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ving Mulch Options ıor Precision Management of Horticultural Crops

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Living mulches, or the use of soil covers in horticultural cropping systems, represents a new application of old technologies used in orchards. Grass sods have been managed between tree rows to reduce soil erosion, improve trafficability, increase water infiltration and nutrient recycling, and prevent dust and mite problems.

In apple and pear orchards, deep-rooted perennial grasses like tall fescue or orchardgrass require frequent mowing and adequate water or nutrients to prevent yield losses. New applications, however, include dwarf or intermediate species; you manage these either by varying soil water and nutrient availability or by using chemical or mechanical mowing treatments.

Selection criteria

The diversity among living mulch species and cultivars gives you a number of management options to achieve your desired production results—and, at the same time, minimize costs and conserve resources.

The way to reduce the number of your living mulch choices is to decide which selection criteria are appropriate for your management objectives. Your criteria might include annuals or perennials that:

1. establish rapidly to suppress weeds and provide early trafficability and erosion control;
2. provide adequate wear tolerance and persistence;
3. tolerate drought and low fertility;
4. reduce costs associated with mowing intervals, fertilizer needs, thatch removal, or chemical mowing; and
5. enhance crop yield and quality.

Types of living mulches

Winter annuals (table 1) are planted or emerge naturally with the first fall rains, set seed in June, and form a dead mulch during summer. To reduce growth that protects vertebrate pests, annual covers often require a single mowing 6 weeks before natural reseeding. Using annual covers simplifies perennial weed control in summer because you can apply herbicides after the mulch matures.

Fall-planted mulches include spring barley, annual ryegrass, and field brome. The brome tillers profusely and remains relatively short. Except for spring barley varieties that normally die in winter, you'll have to mow annual ryegrass and field brome or kill them in spring to reduce competition or summer fire hazard.

Naturally seeding annuals include annual bluegrass, rattail fescue, and subclover. The way to enhance the natural selection of these mulches is to choose herbicides, rates, and application times that selectively control *other* weeds within the cover. Your first establishment of subclover will require an extremely shallow seedbed—mix the seed in the top ¼ inch of soil. Fertilizers containing phosphorous (P) often enhance establishment of legumes in the Pacific Northwest.

Perennial ryegrass cultivars, especially new turfgrass varieties, offer new dimensions in mulch management for many Pacific Northwest horticulturists (table 2). Ryegrasses germinate and establish quickly; they provide early cover for improved trafficability, erosion control, and weed suppression.

Moderate stands of dwarf or intermediate ryegrass have allowed

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only 10 to 30% of the cover to become established as germinating annual weeds. After one or more mowings and minimal nitrogen applications, plots remained 90 to 95% weed-free for 1 to 3 years, except where perennial weeds like false dandelion became established with the grass.

After establishment, ryegrasses exhibit good wear tolerance but recuperate poorly with excessive traffic because they do not spread. Ryegrass withstands drought in nonirrigated orchards but lacks extreme cold tolerance, especially at higher elevations.

Low to moderate fertility levels are required, or turf density will thin, and weeds will begin to encroach. Ryegrass root systems are moderately dense. You can stimulate grass growth with nitrogen applications or suppress it by withholding fertilizer and water.

Tall fescues and orchardgrass are vigorous, long-lived grasses that tolerate diverse climatic and soil conditions found in the Pacific Northwest (table 2). Both are winter-hardy, and they develop extensive root systems.

They compete for available soil moisture on nonirrigated sites; if you use irrigation, you'll need to mow frequently. Establishment is moderately fast, although weeds can provide as much as 50% of the initial cover.

Fine fescues include creeping red, chewings, hard, and sheep fescues (table 2). All have fine-textured and wiry leaf blades that decompose slowly and may form a thatch of undecomposed leaves and stems after several years.

This thatch may impede water infiltration and provide cover for small vertebrate pests like field mice if your mowing height is more than 1.5 to 2 inches. Eventually, a fine fescue turf may require renovation to improve vigor and maintain cover. A light disking or replanting may be required.

Germination is moderately fast, but establishment is slow, often requiring several months. During the first year, these grasses allow establishment of germinating weeds, trafficability is poor, and erosion potential can be severe.

You can enhance establishment by mixing small quantities of improved perennial ryegrass cultivars (3 to 10 lb seed/acre or mix 20 to 50%); these grow and establish fast. Under low-fertility conditions within the sod strip, the perennial ryegrass will be eliminated in 1 to 4 years.

After establishment, fine fescues offer low fertility and mowing requirements, good competition with weeds, and fair to excellent drought tolerance. Trafficability is excellent except for susceptible varieties of creeping red fescue that become infested with

Table 1.—Annual living mulches for horticultural cropping systems

Common name	Growth habit	Seeding rate (lb/A)	Establishment rate	Nitrogen requirement (lb/A)	Representative cultivars (seed source)[a]
Annual seeded covers					
Spring barley	upright	120	fast	30 to 50	Advance, Bus, Poco, Steptoe
Spring or winter oats	upright	120	med. fast	30 to 50	Amity (W), Walken (W), Grey Winter (W), Cayuse (S), Border (S), Kanota (S), Otana (S)
Annual ryegrass	upright	30	fast	30 to 50	Common variety
Field brome	slightly spreading	10 to 15	fast	30 to 50	(Contact local SCS in Oregon)
Winter or spring field peas	spreading	120	moderately fast	by soil test	Austrian Winter (W or S), Melrose (S), Miranda (S)
Grain/pea	upright	80/100	fast	20 to 30	(See "Winter or spring field peas," above)
Naturally seeding annuals					
Annual bluegrass	spreading tillers	—	moderate	by soil test	(Manage selection[b])
Rattail fescue	small, individual clumps	—	slow	by soil test	(Select tolerant herbicides)
Subclover	spreading	20	moderate	by soil test	Mt. Barker

[a] (W) = winter, (S) = spring.
[b] Apply marginal rate of herbicide in spring or select tolerant herbicide combination.

Helminthosporium disease during wet weather.

Bentgrasses are native west of the Cascades and are considered a Pacific Northwest climax species (the last naturally occurring species that eventually dominates a site). They tolerate acid soils and summer droughts. Growth is short although the vigorous spreading habit can invade crop rows or other weed-free areas.

They persist under low fertility and wet conditions, although establishment is slow. Native bentgrasses have replaced less vigorous or mowed turfgrasses maintained under low-fertility conditions.

Kentucky bluegrass is a vigorous creeping perennial that's particularly well adapted to conditions east of the Cascades, where winter temperatures fluctuate. Optimum growth occurs at neutral or alkaline soil pH. Recuperation is excellent after wear injury. Recent turfgrass cultivars have not been tested for interplanting in horticultural crops.

Grass mixtures often perform better than individual varieties, especially during the establishment phase. Mixing a fast-establishing perennial ryegrass with a fine fescue often improves results during the first year. You can mix improved turfgrasses (as described under "Fine fescues," page 2) or buy a locally available mix. Consult local sources for the most recent information and availability of grass mixtures.

Perennial legumes offer a wide array of plant materials, but most are too tall or vigorous for horticultural crops. Dwarf English trefoil is short (about 12 inches) and appears manageable in some cropping systems. New Zealand white clover provides a vigorous early spring cover, which you can maintain with irrigation. Unfortunately, its limitations include weed and vertebrate pest control.

Table 2.—Common grasses for orchards

Common name	Growth habit	Seeding rate (lb/A)	Extablish-ment rate	Minimal N require-ment (lb/A)	Tolerance to:[a]				Representative cultivars[b]
					Wear	Drought	Shade	Cold	
Tall fescue	Bunch (weakly spreading)	20 to 30	Moderate	0 to 20	E	E	F	G	Clemfine, Falcon, Mustang, Olympic, Rebel
Orchardgrass	Bunch	20 to 25	Moderate	0 to 20	G	E	G	G	(Testing inadequate)
Fine fescues									
Creeping red	Weakly rhizomatous	15 to 20	Slow	0 to 20	E	E	G	G	Ensylva
Chewings	Bunch	15 to 20	Slow	0 to 20	E	E	G	G	(Testing inadequate)
Hard	Bunch	15 to 20	Slow	0 to 20	E	E	G	G	(Testing inadequate)
Sheep	Bunch	15 to 20	Extremely slow	0 to 20	E	E	G	G	Covar, Bighorn
Perennial ryegrass	Bunch	20 to 30	Fast	20 to 40	G	E	F	P	*Dwarfs:* Elka, Trimmer *Intermed.:* Acclaim, Barry, Fiesta, Manhattan II, Palmer, Prelude, others
Bentgrass	Rhizomatous and stoloniferous	5 to 10	Moderate	0	G	G	P	F	Astoria, Colonial, Exeter, Highland
Kentucky bluegrass	Rhizomatous	12 to 15	Moderate	20 to 50	E	F	F	G	(Many cultivars; testing inadequate)

[a] E = excellent; G = good; F = fair; P = poor.

[b] Numerous grass varieties or cultivars exist and are being developed by seed companies. Cultivars listed represent testing or observation under turf or within horticultural cropping systems. Consult local information and seed sources for current suggestions regarding cultivars and their availability.

Preparing and establishing your seedbed

Establishing living mulches requires control of all perennial weeds before you plant. Most cropping systems require a weed-free strip maintained within the crop row, normally one-third to one-half the total area. Select a strip width that allows a single pass with your mowing or flailing equipment.

Seedbed preparation should include shallow tillage to loosen the soil surface, but you must maintain firmness for maximum emergence. You can mix preplant fertilizer (see tables 1 and 2) into the shallow seedbed. Because seed of most grass and legume covers are small, plant it near the soil surface in a firm, moist seedbed.

Broadcast bunch-grass seed or use a Brillion seeder; mix it in the soil surface with a chain-link fence; and firm it with a roller or overhead irrigation.

Creeping grasses or covers may be drilled in rows 6 to 8 inches apart, provided you can control weeds adequately before the mulch covers the soil. After cover emergence, mowing will control annual broadleaf weeds, but you'll need to control newly emerged perennials within 6 to 8 weeks to prevent establishment. Planting usually occurs in early spring, although you can plant winter annual and fast-growing perennial species before mid-September.

You can sow fallow fields to grass the season before you plant the crop. Before you apply broad-spectrum turf herbicides, check to see if these have label restrictions that involve soil activity and crop rotations.

In midwinter, you can spray intended crop rows to kill the sod before planting. After the soil settles around newly planted trees, spray a soil-applied herbicide registered for new plantings within the row.

Maintaining established living mulches

Mowing or flailing at frequent intervals is a standard practice for managing cover growth in most orchards.

In mowing, maintain a reasonably smooth ground surface (to reduce time) and mow at regular intervals (to prevent excess clippings). New high-speed, front-gang rotary mowers have performed two to three times faster than conventional mowing equipment in orchards, although this calls for a separate implement.

In contrast, flails use considerable power, but they reduce vegetative growth and moisture loss, and they maintain a flat surface needed for nut harvesting. Occasional dragging and floating will eliminate tire ruts, mole and gopher mounds, and other irregularities.

In young filberts, grass mulches have withstood flailing in preparation for harvest. Flailing can also hasten early season dormancy for some sods, reducing water use on nonirrigated sites.

Chemical mowing is a recent innovation that uses turf regulators or sublethal rates of new postemergence herbicides to suppress sod growth. Chemical mowing can be particularly useful in the early spring, when grasses are growing vigorously or while trees are propped to prevent limb breakage.

Although specific labels for chemical mowing are incomplete, growers may apply a postemergence grass herbicide *at lower than labeled rates,* to suppress the growth of a susceptible grass, rather than kill it. Recent research and Extension trials suggest the following possibilities:

1. Most regulators or sublethal herbicides suppress grass growth for 4 to 8 weeks, depending on the product, rate, and growing conditions after treatment. The grass must be growing vigorously at the time of application—otherwise, increase your rates slightly to avoid erratic results.
2. Apparently, competition for soil moisture and nutrients is reduced with some products that control shoot and root growth of the sod. As a result, sod management also may become an option in nonirrigated orchards, vineyards, or other crops.
3. Chemical suppressants will not provide equal control of all grass species. Tolerant or partially regulated species (such as fine fescues and broadleaf weeds) will predominate. Occasionally, a herbicide that controls broadleaf weeds must be tank-mixed or applied separately, if mixtures lack compatibility.
4. You can enhance the conversion of a grass mixture to a tolerant, slow-growing species such as a fine fescue if you control growth of the susceptible grass with the chemical mowing treatment.
5. Estimated costs for chemicals range from $6 to $35 per treated acre (as of spring 1987).
6. Consult local sources of information to assess new developments and product labeling for use in your particular crop.

Weed management within the living mulch strip requires frequent observation and year-round strategies. If you maintain a competitive balance slightly in favor of the living mulch, you'll enhance weed suppression without increasing mowing or crop competition.

Careful observation, and small additions of fertilizer, will maintain turf growth and minimize open spaces for weeds. Infrequent use of severe turf-suppression treatments that create open spaces, such as flailing or chemical mowing, will delay weed encroachment into the turf.

Inevitably, as fertility and vigor of the mulch decline and open spaces develop in the turf, weeds will begin to encroach—including clovers, dandelions, and thistles. Soon afterward, vertebrate pests will also infest the site, seeking fleshy roots as food sources. In orchards and Christmas trees, 2,4-D is registered for selective broadleaf weed control in sods.

Apply 2,4-D within the living mulch strip only and avoid irrigation, or apply when rain is not forecast within 10 days after treatment. This will reduce chances that root uptake will cause crop injury. In Christmas trees, apply either before budbreak or after bud set in midsummer. Registrations involving 2,4-D and other selective herbicides are being pursued in other horticultural crops.

Use pesticides safely!

- **Wear** protective clothing and safety devices as recommended on the label. **Bathe or shower** after each use.
- **Read** the pesticide label—even if you've used the pesticide before. **Follow closely** the instructions on the label (and any other directions you have).
- **Be cautious** when you apply pesticides. **Know** your legal responsibility as a pesticide applicator. You may be liable for injury or damage resulting from pesticide use.

Examples of living mulches

In addition to the applications described for orchardists, small fruit growers have mowed or flailed natural vegetation or (more recently) planted grasses between rows, especially in areas prone to erosion. On steep sites, strawberry growers plant spring barley between rows in the fall. The barley dies in winter, or it can be incorporated into the row middles in spring.

Vineyardists have employed a wide range of cultural and living mulch practices to achieve grape quality and reasonable harvest conditions in the fall. Often, alternate rows are cultivated to control weeds in alternate years; traffic and harvest are restricted to the noncultivated row middle.

In eastern Washington, spring grains and vetch have been planted each fall to add the stress that helps ripen grapes. The next spring, 40 to 50 lb nitrogen is released from decomposition of the vetch.

Other vineyardists mowed or flailed row middles, which established deep-rooted, prostrate weeds like false dandelion or field bindweed. More recently, they have successfully managed improved turfgrasses, sheep fescue, and annuals (including rattail fescue).

Christmas tree growers often allow weed growth just before harvest to reduce muddy conditions at harvest and to prepare for replanting. Some growers have managed vegetative covers including annual weeds, subclover, or moss between tree rows to reduce soil erosion and improve trafficability. Recent possibilities include dwarf turfgrasses, dwarf English trefoil, or annuals like field brome.

Nursery producers of field-grown stock are adopting field brome, Sudangrass, or other annual covers in close-spaced crops, or they are managing sods to improve harvest conditions in winter. Some concern exists, however, about Sudangrass as a host for *Pseudomonas syringae* that infects many ornamentals. Research results, to date, haven't verified a natural movement of the disease from the grass to ornamentals, although detection methods are being improved.

Vegetable growers have used annual cereals like rye for windbreaks or winter cover crops. An asparagus grower in the Hermiston, Oregon, area has learned to manage downy brome between the crop rows with diuron (Karmex), to reduce sand blasting of spears.

Michigan growers found that natural allelopathic chemicals produced from a fall-planted cereal rye inhibited small-seeded weeds when they planted large-seeded vegetables, if they'd controlled the mulch and left it as a loose mat over the soil surface.

Managing dwarf perennial ryegrass *as an annual* in row crops such as Easter lilies, fall-planted cabbage, or possibly rill-irrigated crops may reduce soil erosion and improve trafficability with minimal competitive interactions. Low densities of the perennial ryegrass are planted between rows or in the furrow at the same time the crop is planted.

About one-third of the area is maintained free of vegetation within the crop row. Grass growth between rows either was not excessive or was chemically mown using sublethal rates of postemergence grass herbicides (labels for bearing crops are pending).

Sweet corn has been planted into 4-inch cultivated strips of New Zealand white clover, followed by moderate applications of atrazine to suppress the vigorous clover growth. Results in Oregon and New York suggest that about 75 lb nitrogen is released from killed clover roots within 2 weeks after atrazine treatment.

Long-term research with crownvetch in Pennsylvania corn fields suggests a consistent and gradual improvement in soil productivity and crop yields over a 12-year period, although results were not detectable for the first 6 years.

Crop management options: A summary

New technologies involving new grass cultivars that respond to management practices (irrigation, fertilizer, and chemical mowing treatments) will contribute to greater precision in crop management and quality while conserving resources and preserving long-term productivity. In perennial crops, for example, it may be possible to manage variable fields by planting and managing more than one type of grass.

Perhaps tall fescue could be managed on a wet site, or a winter annual might be required on shallow or rocky areas within the field. Chemical mowing could not only reduce the time and total cost of mowing but also reduce crop competition during critical periods, by reducing root mass after treatment.

In addition to providing improved trafficability, soil productivity, and erosion control in row crops, living mulches and their management may enhance or modify other production factors—for example, relationships between pest and beneficial organisms, equipment, and (perhaps) our view of optimum agricultural production systems.

For example, why couldn't Christmas trees be precision-planted (or tractors modified) to avoid random movement of equipment, which causes soil compaction throughout a field? A prototype tractor with a mobile toolbar and a 30-foot wheel span is being evaluated; it would confine wheel traffic to the same strip.

In conclusion, your imagination provides your greatest opportunity for adapting these technologies and maintaining production efficiencies in your horticultural cropping system.

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