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Alternative Orchard Floor Management Strategies

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Introduction

Fruit trees are high-input crops requiring insecticides, fungicides, herbicides, fertilizer, irrigation, and hand labor for pruning and harvesting. Management of the orchard floor can influence the effectiveness of irrigation, fertility, disease and insect management practices. Producing economic yields of high-quality fruit requires judicious management of all of these factors.

Orchard Floor Management Objectives

Orchard floor management involves managing both tree rows and alleyways. The objectives of proper orchard floor management include: suppressing weeds, stabilizing the soil, maintaining beneficial insect populations, and minimizing maintenance inputs. Major maintenance inputs include mowing and irrigation. No single orchard floor management system meets all of these requirements under all conditions. Developing an orchard floor management system involves weighing the costs and benefits of different approaches with regard to these diverse objectives, and matching practices to local conditions.

Typical orchard floor management in the Intermountain West is to maintain grass in the alleyways and a vegetation-free strip in the tree rows (Figure 1). Vegetation-free strips minimize direct competition between orchard trees and orchard floor vegetation for water and nutrients. For apples, approximately 22 square feet (example: 4.5′ x 5′) of bare ground is required per tree for optimum growth and productivity. Grass alleyways stabilize the soil against erosion and compaction, and reduce dust and mud.

Figure 1. Grass alleyway and vegetation-free "herbicide" strip, in a tart cherry orchard

Orchard Floor Management Factors

Weeds are defined as plants that are growing where they are not wanted. Orchard weeds compete for water and nutrients, reducing growth and yield of fruit trees. Alleyway weeds increase the soil weed seed bank. Weeds in the tree rows can interfere with irrigation sprinklers and harvest, and can attract and harbor arthropod pests and rodents. Best practices for orchard floor management limit weed growth.

Soil stabilization is important in reducing soil compaction and erosion. Utah orchards are often on sloped ground with highly erodible soils. Fruit orchards require intensive maintenance that frequent vehicle traffic, including equipment and labor aids for pruning, thinning, pesticide application, and harvesting and transporting fruit. Alleyway vegetation stabilizes the

soil, supports equipment, reduces mud and dust, and maintains soil structure with frequent orchard traffic.

Irrigation water is a limiting resource in Intermountain West orchards. The amount of water required for an orchard is partly determined by orchard floor management. Some management practices that improve soil properties or reduce insect populations may require additional irrigation inputs. These higher water requirements must be weighed against their potential benefits, particularly in seasons or situations where irrigation water is scarce or expensive. The conventional weed-free strip and grass alleyway minimizes competition with orchard trees for water and nutrients. To properly maintain the grass alleyway however, water needs to be applied to the entire orchard floor. Slow growing grasses tend to use less water than fast-growing grasses or broad-leaf plants, leaving more water available for trees. Clean-tilled orchards may reduce water loss but still exhibit significant surface evaporation from the bare soil. Repeated cultivation to maintain bare ground also breaks down soil structure, and stirs up dust, which promotes mite problems in the trees. Mulches applied in the tree row can act as a barrier to surface-evaporation losses. In a water-limiting environment, mulches may best conserve water in the tree row but may provide a favorable environment for voles.

Pest Management. Each orchard floor management system requires a different approach to pest management. Insect diversity and numbers increase in vegetative ground covers and arthropod populations that are well balanced between pests and beneficial predators can prevent or reduce crop damage. Ground covers may provide additional habitat for two-spotted spider mites and other leaf-feeding arthropods. When orchard floor vegetation is mowed or cultivated leaf-feeding pests migrate into trees. Damage to trees can be limited if mowing is avoided during peak pest populations and the hottest summer months. Another strategy is alternate-row mowing so that leaf-feeding pests can move from row to row instead of up into the trees.

Alternative Systems

The common approach of a vegetation-free strip maintained with herbicides, and a grass alleyway provide benefits in soil stabilization, minimized competition, and a less favorable environment for arthropod pests. However, some alternative approaches may provide other benefits such as reduced fertilizer inputs, or adaptation to organic management. Each alternative; however, should consider the previously discussed management factors. We will present some common alternative management approaches and experiences with their application in Utah.

Commonly used grass species for orchard alleyways:

I. Creeping red fescue
II. Perennial rye
III. Kentucky blue grass
IV. Orchard grass

Some potential advantages of alternative systems include improving the soil in the tree row by generating organic matter, and reducing the need for purchased fertilizer. Disadvantages may include additional water requirements or specialized equipment (tillers, mulch applicators, specialized seeders, and specialized irrigation systems).

Some commonly considered alternative systems include:

- Growing a nitrogen-rich cover crop in the alleyway.
- Mulches to combat weeds in the tree row.
- Cultivation in the tree row and/or the alleyway.

Legumes can be used as alleyway vegetation to provide additional nitrogen in the orchard. Mowing and discharging the nitrogen rich plant material in the tree row effectively bands the nitrogen next to the tree roots. Plant adaptability to the Intermountain West climate limits the legumes that can be considered. Alleyway-grown alfalfa (Figure 2) has been shown to produce 70 lbs of nitrogen per acre in an orchard system (Table 1). A drawback to this type of system is the lack of control over the timing of nitrogen availability. If the nitrogen becomes available late in the season this could create a

Figure 2. Alfalfa grown in the alleyway of an established tart cherry orchard.

Table 1. Alleyway cover crop trials conducted at the Kaysville, Utah, experiment station and in a commercial orchard in Juab County, Utah.

Cover Crop	Shade tolerance	% Nitrogen	Yield (lbs. of N/ acre)	Establishment cost ($/acre)
Grass	Good	-	-	$178
Hairy Vetch	OK	4.0%	50.8	$375
Alfalfa	Good	2.0%	71.6	$284
Black Medic	Good	1.5%	23.6	$173
Birds-foot Trefoil	Good	1.8%	23.9	$305

Yield per acre, nitrogen content and establishment costs are from Rowley (2011). Relative shade tolerance is from the UC Davis cover crop web page (2006).

flush of shoot growth that would delay hardening off of the orchard tree and increase susceptibility to early winter injury. Considerations on the time of mowing could appropriately add the nitrogen according to tree needs, and limit potential negative effects. Introduction of leguminous plants to orchards have shown an increase in arthropod diversity and number. This diversity may better maintain a natural balance of orchard pests and predators. However, legumes also show an increase in the number of some piercing and sucking pest arthropods, which can cause cat-facing damage by feeding on developing fruit. Although legumes add nitrogen to the orchard soil, the fertility benefit may not overcome the cost of managing increased arthropod pest populations. In addition, our results also indicate that legume covers in the orchard alleyway consume more water than grass covers. Some of these such as alfalfa and white clover will not tolerate the degree of shade found in mature tart cherry orchards, and die out over several seasons.

Figure 3. Establishing peach orchard with vegetation free strip maintained by herbicides (left) or by paper mulch (right).

Mulches such as straw, wood chips, paper or weed fabric, can also suppress weeds in tree rows. Straw is effective at preventing weed growth; however, introducing weed seeds with straw is an added risk. Wood chip mulch has been shown to have a positive effect on tree growth and yield. Paper mulch can be recycled shredded paper, layered newsprint, or slurry made from shredded paper. Paper mulch controls weeds very well by preventing seedlings from reaching light, but requires annual applications to adequately control weeds (Figure 3). The expense of applying and maintaining paper mulch may be prohibitive unless a free source is readily available. Weed fabric is a woven plastic product that allows water to penetrate to the soil but does not allow light through. Weed fabric has a high initial cost (approx. $3000 per acre) but can last as long as 15 years. Living mulches are shallow-rooted cover with limited success (Figure 4) limiting weeds but

Figure 4. Alyssum grown in the alleyways of an establishing peach orchard and birds-foot trefoil in the alleyway.

showing some competition with the trees crops that are not competitive with orchard trees, but compete with weeds. Annual alyssum has been used with limited success (Figure 4) limiting weeds but showing some competition with the trees.

Other living mulches that have been tested in orchards include: white, ladino and kura clover, native weeds, and sweet woodruff. Living mulches usually work better in established orchards where final tree size has already been reached, and competition for tree growth is less critical. Mulches in the tree row provide habitat for vertebrates (voles and mice) which feed on the bark of trunks and roots during the winter months, damaging or killing the tree. Special care must be taken to eliminate environments for vertebrates during the winter months. Some considerations to reduce pest pressure should include: moving mulches away from the base of the tree, mowing vegetation low in the fall, flail chopping dropped fruit to speed decay, using trunk guards, or implementing vertebrate control methods such as poison baits.

Cultivation can be used in either the tree row or the alleyway or both. Cultivation is effective in controlling most annual weeds if carried out at frequent intervals. Bare ground radiates heat during cold nights and may help protect against spring frosts. However, cultivating near trees damages shallow feeder roots and can decrease tree performance. Clean-tilled ground in the alleys also result in erosion, loss of soil structure and increased dust as described above.

Summary

Each of the alternative orchard floor management practices discussed has advantages and disadvantages. Environmental conditions and crop determine the orchard floor management systems that may be successful in a given location. Regardless of which system is used, attention must be given to the factors of weed suppression, soil stability, irrigation requirements and pest dynamics, to ensure a given orchard floor management system enhances yield of marketable fruit, tree health, and improves the orchard environment.

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