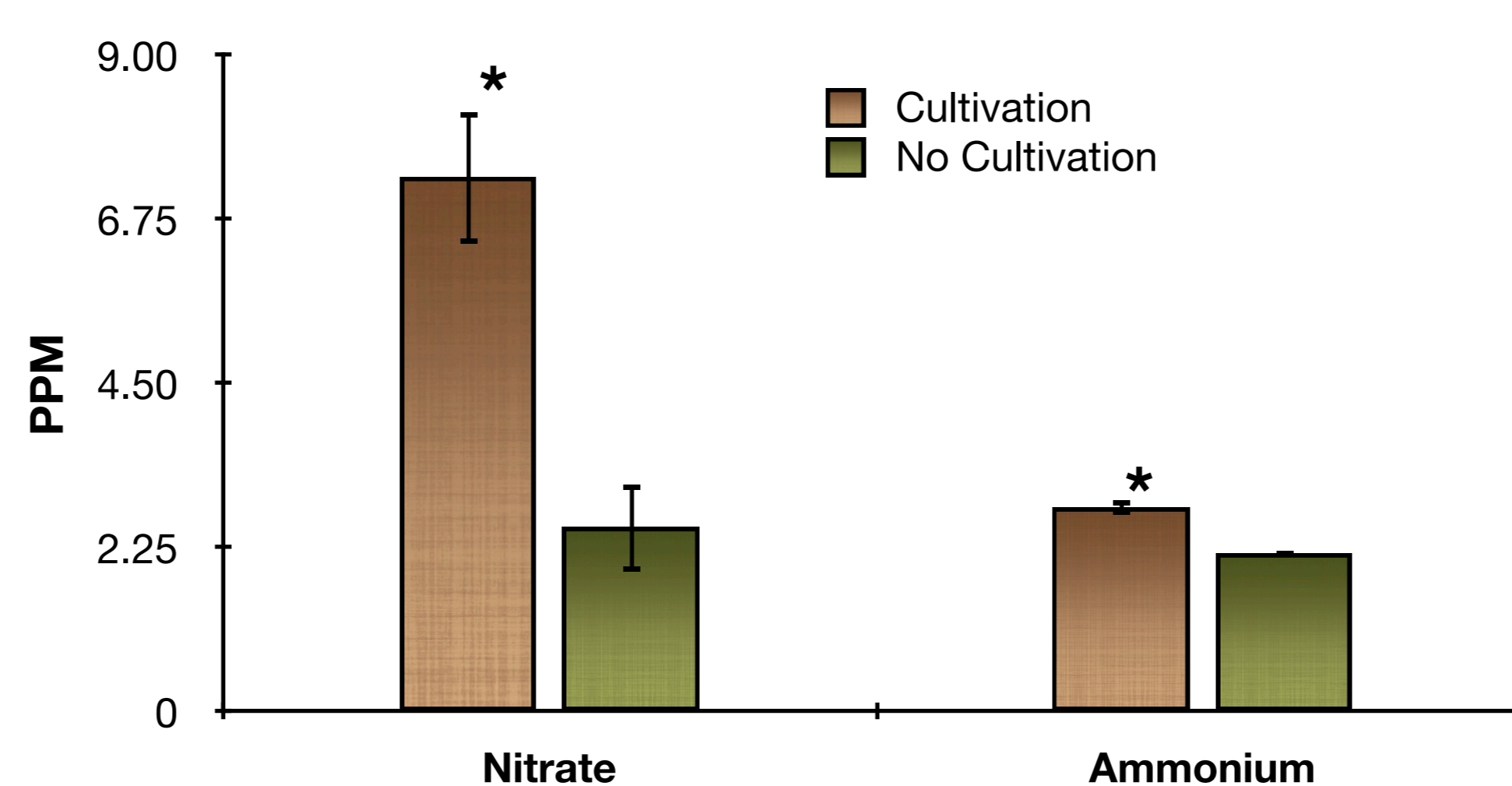
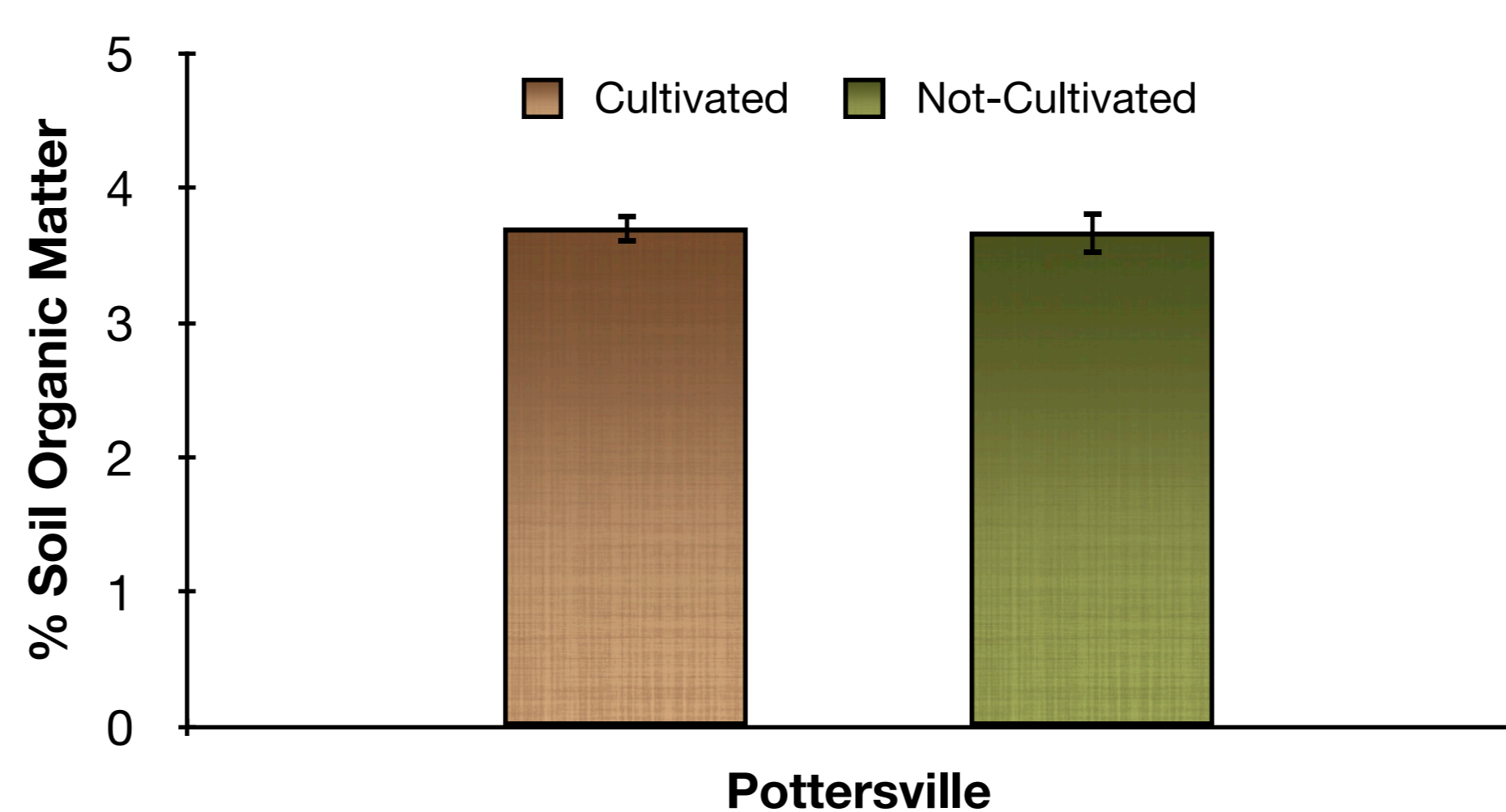


Figure 6: July % soil organic matter (±SEM)



Economics

- Cultivation was cheaper than herbicide application costs (Table 1).
- Savings (assuming \$50 per herbicide application) ranged from \$58.26 per acre for a Wonder Weeder® including 3 point hitch were purchased to \$71.63 when mowing and cultivating simultaneously. This translates to \$5826 and \$7163/100 acres/year.

Table 1: Estimated floor management costs per acre, 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® ²	Wonder Weeder® + Mower ²
Tractor	\$13.37	\$13.37	\$0.00
Equipment	\$2.50	\$5.00	\$5.00
Herbicide	\$50	\$0.00	\$0.00
# Applications	2	4	4
Total	\$131.74	\$73.48	\$60.11
Savings	NA	\$58.26	\$71.63

Equipment cost estimated at: ¹\$2,500, ²\$10,000

Conclusions

- Cultivation had a definite impact on weed coverage and end of season dry biomass. Cultivation actually outperformed herbicide in the latter measure.
- Significant increases in July soil ammonium and nitrate is consistent with our year one results showing that cultivation may provide some "bonus" nitrogen to trees during a critical period of fruit growth and development.
- Previous studies have shown decreases in organic matter from cultivation treatment. Ours shows no decrease in organic matter. We believe that's due to a difference in implements: that ground-driven cultivating implements, run at a shallow level in the soil, may not decrease organic matter at all. The key is achieving a balance between reducing competition and retaining ground cover.
- Impacts on codling moth and plum curculio were not clear but there may have been a slight reduction in PC adult damage.
- The significant cost savings that may be expected with this system (over herbicide based programs) was the most exciting result, the grower at the Flushing site took this one step farther by integrating cultivation into his mowing operation.

Next Steps

- Continued cultivation vs. herbicide trials at Pottersville site, assessing effectiveness of weed control, soil parameters, and insect damage.
- Expansion of the project into wine grapes: comparing cultivation to herbicide application at one vineyard, and cultivation to flame-weeding at another
- Direct trials testing the efficacy of cultivation for control of key insect pests including: Plum Curculio, Codling Moth, and Grape Berry Moth
- Exploration of additional cultivation equipment (*i.e.* grape hoe, hillside cultivator, and grower built implements)
- Field days at demonstration sites/cooperating farms to extend strip cultivation to additional perennial fruit growers