TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE
PLANT MATERIALS - 14 PULLMAN, WASHINGTON
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CONSERVATION COVER TECHNOLOGY

This Technical Note is subdivided into the following Sections:

**Late Fall Seeded Cover Crop Trial Near Quincy, Washington.
Photo taken in early April.**

SECTION 14.1 Principal Uses of Cover Crops and Green Manures

"Green manuring" involves the soil incorporation of any field or forage crop while green or soon after flowering, for the purpose of soil improvement. A cover crop is any crop grown to provide soil cover, regardless of whether it is later incorporated. Cover crops are grown primarily to prevent soil erosion by wind and water. Cover crops and green manures can be annual, biennial, or perennial herbaceous plants grown in a pure or mixed stand during all or part of the year. In addition to providing ground cover and, in the case of a legume, fixing nitrogen, they also help suppress weeds and reduce insect pests and diseases. When cover crops are planted to reduce nutrient leaching following a main crop, they are often termed "catch crops."

Winter Cover Crop

A winter cover crop is planted in late summer or fall to provide soil cover during the winter. Often a legume is chosen for the added benefit of nitrogen fixation. In northern states, the plant selected needs to possess enough cold tolerance to survive hard winters. Hairy vetch and rye are among the few selections that meet this need.

Many more winter cover crops can be adapted. These cool-season legumes include clovers, vetches, medics, and field peas. They are sometimes planted in a mix with winter cereal grains such as oats, rye, or wheat. Winter cover crops can be established by aerial seeding into maturing cash crops in the fall, as well as by drilling or broadcasting seed immediately following harvest.

Cover Cropping for Wind Erosion Control and Nutrient Stability.

Fall cover cropping can greatly reduce the amount of wind erosion if the crop is seeded early enough in the fall to acquire adequate biomass to protect the soil. Planting too late in the fall should be avoided because it places a financial burden on the grower, fails to protect the soil, and lowers the acceptance of this practice. Low residue crops which are harvested late in the fall provide little soil protection during winter and early spring.

Your main Purpose for using a cover crop	**Species Ranking for the Columbia Basin**
Legume N Source	1. Hairy vetch 2. Crimson clover
N Scavenger	1. Triticale, Sorghum-Sudan 2. Winter wheat, Annual ryegrass, Oats
Build Soil Quality	1. Annual ryegrass, Triticale, Sorgum-Sudan, Sweet clover 2. Winter Wheat, 3. Hairy vetch, Mustard
Erosion Control	1. Annual ryegrass, Winter wheat, Sorgum-Sudan 2. Triticale, Oats, Crimson clover, Hairy Vetch, Sweet clover
Loosen Sub-soil	1. Sorgum-Sudan, Sweet clover
Suppress Weeds	1. Buckwheat, Triticale, Oats 2. Annual ryegrass. Winter wheat, Sorghum-Sudan, Hairy vetch, Sweet clover
Suppress disease/nematodes	1. Mustard, Sorghum-Sudangrass
Grazing	1. Triticale 2. Winter wheat, Annual ryegrass

What are the Benefits of cover crops?

Cover crops improve the physical, chemical, and biological quality of soil. They do this by covering the soil surface, penetrating the soil (roots), adding organic matter to the soil, and by being involved in the soil nutrient cycle. They can also help in managing insects and disease. However, no one cover crop will give you all these benefits. You must decide what you want to achieve and then choose the right cover crop.

A few considerations to consider when developing a cover crop plan: Cover crops can aggravate a 'Green Bridge' problem. This problem occurs when a fall planted or volunteer grain crop is not fully destroyed before seeding a spring grain crop. Root diseases develop rapidly when the 'Green Bridge' is not properly managed. Secondly, cover crops can also interfere with rotation requirements for some crops. Cover crops

can generate a tremendous amount of biomass, and this material can make spring planting very difficult for some equipment.

Cover Cropping

Cover cropping is one of the best options available to decrease wind erosion after a potato crop has been harvested. Cover crops also serve to hold nutrients in place, act as trap crops for insect pests or reservoirs for natural enemies of crop damaging insects, and have allelopathic effects on weeds and diseases.

A key factor in the success of fall cover cropping is seeding it early enough for adequate growth to occur. Delaying fall seeding even a few days can greatly reduce the amount of ground cover produced. Increasing the seeding rates is not as effective as early seeding. October 20th has typically been the cut-off date for fall cover crop seedings in central Washington.

Results of studies conducted in the Columbia Basin show:

- **Residual nitrogen is subject to deep leaching throughout the winter months.**
- **Fall cover crops must be seeded early enough in the fall to develop a root system capable of extracting nitrate deep in the soil profile.**
- **Fall cover crops that over-winter retain much of the nitrogen in the foliage and should be incorporated into the soil 2-3 weeks before seeding the spring cash crop.**
- **Fall cover crops that do not over-winter breakdown in the soil and nitrogen is released over the winter and spring.**
- **Spring oats seeded in the fall grew very rapidly but did not over-winter.**
- **Cereal rye has been one of the best fall cover crops in 3 years of testing in Washington.**
- **Winter wheat, white mustard and canola are also good cover crop options.**
- **Sudan grass is an excellent cover crop but requires an early planting date.**

Winter wheat generally remains the cover crop of choice by Washington growers in the irrigated Columbia Basin and 'Stephens' is the most commonly used cultivar. Winter wheat seed is readily accessible and inexpensive. It does not require extensive seedbed preparation, becomes established quickly, and tolerates potato herbicide residues quite well.

The Aberdeen, Idaho Plant Materials Center conducted trials and seeded crops in 1992. Brassica species (yellow mustard, rapeseed, turnip, etc.), rye and triticale provided the most fall cover. Data collected the following year show the same brassicas providing approximately 75% ground cover. The triticales provided roughly 50% ground cover but

weed suppression was much better than the brassicas. Peas and vetches did not perform well in this trial.

Fall Seeded Cover Crops

Catch Crop

A catch crop is a cover crop established after harvesting the main crop and is used primarily to reduce nutrient leaching from the soil profile. For example, planting cereal rye following corn harvest helps to scavenge residual nitrogen, thus reducing the possibility of groundwater contamination. In this instance, the rye catch crop also functions as a winter cover crop. Wheat or rye cover crops following corn generally retained 10 to 90 lbs/ac of soil nitrogen that would otherwise be available for leaching. It is reported that 10 to 45% of the nitrogen fertilizer was retained in rye, annual ryegrass, and hairy vetch cover crops which were planted following harvest of corn. Furthermore, these three cover crops were more efficient than resident weeds at uptaking nitrogen. While fall cover crops generally reduce nitrate leaching, cover crop residues can increase nitrate leaching if decomposition of cover residues is rapid and coupled with excessive rainfall or over-irrigation.

Fall cover crops have been used in California to improve the nitrogen supply in soil. Annual legumes seeded in October have contributed in excess of 200 lbs N/ac/yr by March in an ongoing study conducted at Davis, CA. The accumulated nitrogen is largely held in the top growth and released after plow down. Annual legumes will utilize residual nitrogen as well as fix nitrogen and may be an excellent EARLY fall cover crop for the Pacific Northwest. Most annual legumes have exhibited slow growth in cool temperatures in trials conducted in the Pacific Northwest.

Corn and potatoes are two important crops grown in the Pacific Northwest. Neither utilizes large amounts of nitrogen late in development. Low utilization coupled with decomposition of post-harvest residues can result in a large pool of residual nitrogen remaining in the soil.

October seeded cover crops failed to acquire much growth beyond the 2-leaf stage and root development was minimal. A concurrent study evaluated whether surface applied nitrogen fertilizer would stimulate fall growth and overall plant vigor. Results showed that applying nitrogen to did not improve fall above-ground growth. The limiting factor for fall growth was not available nitrogen but rather growing degree days.

Erosion Control Practices in Potatoes

Wind erosion is a serious threat until the potato crop has developed enough foliage to protect the soil. There are basically 3 wind erosion periods: 1) after fall fumigation, 2) after spring planting of the potatoes, and 3) after the potatoes are harvested. All three periods are suspected of contributing to the fugitive dust problem.

The first period lasts roughly 4 months (late October to early March). Wind speeds exceed 60 mph are common and the amount of residue remaining on the soil surface after fumigation practices is inadequate to provide protection.

The second period is much shorter in duration, 20-45 days, for a given field but lasts from late February to early May due to the spread in planting dates. During this period, the wind erosion hazard is very severe. Highly erosive wind events commonly occur during March and April. Preparation of the soil for planting of the potato crop further reduces residue levels and any large clods of soil. Hilling does increase the surface roughness of the field but due to the distance between hills and the fact that many times the hills are not arranged perpendicular to the prevailing wind, any potential erosion control benefit is minimized.

The duration of the third period is quite variable. It may begin as early as September if a cover crop was not seeded after potato harvest or if a seeded cover crop did not develop adequately to protect the soil.

Surface Roughening / Emergency Tillage

Surface roughening involves tilling narrow strips across a field. These tilled strips create ridges which can reduce wind erosion if they are constructed perpendicular to the prevailing winds. Surface roughening is not intended to be an enduring practice but it can provide a certain degree of soil protection for one or perhaps two wind storms. Surface roughening following potato harvest is not practiced to a large extent because Washington potato soils have very low aggregate stability. The ridges simply breakdown too fast to be effective. Plowing wet soils might produce more resilient ridges but plowing wet soils greatly increases soil compaction and clod formation. Soil compaction has been shown to greatly reduce potato yields. It would be safe to assume that this practice would not be employed.

Mulching

Living Mulch

A living mulch is a cover crop that is interplanted with an annual or perennial cash crop. Living mulches suppress weeds, reduce soil erosion, enhance soil fertility, and improve water infiltration. Examples of living mulches in annual cropping systems include overseeding hairy vetch into corn at the last cultivation, no-till planting of vegetables into subclover, sweetclover drilled into small grains, and annual ryegrass broadcast into vegetables. Living mulches in perennial cropping systems are simply the grasses or legumes planted in the alleyways between rows in orchards, vineyards, Christmas trees, berries, windbreaks, and field nursery trees to control erosion and provide traction.

Straw
Spreading straw has been shown to greatly reduce erosion associated with furrow irrigation in many trials. A 1988 study conducted at the Malheur Experiment Station in Ontario, Oregon showed that straw spread at a rate of 790 lb/acre (5.4 lb/100 ft of row) reduced irrigation induced erosion from 18 to 3 tons/acre. The study also showed that irrigation water use efficiency improved considerably with straw applications. This study was conducted on heavier soils and would react somewhat differently than the sandy soils of the Columbia basin.

Straw mulch will reduce wind erosion providing that the straw is firmly anchored. Left unanchored, straw simply blows off the field to create other problems for the grower. Implements such as a crimper could be drawn behind a straw spreader to vertically pin the straw in place. Needless to say, this is an added expense to the grower. Straw is relatively inexpensive but the labor and equipment costs involved can be high. Clearly, it is much more cost effective to manage the crop residue already in the field.

Manure is a relatively inexpensive mulch if a source of manure is readily available. Soil loss estimates generated by the Franklin WA Conservation District (1993) show that manure spreading can reduce wind caused soil erosion as much as 9 tons/acre/year. However, soil losses in each case still exceeded tolerable levels. Manure rates needed to reduce wind erosion are quite high. A 1974 report shows that 10-15 tons of liquid manure provided adequate soil protection. Liquid manure should provide better erosion control than dry manure because it binds soil particles but the cost per acre will be higher due to the higher weight involved. It is known that potato fields are subject to high nitrate losses and fall manuring could aggravate the problem.

Nonvegetative Soil Stabilizers

The NRCS does not have a practice standard for nonvegetative soil stabilizers to reduce wind erosion. Soil stabilizers and crusting agents have been tested extensively for many years. A classic study conducted in 1963 evaluated the wind erosion protection offered by rock, various asphalt emulsions, starch compounds, latex emulsions, and wheat straw. Results of this study showed that most of the treatments were cost prohibitive. A recent advance in polymer chemistry technology is placing this practice within economic reach of potato producers. The efficacy of new polymers requires testing and validation. The Pullman PMC will initiate a study in 2006 to investigate the efficacy of polymers on dryland soils prone to wind erosion.

Weed Suppression

Weeds flourish on bare soil. Cover crops take up space and light, thereby shading the soil and reducing the opportunity for weeds to establish themselves. The soil-loosening effect of deep-rooting green manures also reduces weed populations that thrive in compacted soils.

Providing weed suppression through the use of allelopathic cover crops and living mulches has become an important method of weed control in sustainable agriculture. Allelopathic plants are those that inhibit or slow the growth of other nearby plants by releasing natural toxins, or "allelochemicals." Cover crop plants that exhibit allelopathy include the small grains like rye and summer annual forages related to sorghum and sudangrass. The mulch that results from mowing or chemically killing allelopathic cover crops can provide significant weed control in no-till cropping systems.

Economics of Cover Crops

The most obvious direct economic benefit derived from legume cover crops is nitrogen fertilizer savings. In most cases these savings can offset cover crop establishment costs. Indirect benefits include herbicide reduction in the case of an allelopathic rye cover crop, reduction in insect and nematode control costs in some cases, protection of ground water by scavenging residual nitrate, and water conservation derived from a no-till mulch. Longer-term benefits are derived from the buildup of organic matter resulting in increased soil health. Healthy soils cycle nutrients better, don't erode, quickly absorb water after each rain, and produce healthy crops and bountiful yields.

With annual cover crops, the highest cost is seed. Hairy vetch and crimson clover typically range from 50¢ to $1.50 per pound. With a 20-pound per acre seeding rate, seed costs range from $10 to $30 per acre. With a 25-pound seeding rate at 85¢/lb and a $6.50 no-till drilling cost, it would cost $28 to plant an acre of this cover crop.

Cereal and other grass cover crops

Crop	Planting dates	Seeding rate lb/1000 SQ. ft.	Winterkill	Seed availability
Cereal rye	Late Aug.-Late Oct.	2-3	No	+[2]
Winter wheat	Late Sept.-Late Oct.	2-3	Seldom	+
Spring oats	Late Aug.-Early Sept.[1]	2-3	Susceptible	+
Spring barley	Late Aug.-Early Sept.[1]	2-3	Occasional	+
Winter triticale	Late Aug.-Late Oct.	2-3	Seldom	-
Annual ryegrass	Late Aug.-Mid Sept.	0.5-1	Seldom	+

[1]These crops can be planted until mid-October in the Willamette Valley

[2]+ means seed is usually available at feed or garden stores

- means seed usually must be ordered

Legume cover crops

Crop	Planting dates	Seeding rate lb/1000 sq. ft.	Winterkill	Seed availability
Hairy Vetch	Late Aug.-Early Sept.[1]	1.5-2	Seldom	+[2]
Common Vetch	Late Aug.-Early Sept.[1]	1.5-2	Seldom	+
Austrian winter peas	Early Sept.-Late Sept.1	2-3	Occasional	+
Crimson Clover	Late Aug.-Early Sept.[1]	0.5-1.5	Seldom	-
Fava bean	Early Oct.	2-3	Seldom	-

[1]These crops can be planted until mid-October in the Willamette Valley

[2]+ means seed is usually available at feed or garden stores

- means seed usually must be ordered

Other broadleaf cover crops

Crop	Planting dates	Seeding rate lb/1000 sq. ft.	Winterkill	Seed availability
Buckwheat	May-Early Aug.	1-2	Yes	+[1]
Rape	Late Aug.	1/8-1/4	Seldom	+
Mustard	Late Aug.	1/8-1/4	Seldom	-
Turnip	Late July-Early Aug.	1/8-1/4	No	-

[1]+ means seed is usually available at feed or garden stores

- means seed usually must be ordered

WSU extension bulletin Craig Cogger

LATE FALL SEEDED COVER CROP TRIAL RESULTS PLANTED OCT. 11 & 12, 1995 AT GEORGE AND LIND, WA, RESPECTIVELY.

VARIETY		FALL STAND COUNTS*		SPRING GROUND COVER **		SPRING BIOMASS PROD ***	
		GEORGE	LIND	GEORGE	LIND	GEORGE	LIND
		(no./3ft of row)		(%)		(LB/acre)	
'Stephens'	Winter Wheat	30	26	81	83	316	3221
'Celia'	Winter Triticale	37	27	88	82	310	4066
'Centurk'	Winter Wheat	40	16	88	87	394	3190
'Common'	Aust Winter Pea	13	5	27	37	77	538
'Alpowa'	Spring Wheat	33	27	86	88	437	4265
'Breaker'	Winter Triticale	26	28	93	93	531	5307
'Dusty'	Winter Wheat	27	8	72	75	157	1258
'Granger'	Aust Winter Pea	17	6	23	45	60	444
'Parma'	Winter Triticale	27	21	87	87	439	4737
'Grey'	Winter Oats	33	6	23	28	34	548
'Hoody'	Winter Barley	32	33	73	80	159	3368
'Norstar'	Winter Wheat	44	31	78	83	254	1876
'Nugaines'	Winter Wheat	0	0	0	0	0	0
'Penawawa'	Spring Wheat	31	25	38	65	145	1478
'Tyfon'	Turnip	91	56	0	0	0	0
'Yamhill'	Winter Wheat	27	11	78	80	188	2837
'Moro'	Winter Wheat	--	30	--	88	0	3165
LSD .05		14.7	8.8	13.4	8.8	135.2	1047.8

* Rated 11-8-95
** Rated 4-3-96 at Lind, 4-8-96 at George
*** Clipped 4-10-96 at George, 5-9-96 at Lind

SECTION 14.2 Conservation Covers for Vineyards and Orchards

Vineyards

Conservation covers can greatly improve trafficability during the winter months, reduce soil erosion, and reduce between-row maintenance operations. Western Washington vineyards are typically planted on a south facing slope with the row aligned north to south. Much of the field work occurs when the soils are wet, muddy, and subject erosion and compaction. Eastern Washington vineyards are usually irrigated and the between-row areas are commonly left bare. Bare ground management in vineyards can create mite problems, compact the ground, and require extensive weed management.

Numerous annual and perennial grasses, legumes, and even plants commonly thought of as weeds have been tried over the years by vineyard growers. Legumes are generally unacceptable because they compete for moisture, harbor pests, and require too much maintenance. Weeds are also unacceptable because they frequently harbor or attract rodents and the seeds may spread to other areas. Grasses have performed best in cover trials but further trials are needed to determine which species/cultivars may best meet the needs of growers in Washington.

A vineyard cover trial conducted at a Benton County vineyard by the Corvallis, OR PMC in 1986-1991 compared 15 different grasses and grass mixes.

1. 'Covar' Sheep fescue
2. 'Pomar' Orchardgrass
3. 'CBS II' Perennial ryegrass
4. Mecklenburg* Sheep fescue
5. 'Zorro' Annual fescue
6. 'Ensylva' Creeping red fescue
7. 'Elka' Perennial ryegrass
8. 'Shadow' Chewings fescue
9. 'Pennlawn' Creeping red fescue
10. 'Dorado' Chewings fescue
11. 'Aurora' Hard fescue
12. 'Durar' Hard fescue
13. 'Elka' + 'Aurora' (80%/20%) mix
14. 'Elka' + 'Covar' (80%/20%) mix
15. 'Elka' + 'Enslyva' (80%/20%) mix

* Mecklenburg was a generic population and not an actual cultivar of sheep fescue

'Covar' sheep fescue like most fine-leaf fescues germinates rapidly but establishes slowly. Weed invasion during establishment was a problem in this trial. 'Covar' provided adequate soil protection and withstood traffic very well. It went dormant early each year, usually by mid-June. This may have reduced moisture competition but allowed summer-active weeds to flourish.

'Pomar' dwarf orchardgrass is a short perennial grass originally selected as a cover crop for orchards. Much of its growth occurs early in the spring when soil temperatures are cool. 'Pomar', like most orchardgrass cultivars, has a fairly high nitrogen requirement with vigor decreasing rapidly in nitrogen deficient soils, 'Pomar' established very rapidly and provided excellent ground cover the year of establishment. Weed encroachment was moderately severe, and overall, it performed poorly in comparison to the fine-leaf fescues. 'Pomar' seed may no longer be available because foundation seed is no longer produced.

'CBS II' perennial ryegrass and 'Elka' perennial ryegrass did not perform well, 'CBS II' provided adequate cover the establishment year but the stand deteriorated after a few years. Perennial ryegrasses generally require higher soil fertility than what commonly occurs in vineyards. Furthermore, summer precipitation falls sparingly west of the Cascades which may stress the grass and contribute to stand reduction.

Mecklenburg sheep fescue is not a true cultivar but rather an "ecotype" of sheep fescue. Mecklenburg was imported from Europe during the 1985 Conservation Reserve program. It is our understanding that a cultivar has been developed out of the original Mecklenburg seed stock. The new cultivar is named – **'MX86' sheep fescue**. Mecklenburg performed best in this trial. It was the shortest grass tested, provided exceptional weed suppression and soil protection, and withstood traffic very well. It remains green 3-5 weeks later into the summer than 'Covar' which may be undesirable because of the reduced light reflectance ad possibly higher moisture competition. Observations in CRP plantings show that it POORLY adapted to areas that receive less than 18" annual precipitation.

'Zorro' annual fescue is commonly used as a cover crop in California. It provides high light reflectance, early maturity, and low moisture competition. Since it needs annual seeding, mowing must be postponed until after seed set. 'Zorro' performed poorly in this trial. Vegetative cover was highly variable from year to year, and was dependent on the amount of seed set the prior year and the growing conditions after germination. Erosion protection was marginally acceptable and was primarily provided by leaf litter. 'Zorro' was unable to compete with weeds such as false dandelion and the plots were among the weediest of the cultivars evaluated. Rodents favor high amounts of leaf litter and false dandelion, and were prevalent in the 'Zorro' plots.

'Ensyla' creeping red fescue is reportedly a shade tolerant, drought tolerant, fast creeping red fescue. It did not appear to be as aggressive a creeper as 'Pennlawn' creeping red fescue. Weeds made up a large percentage of the ground cover by 1991.

'Elka' perennial ryegrass established quickly and provided good erosion control the establishment ear. The stand deteriorated rapidly and only 14% of the plot area was covered with 'Elka' in 1991. Vigor dropped significantly in the last two years and the weed population escalated. 'Elka' and other perennial ryegrasses perform better with higher soil fertility making them poorly suited for long-term cover crops in vineyards.

'Shadow' chewings fescue is closely related to creeping red fescue but is nonrhizomatous. 'Shadow' exhibited very good seedling vigor, quick establishment, and the stand improves with age. 'Shadow' was the tallest cultivar tested and a single mowing left a considerable amount of leaf litter on the vineyard floor. Although high amounts of leaf litter may improve light reflectance during the summer, it does provide a haven for rodents.

'Pennlawn' creeping fescue was one of the top performing grasses in this trial. Rhizome growth enabled 'Pennlawn' to quickly fill bare areas thereby reducing soil erosion and preventing weed invasion. However, rhizome growth into the vine rows could be a problem. Creeping red fescues, unlike the fine-leaf fescues, are tolerant of close mowing which enables vineyard managers to clip the seedheads of shorter weeds. 'Pennlawn' withstood traffic quite well in this trial but creeping red fescues reportedly may not perform well if traffic occurs during peak soil compaction conditions.

'Dorado' chewings fescue performed similarly to 'Shadow' chewings fescue. 'Dorado' provided slightly better vegetative cover, vigor, and fewer weeds than 'Shadow'. 'Dorado' was a little slow to establish but the stand improved considerably with age. 'Dorado' and 'Shadow' remained green longer into the summer than the sheep and hard fescues.

'Aurora' hard fescue performed fair to well in this trial. Hard fescue is closely related to sheep fescue and exhibits very good drought and heat tolerance. A relatively high percentage of bare ground, greater than 10% occurred between the 'Aurora' plants. 'Aurora' must be very competitive because weed invasion in the void areas was surprisingly low. Although the overall height of 'Aurora' was measured at 16-18 inches in this trial, the leaves typically grew less than 5 inches tall.

'Durar' hard fescue is a 1949 Soil Conservation Service release. 'Durar' was selected primarily for its stand longevity and durability, hence its name. It typically is utilized in harsh, dry sites in the intermountain west. 'Durar' performed poorly in this trial. It germinated readily, provided good initial cover, but the stand was inadequate to suppress weed invasion. It is not well adapted to climatic conditions west of the Cascades.

'Elka' perennial ryegrass + fine-leaf fescue mixtures should in theory provide very good short and long-term cover. 'Elka' should provide quick cover and die out after a few years; and the slower establishing, more permanent, fine-leaf fescues would fill the voids left by the ryegrass. The mixtures tested did not perform well in this trial. The mixture stands were less than the two cultivars seeded separately. Twenty-percent fine-lef fescue is insufficient seed to provide long-term cover. Perhaps a better mixture would be 80% fine-leaf fescue and 20% perennial ryegrass.

Comparison of 15 grass covers evaluated at a Benton County, Oregon vineyard from 1986-1991.

Cultivar	'86[1] Stand	1988 Veg. Cover (%)	1988 Bare Soil (%)	1988 Weeds (%)	1988 Leaf Litter (%)	1991 Veg. Cover (%)	1991 Bare Soil (%)	1991 Weeds (%)	1991 Leaf Litter (%)	Culm Ht (in)	Vigor[2] '87	Vigor[2] '91	Traffic[2] Tolerance	Rodent[3] Activity
Covar	VG	31	16	9	43	38	9	48	4	16	5	7	4	low
Pomar	E	25	34	7	35	40	9	46	5	18	4	5	3	low
CBS II	F	26	34	4	36	22	13	60	4	14	4	8	2	high
Mechlenberg	**G**	**45**	**15**	**2**	**39**	**89**	**2**	**3**	**6**	**10**	**3**	**1**	**3**	**low**
Zorro	VG	14	13	11	61	12	16	61	11	15	9	8	5	high
Ensylva	F	23	33	4	40	41	7	45	7	17	3	6	4	med
Elka	F	29	32	2	37	14	15	66	5	13	3	8	3	low
Shadow	G	37	9	2	52	68	3	16	10	24	4	3	2	low
Pennlawn	VG	35	7	0	58	76	2	10	12	24	4	2	2	low
Dorado	F	40	16	3	41	78	2	13	7	21	4	3	4	low
Aurora	G	33	15	5	47	59	11	19	11	18	5	4	3	low
Durar	G	25	19	6	52	36	17	39	17	20	5	5	4	med
Elka + Aurora	F	29	33	4	33	54	13	25	8	--	--	4	3	med
Elka + Covar	F	31	29	4	36	31	12	45	11	--	--	5	3	med
Elka + Ensylva	F	26	40	2	34	36	18	27	19	--	--	4	4	low

1 E= 90-100% stand, VG= 85-90%, G= 80-85%, F= 70-80%

2 1= Excellent, 9= Very poor

3 1991 ratings LOW = activity in 0-25% of the plots
MED = activity in 25-50% of the plots
HIGH= activity in 50-100% of the plots

Orchards

Orchard floor management is not a glamorous endeavor. Most orchardists give it little consideration. There are three basic types of orchard floor management:

- Total bare ground, weed free
- Bare soil in the tree row with grass cover between the rows
- Total grass cover in the orchard

Total bare ground, weed free orchard floors are not common in Washington but it advantages and disadvantages. Since weeds are not allowed to grow, pollinators are more likely to work the fruit tree blossoms rather than the flowers of weeds. This is especially important for pear orchards. Mowing is eliminated, soils warm faster in the spring, and competition for water is eliminated. Dr. John Fellman, WSU Tree Fruit Scientist, stated that an important disadvantage of bare soil in Washington orchards is dust mites. Orchard traffic stirs up dust that gets into the tree canopy. It goes without saying that soil erosion is a hazard. Muddy conditions can severely hamper tractor access and operations.

Total grass cover orchard floors are more common than bare soil floors. Grass covers are seeded when the orchard is fairly young and irrigated in the drier areas of Washington. Mowing keeps the grass cover short and weeds suppressed. The grass cover cushions the soil and reduces soil compaction. Erosion hazard is greatly diminished. A total grass cover can be costly. The grass will compete for moisture. Maintenance of the cover

within the row requires careful mowing to prevent damage to the trees. If the grass is uncut in the tree row, rodents will migrate to these areas where they are less exposed to predators.

Bare soil in the tree row with grass cover between the rows is the most common orchard floor management scheme. Grasses are seeded when the orchard is fairly young just like a total grass cover. The grass cover is selectively eliminated in the tree row strip via an application of broad spectrum herbicide. The advantage of a "clean strip" is that it reduces rodent cover near the trees, reduces moisture competition, the bare soil warms earlier in the row, and doesn't require careful mowing. The cover between the rows is mowed. Since the tractors are operating on grass cover, dust mites are less of a problem.

WSU Orchard Floor Experiment

A WSU tree fruit research trial conducted in 2003 was set out in an 8-yr old block of Gala/M26 in transition to organic certification, with 3 replicates. The weed strip was tilled in mid-April and living mulch species were planted in mid-May. Six perennial landscape species were planted (alyssum, native beach strawberry, native ginger, sweet woodruff, creeping thyme, and scotch moss). These species were selected as an alternative to legumes to avoid potential rodent problems. Twenty entries of annual and perennial legumes, and colonial bentgrass, were planted (white clover, strawberry clover, kura clover, subclovers, medics, trefoil) singly and in combination. Weeds were hand pulled during May, June, and July. Crop establishment and weed competitiveness were noted through the season, and select biomass samples were taken. A late summer planting of selected legumes was also done to test this timing for weed problems.

Performance of the trial

Living mulch species performed variably in this initial season. Weed pressure was intense with the spring planting, dominated by annual cool season and warm season grasses. Only a few entries performed well without extensive hand weeding - the white clovers and the bentgrass. Over time, the strawberry clover also established a cover. With weeding, the alyssum nearly reached 100% ground cover and provided flowers season long. The fall planting had much less weed pressure, as has been experienced in the past. All the species that were fall planted (trefoil, kura clover, medic) had excellent germination and growth with no weeding, compared to less effective stand establishment in the spring planting, when kura clover failed to establish. First year data are contained in the accompanying living mulch report.

Living Mulch	% Cover, 100 days after planting
Grass	
Colonial Bent grass *A. tenuis*	88
Carpet type ground covers	
Sweet Alyssum *L.maritima*	77
Sweet Woodruff *G.odoratum*	47
Creeping Thyme *T. praecox minus*	35
Irish Moss *S. subulata*	37
Native Beach Strawberry *F. chiloensis*	33
Native Ginger *A. caudatum*	1
Clovers	
T.repens 'Dutch'	84
T.repens 'NZ'	84
T.repens 'NZ/T.fragiferum mix	78
T.fragiferum 'O' Connor's'	55
T.ambiguum 'Prairie'	8
T.ambiguum 'Rhizo'	8
Subclovers	
T. subterraneum 'Antas'	7
T. subterraneum 'Howard', 'Mt. Baker'and 'Tallarook' /mix	32
T. subterraneum 'Clare', 'Nungarin'/Mix	27
Medics	
M. lupulina PI 260980 Afghanistan	47
M. polymorpha 'Santiago'	8
M. lupulina PI 251150Yugoslavia	43
M. polymorpha 'Serena'	12
M. polymorpha/scutellata Mix	5
Birdsfoot Trefoil	
L. corniculatus 'Norcen'	57
L. corniculatus 'Kalo'	43