Mulching Systems for Weed Control, Water Conservation, and Nitrogen Management in Organic Apple Orchards

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Introduction

Non-chemical weed control that maintains soil quality is a priority need for organic orchardists in many regions. Mulching systems, including cover crops and living mulches, offer the potential for adequate weed control along with benefits for water conservation and soil fertility in Washington State and British Columbia irrigated orchards. Studies were conducted to determine the effects of various mulches and cover crops on weed control, tree growth and yield, and soil moisture.


Wood chip


Shredded paper


Chopped alfalfa hay


Mustard (fall)


Winter rye (spring)


White clover (fall)

Methods

Trial location: Wenatchee Valley College Orchard, E. Wenatchee, WA; 4-yr apple (*Malus domestica* Borkh.) 'Red Delicious'/M26.

Treatments:

A - control (bare ground) **B** – wood chip

C - shredded paper **D** – chopped alfalfa (*Medicago sativa* L.) hay

E – Oriental mustard (*Brassica juncea* L. 'Pacific Gold) cover crop

F – winter rye (*Secale cereale* L. 'Wheeler') cover crop

G – dwarf white clover (*Trifolium repens* L.) living mulch (mowed)

H – dwarf white clover living mulch (flamed)

Treatments A-D were established May 1999. Treatments E-H were established September 1999. Trt. C was renewed annually.


Commercial mulch spreader.

Control trees (L) vs. alfalfa (R) with delayed senescence, greater leader growth.


Enviroscan probe set for 4 depths.

Prototype applicator for sprayable paper mulch

Tree Growth and Fruit Yield

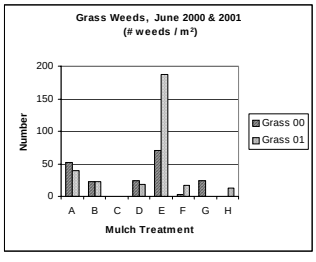
The alfalfa hay treatment led to significantly greater tree growth initially, likely due to the N input. This effect faded over time, whereas relative growth in the clover plots increased over time. Wood chips also enhanced tree growth relative to the control, likely due to non-nutrient factors such as moisture.

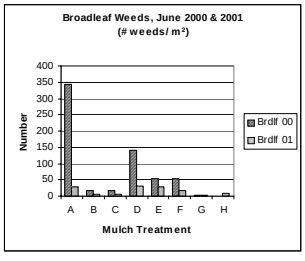
Other than a much higher fruit yield for alfalfa plots in 2000, treatments did not significantly influence fruit yield. Clover plots did show a trend towards higher yields in 2000 and 2001. Alfalfa increased fruit size in 1999. There were no meaningful differences the next two years. The treatments had no consistent effect on fruit quality. The higher N treatments tended to lower fruit firmness and decrease fruit color.

Weed Control

Weed pressure in the plots was not been severe. Overall, the paper, wood chip, and clover plots have provided good weed control (Fig. 1). The alfalfa plots were often the most weedy, and the mustard led to an annual grass infestation. Rye was effective for one season, particularly for grassy weeds. In 2002, the clover was damaged by rodents, and it did not compete well with weeds.

Figure 1. Effect of mulch treatment (A-H) on weed populations.



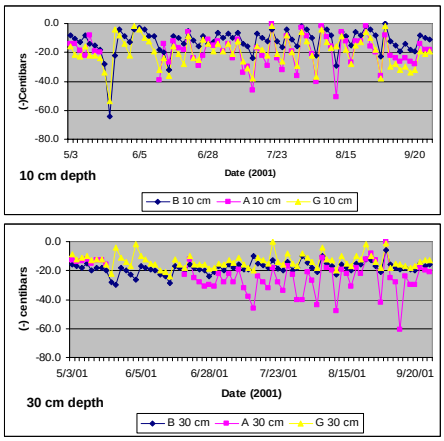


Soil Moisture and Water Use

The surface mulches generally exhibited higher soil moisture than the control. All plots received the same irrigation. Soil moisture was monitored over time in control, wood chip, and clover plots (above) at 10 and 30 cm depth with tensiometers. While clover showed a slight depletion relative to the control at 10 cm, it had consistently higher moisture at depth (Figure 2). Wood chip mulch led to more even soil moisture levels at both depths.

In a neighboring experiment, soil moisture was continuously monitored at 10, 20, 30, and 50 cm depth in a block of 'Gala'/M26 apples. Four plots had no mulch and four had wood chip mulch on the tree row. Irrigation was adjusted to need, and the mulch decreased water inputs by 20-25%. The effect of the mulch was even evident at 50 cm depth.

Figure 2. Effect of control (A), wood chip (B), and clover living mulch (G) on soil moisture. (more negative equals more dry)

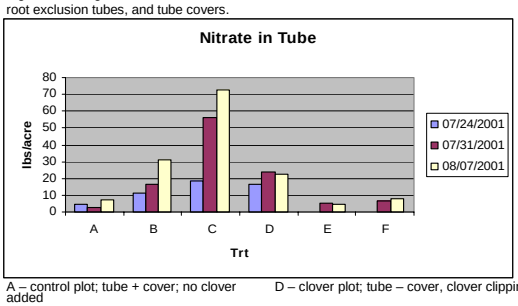


Nitrogen Status and Soil Quality

Nitrogen was monitored in the soil and the leaves. Treatments that added N (alfalfa, clover) tended to elevate leaf N but seldom changed soil nitrate. By excluding tree root uptake with plastic tubes inserted to 8" depth, and by capping some tubes to eliminate possible leaching, the clover led to an appreciable N release and contribution (Fig. 3). Clover can potentially supply all the N needed for an established apple orchard.

Treatments did not significantly change soil organic matter or bulk density. But alfalfa, paper and wood chip tended to increase water infiltration rates relative to the control and other treatments. Organic mulches in a related Ag Canada study did lead to significant changes in soil biota, especially an increase in omnivorous and predatory nematodes and a resultant decrease in the root lesion nematode *Pratylenchus penetrans* which can damage fruit trees.

Figure 3. Nitrogen release over 3 weeks from ambient soil with and without clover, root exclusion tubes, and tube covers.



A – control plot; tube + cover; no clover added

B – control plot; tube + cover; clover clippings added.

C – clover plot; tube + cover, clover clippings added

D – clover plot; tube – cover, clover clippings

E – control plot; no tube

F – clover plot, no tube

Future Directions and Challenges

A major drawback for mulches is the cost of procurement and application. The wood chips provided excellent weed control for three years with a single application, while the shredded paper controlled weeds the best but required an annual and awkward application. Recent research into a sprayable paper mulch is meant to address this constraint. The clover living mulch provided multiple benefits at low cost but appeared to attract rodents who then fed on it and weakened the stand. More exploration of other plants that could fill the tree row niche and not compete with trees is warranted. In addition, on-going studies are examining the potential to grow a mulch material in the drive alley that can be mechanically cut and placed on the tree row, eliminating much of the expense of hauling in and spreading mulches. Clearly, mulches can provide effective weed control where aggressive perennials such as quackgrass are not a problem while also conserving irrigation water. Related studies in British Columbia have also documented significant increases in tree growth and fruit yield with mulches on coarse-textured soils.

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