USING COVER CROPS IN OREGON

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Contents

Using Cover Crops in Oregon

Cover crops usually are not grown for harvest, but they serve many other functions in crop production systems. For example, they are used to enrich soil with organic matter; cycle nutrients; protect soil from water and wind erosion; and suppress weeds, insect pests, and diseases.

Cover crops are used successfully in Oregon in both annual and perennial systems.

- In rotations of annual crops, covers are planted during the fallow season or when crops are not being managed. When they are planted to improve soil fertility they sometimes are referred to as green manures.
- Soil covers, living mulches, and floor management in orchards, berries, vineyards, nurseries, and Christmas trees often involve perennial sods or ground covers. Traditionally, vegetation management in perennial systems has focused on the alleyway between rows. However, there is growing interest in managing selected vegetation within rows.

When managed creatively, cover crops can meet a variety of needs in many different cropping systems. For example, you can manipulate the cover crop species; residue management; and planting, killing, or mowing dates and methods to achieve particular goals and avoid potential problems.

Soil variability, microclimate, and pest ecology all affect the success of cover cropping. Experiment with a small acreage to find out which cropping system best meets your needs.

The information in this publication is intended to help you make cover cropping management decisions. This publication is organized into two sections. The first provides general information about managing cover crops. The second section contains specific information about individual crops or mixes of crops.

Benefits of Cover Cropping

Organic matter

Healthy soils contain a complex web of organisms. Growing cover crops when fields normally would lie fallow produces plant material that, when returned to the soil, serves as food for these organisms. For example, an oat and vetch mixture can produce 3–4 tons of dry matter per acre when grown as a winter annual cover crop in the Willamette Valley. Nearly all of this material is consumed by bacteria, fungi, and other soil organisms after it is incorporated or killed.

Plant residues and plant material transformed by soil organisms that resist decomposition contribute to soil organic matter content. Organic matter acts as a reservoir for plant nutrients; improves soil tilth; and increases water-holding capacity, infiltration rates, aeration, and cation exchange capacity.

The organic matter content of undisturbed soil is fairly constant, having reached a balance between organic matter additions (mostly dead plant material) and losses (mostly due to decomposition by soil organisms).

Cropping systems usually involve tillage, which aerates the soil and increases the rate of organic matter decomposition. Erosion also may increase. These factors usually result in a new equilibrium with less soil organic matter. Returning cover crops to the soil can gradually increase, or at least slow the decline, of soil organic matter.

Soil protection

Cover crops can protect soils from water and wind erosion. They reduce raindrop impact and the rate at which water flows down slopes, thus preventing the detachment of soil particles. A cover crop also greatly reduces wind velocities at the soil surface. Winter soil protection in annual systems usually is best achieved with cereals or grasses that establish quickly in fall, cover the soil, and develop fibrous root systems that hold soil in place, resisting transport by water or wind. In perennial systems, established legumes also can do an excellent job of protecting the soil.

Soil Structure	Soil fertility	Pest management	Environmental quality
• Better aggregation • Greater water infiltration • Greater water-holding capacity • Better aeration • Reduced erosion • Reduced soil crusting • Reduced soil compaction	• Nutrient cycling • Nitrogen additions by legumes • Enhanced phosphorus availability • pH buffering • Energy and nutrient source for soil biota	• Habitat for beneficial arthropods • Weed suppression • **Some** cover crop species suppress nematodes	• Reduced erosion • Reduced nitrogen leaching • Reduced surface water runoff

Figure 1.—Benefits of cover crops.

Soil structure

Healthy soil structure favors root growth, aeration, and water storage and infiltration. It also reduces soil compaction and erosion.

Cover crops improve soil structure in many ways. For example:

- Roots and root exudates promote soil aggregation.
- Cover crop residue additions stimulate microbial activity, which also promotes soil aggregation.
- Organic matter provides food for earthworms, which create large channels for the movement of air and water, especially in perennial and reduced-tillage systems where worms are more likely to thrive.
- Incorporating residues that resist rapid decomposition (e.g., mature cereals) also can result in channel formation.
- A cover crop canopy reduces raindrop impact that destroys surface soil structure.

Soil fertility

Storage of plant nutrients

As cover crops grow, they take up nutrients from the soil and incorporate them into plant tissue. The cover crop "stores" these nutrients until it is returned to the soil and decomposes, at which time the nutrients gradually become available to plants. This nutrient cycling through the cover crop can prevent leaching losses of nitrate-nitrogen from the soil. Other nutrients, such as phosphorus, may be more readily available from decomposing plant residues than from the mineral (inorganic) part of the soil.

Nitrogen additions

Legume cover crops can transfer nitrogen from the atmosphere to the soil. Legumes live in a mutually beneficial relationship with rhizobial bacteria that form nodules on the legume's roots. The bacteria convert atmospheric nitrogen into plant-available forms (often called fixation), and in return they receive sugars from the legume.

It should be noted that legumes also take up plant-available nitrogen from the soil. Thus, it is difficult to determine what percentage of total accumulated nitrogen in legume tissue comes from fixation. Regardless of the source, however, part of the nitrogen in legumes becomes available to subsequent crops as legume residues are broken down by soil organisms.

Pest suppression

Cover crops suppress weed growth by competing with weeds for light and nutrients and sometimes by releasing toxic substances into the soil.

Cereals, grasses, and crucifers that establish quickly in the fall suppress slower growing fall and winter weeds. The rapid spring growth of most cover crops is ideal for spring weed suppression. In addition, winter-killed, herbicide-killed, or mown cover crops can form a mulch that smothers weeds.

Limited research suggests that in some situations cover crops can help suppress nematode populations and soilborne bacteria and fungi that cause diseases (pathogens). They may suppress pathogens either directly or by increasing populations of other organisms that compete with pathogens in the soil.

Cover crops potentially offer habitat for beneficial insects, including predators and parasites of insect pests and disease vectors, as well as bees and other pollinating insects.

Water quality

Vegetable growers operate in an extremely competitive environment. Profit margins are small, even when economically optimal rates of nitrogen are applied. However, optimal nitrogen rates may result in substantial quantities of nitrogen remaining in the soil after harvest. This nitrogen can adversely affect groundwater when leached below the root zone by fall and winter rains.

One way to decrease potential leaching of nitrogen is by using cover crops to capture, or scavenge, a portion of the soil nitrate before fall rains begin. Scavenged nitrogen is stored in plant tissues until spring, when the cover crop is incorporated into the soil (Figures 2 and 3).

The most efficient nitrogen scavengers are grasses, cereals, and brassicas that grow rapidly in fall and early winter. Legumes are less likely to reduce soil nitrate levels because they grow slowly during those times.

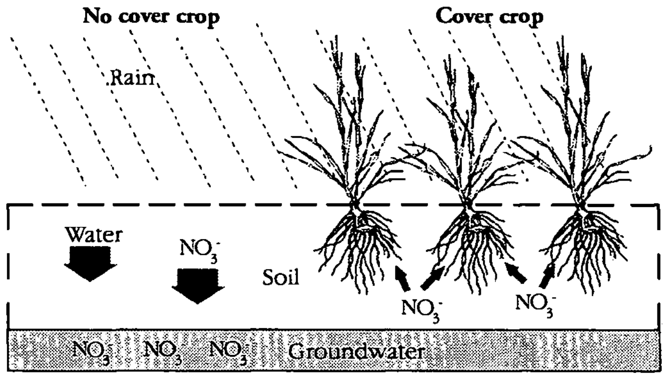


Figure 2.—Nitrogen scavenging decreases nitrogen losses from the soil and prevents potential groundwater contamination. Cover crops that grow rapidly in the fall are able to take up nitrate-nitrogen from the soil and incorporate it into their tissues before winter rains leach it into the groundwater.

Cover crops can reduce erosion of valuable top soil. Reduced erosion decreases the amount of phosphorus and pesticides carried into surface waters, thus minimizing unhealthy algal blooms and other damage to aquatic ecosystems. Cover crops keep soils, your most important resource, in place, while simultaneously reducing degradation of water resources.

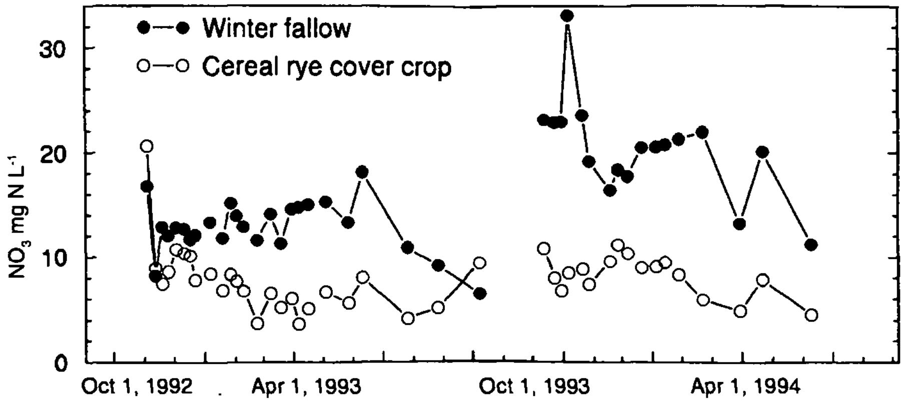


Figure 3.—Nitrate levels in soil solution at 48 inches in bare versus cover-cropped soils following fertilized summer crops in a north Willamette Valley trial.

Economic benefits

Cover crops can reduce production costs for cash crops by decreasing the need for nitrogen fertilizer (through nitrogen fixation by legumes) or pesticide applications (by suppressing pests). Improved soil tilth can result in long-term improvements in yield and lower drawbar power requirements, thus reducing fuel costs. Cover crops in perennial systems often improve vehicular traffic, facilitating harvest and other field operations.

The benefits from protecting the environment, though not easily quantified, are real and deserve consideration when calculating the cost/benefit ratio of using cover crops.

See the section "Economic considerations" on page 22 for factors to consider in a short-term economic analysis of adding a cover crop to a cropping system.

Possible Disadvantages of Cover Cropping

Although cover crops can have many benefits, they also can present some problems. For example:

- Cover crops generally delay soil warming and drying in the spring, which may delay tillage and planting.
- Incorporating a large amount of plant material in spring may interfere with planting if it doesn't have time to decompose sufficiently.
- The relatively high C:N ratios of mature grass and cereal cover crop residues may limit N availability to a following crop. See "Residue C:N ratios" on page 7 for an explanation.
- Cover crops can act as hosts for plant pathogens and the agents that carry them (disease vectors).
- Root exudates or decomposing residues of some cover crops can interfere with a following crop's growth.
- You must spend money for seed, fuel, labor, and machinery, as well as take the time to learn how to integrate cover crops into existing cropping systems.

By selecting appropriate cover crops and managing them with these concerns in mind, you can avoid or minimize most of these problems. Again, experiment with small acreages to learn how a cover crop affects a particular cropping system before applying it to a large area.

Choosing a Cover Crop

To choose a cover crop or cover crop mixture, begin by identifying its primary functions in your cropping system. Determine the relative importance of the following:

- Soil protection
- Nitrogen accumulation for a following crop
- Weed reduction
- Pathogen or disease vector suppression
- Aeration and infiltration improvement
- Improved access for vehicles
- Nitrogen scavenging
- A combination of the above

Then use the fact sheets in this manual and other available information to select species tolerant of your cropping environment and most capable of meeting your goals. Most often, choosing a cover crop or cover crop mixture is an optimization process of maximizing benefits while minimizing negative effects.

Note that varietal differences often are critical to cover cropping success. Also, many cover crops can be used for multiple purposes (e.g., forage or hay), but if you remove their residue, you lose some cover cropping benefits. Factors likely to influence cover crop selection are discussed below.

Seed availability and cost

Often the seed available for cover cropping is limited to varieties that are grown for other purposes (e.g., grain production). Availability may change from year to year as new varieties are developed. Although new varieties have not been produced specifically for cover cropping purposes, they are adapted to Oregon's climate and soils. Specialty cover cropping varieties sometimes are available, but plan ahead and secure seed sources early.

Seed costs vary with location and year. High seed price, coupled with high seeding rates, may make some cover crops economically undesirable.

Limiting environmental factors

Environmental factors that influence the success of cover crops include minimum and maximum annual temperature, soil type, drainage, precipitation, and day length. It is essential to choose a cover crop that is suited for the environment in which it will be planted. For more information on specific cover crops, see pages 25–50.

Minimum annual temperature

Cover crops vary in their ability to tolerate low temperatures. The United States Department of Agriculture (USDA) has developed a map of minimum annual temperatures that can be used as a rough gauge to determine whether a particular crop is likely to survive the winter (Figure 4). within species, varieties may vary somewhat in cold tolerance.

To use the map, find your temperature zone, and then check the fact sheet to learn

Zone	Avg. Ann. Min. Temp. °F
4	-30 to -20
5	-20 to -10
6	-10 to 0
7	0 to 10
8	10 to 20
9	20 to 30

Figure 4.—Oregon plant hardiness zone map. This map was extracted from the USDA's national plant hardiness zone map, which is based on average annual minimum temperature. Find your temperature zone and then check the fact sheets or other sources to learn what zone the cover crop is rated for. It normally will survive in that zone or any warmer zone.

what zone the cover crop is rated for. The cover crop normally survives in that zone or any warmer zone and dies in any colder zone.

Moisture and drainage

Moisture plays an important role in the development of cover crops. Trials in the Willamette Valley have shown that too much rain can harm cover crop growth. Data collected over 5 years show that biomass production decreased as winter rainfall increased.

However, cover crops vary widely in their ability to tolerate wet soils, whether due to high rainfall or poor drainage. For example, annual ryegrass can tolerate saturated soils and temporary flooding (Figure 5). Rapeseed, on the other hand, cannot survive in wet soils during fall establishment.

Soil type

Soil pH, texture, depth, and fertility all have a bearing on cover crop growth. Choose a crop that prefers, or at least tolerates, conditions where it is to be planted.

Photoperiod

Some cover crops are sensitive to day length. For example, buckwheat must be planted in spring or early summer to achieve satisfactory growth. When planted in late summer, decreasing day length forces it to flower soon after it emerges, preventing further growth.

Residue C:N ratios

The ratio of carbon (C) to nitrogen (N) in residues, referred to as the C:N ratio, will affect residue decomposition rate and the availability of N to subsequent crops.

C:N ratios of cover crop residues vary widely and depend on the species and the stage of growth at incorporation or kill:

- The C:N ratio of legumes is low (e.g., 20:1) and relatively constant.

Figure 5.—Annual rye after flooding. Note flood debris on stake in foreground.

- The C:N ratio of brassicas (e.g., rapeseed) is intermediate.
- The C:N ratio of cereals and grasses is intermediate during young, succulent stages of growth but increases greatly in mature plants (e.g., 100:1 or higher) that contain high percentages of cellulose and lignin.

Both legumes and non-legumes are capable of accumulating substantial amounts of N in their tissue, but in general only half of the N in legumes, and very little or none of the N in non-legumes, is available to subsequent crops. Incorporating large amounts of residue with high C:N ratios (e.g., mature grasses and cereals) actually can decrease the N available to a following crop.

When soil microbes decompose residue and reproduce they need both C and N in a ratio of roughly 20:1. They are capable of rapidly cycling the N in legume residue back to plant-available forms, because legume residue C:N ratios also are about 20:1.

However, as microbes decompose residues with higher C:N ratios, they extract plant-available N from the soil solution to meet their needs. This is not a problem if brassicas or relatively succulent cereals or grasses (intermediate C:N ratios) are incorporated or killed with enough time for decomposition to occur before planting, or if residues remain on the soil surface. However, if large amounts of mature cereal or grass residue are incorporated shortly before planting, the decomposition process will not be complete at planting. In this case, soil microbes will compete with the following crop for plant-available N from the soil solution.

Legumes decompose rapidly in soil. Non-legume decomposition is slower; however, it varies greatly, depending on the C:N ratio and quantities of cellulose and lignin, which decompose slowly. A succulent cereal may decompose almost as fast as a legume; a mature cereal may take months to decompose.

Planting mixtures of legumes and non-legumes offers an opportunity to lower the overall C:N ratio of spring residue, which will vary with the relative mix and the stage of growth of the non-legume.

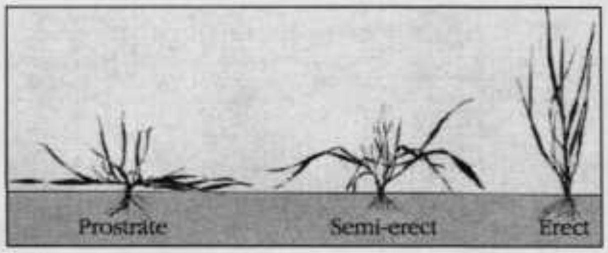
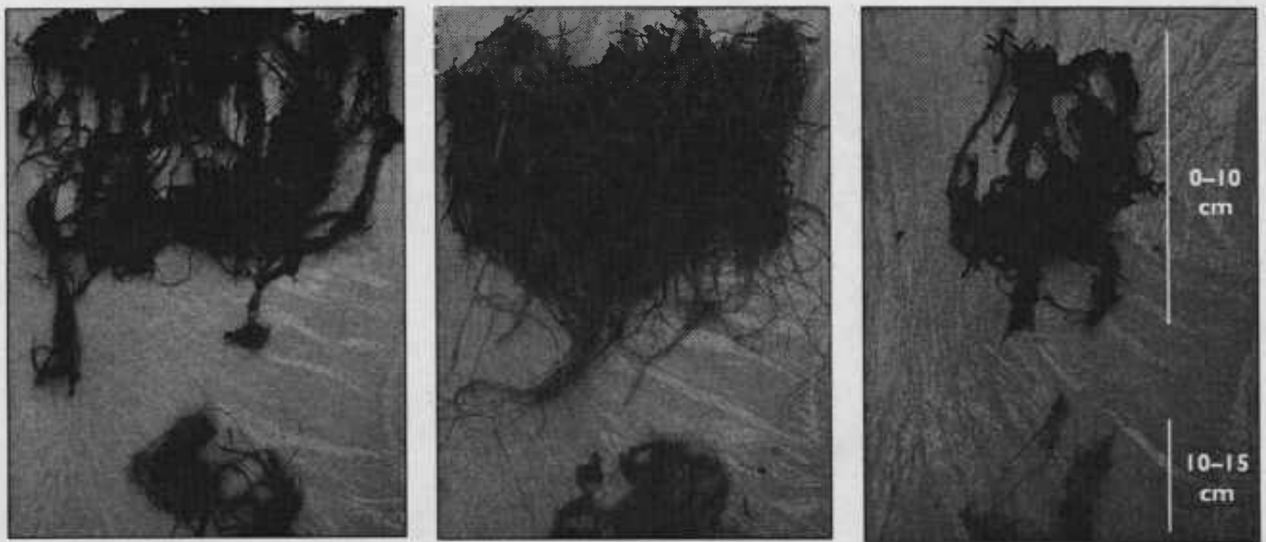


Figure 6.—Cereal growth habit types may be categorized as prostrate, semi-erect, or erect. Prostrate varieties maximize soil protection. Erect varieties are good nurse crops and compete less with legumes when planted in mixtures.

Growth habit

The growth habit of a cover crop affects its ability to protect the soil, smother weeds, or act as a nurse crop, and can affect residue management as well.

Physical stature may be classified as erect, semi-erect, or prostrate. Examples of each, for cereals, are shown in Figure 6. Prostrate forms do the best job of covering the soil, while semi-erect or erect forms are best as nurse



subclover Wheeler rye Austrian field pea

Figure 7.—Root structure of three cover crop species.

crops when planted in mixtures with legumes.

Root structure varies widely among cover crops (Figure 7). Most cereals and grasses have a fibrous root system concentrated near the soil surface, which is ideal for holding soil in place. In contrast, brassicas generally have large tap roots capable of penetrating plow pans and loosening the soil to greater depths. Legume root growth patterns are diverse.

Figure 8.—A winter-killed cereal grain forms a protective mat over the soil surface that is incorporated easily in spring.

Late-maturing and short-statured cereal grain varieties increase flexibility of tillage timing in excessively wet springs, when field preparation must be delayed. They reduce the risk of spring seed production and the accumulation of excessive amounts of biomass, which could interfere with field preparation and planting, and N availability to following crops.

Other growth habit characteristics also may affect cover crop selection. For example, choosing a cover crop that is killed by winter cold can simplify residue management in the spring. If sufficient growth is achieved in the fall, residues form a mat over the soil, which reduces erosion potential (Figure 8). The partially decomposed residue is easily incorporated in the spring, and planting can follow without delay.

Note that spring cereal susceptibility to winter-kill varies considerably, even among varieties of a particular species, and usually depends largely on planting date. Early planting dates increase the likelihood of winter-kill. Many spring cereals will survive the winter in western Oregon when planted after September 21.

Mixtures

Often, a mixture of several cover crop species is best suited to meeting a grower's multiple goals. For example:

- A cereal or grass in a legume/non-legume mix can scavenge N, protect the soil, and suppress weeds during fall and winter.
- The legume in a legume/non-legume mix can lower the overall C:N ratio of spring residue enough to prevent soil microorganisms from competing with the following crop for plant-available N.
- Winter-killed non-legumes will decompose throughout the winter and will not compete with legumes in spring.
- Using mixtures spreads the risk of cover crop failure.
- In on-farm trials in Oregon, mixtures of grains and legumes generally produced greater total biomass than either did alone.

- Cereals can act as nurse crops for legumes during fall and winter. When viny legumes such as vetches begin rapid growth in spring, cereal stems can provide structural support to keep them off the ground and prevent rotting.
- The pollen and nectar of certain broadleafs (e.g., vetches, buckwheat, certain mustards, and fava bean) attract beneficial predatory and pollinating insects. This can complement the winter habitat provided by the early growth of grasses.

Regulatory restrictions

The production of some crops is regulated by government authorities. For example, rapeseed production is regulated in Oregon and other Pacific northwest states.

The Oregon Department of Agriculture has established rapeseed production districts. In order to grow rapeseed, even as a cover crop, it may be necessary to "activate" the production district in your area.

Much of the Willamette Valley is a restricted production zone due to potential cross pollination between rapeseed and other brassica seed crops.

Cover Crops in Annual Systems

Planting and kill dates

You can plant cover crops in the fall, spring, or summer. Likewise, you can kill or incorporate them at any time. However, when used in annual cropping systems in Oregon, cover crops generally are planted in fall and killed or incorporated in spring.

Fall-planted cover crops can protect the soil during winter and do not conflict with cash crop production during the summer. Spring-incorporated residues are most likely to release nutrients when summer crops need them.

Many of the benefits of cover crops depend on the amount of dry matter production (biomass) and total accumulated nitrogen in cover crop tissues. Biomass production and nitrogen accumulation, in turn, depend to a large degree on planting and spring kill dates.

Fall cover crop planting generally has to wait until the summer crop has been harvested and plant residues have been incorporated. In general, if irrigation is available, it is desirable to plant as early as possible so that cover crops become well established before cold, wet weather begins. Doing so maximizes soil protection, nitrate capture, and winter hardiness. It also provides the plants with a solid base for taking advantage of suitable winter growing periods and rapid spring growth. If irrigation is not available, plant just before the first expected fall rains to avoid seed loss from pests.

Some cover crops should not be planted early. For example, if winter wheat is planted too early in western Oregon, it can provide a "bridge" for overwintering pathogens (e.g., stripe rust of cereals) that may infect nearby grain fields the following spring. Spring oats are less winter-hardy when planted early, although this can be desirable if winter kill is wanted.

Cover crop growth rates increase dramatically with longer days and warmer weather in the spring. If excessive biomass production is not a problem (see "Incorporating cover crops," page 15), it often is best to wait as long as possible before incorporating the cover crop. However, it rarely makes sense to extend the cover crop growing season to the point where it interferes with the optimum date for seeding the following cash crop.

The characteristics of a cover crop also limit its planting and kill dates. For example, minimum soil temperature for germination, susceptibility to frost heave, and seedling cold tolerance may limit planting dates. Many cover crops can become weeds if allowed to set seed and should be incorporated, killed, or mown before then.

It usually is desirable to incorporate cover crops while their tissue is still succulent and susceptible to rapid decomposition. However, if your goal is maximize organic matter accumulation, incorporate cover crops closer to maturity. At this time, lignin and cellulose levels are high, resulting in persistent residues.

Planting

Drilling vs. broadcasting

In general, drilling seed is preferable to broadcasting because drilling offers more even planting distribution, consistent planting depth, and better soil/seed contact. However, in some situations, drilling may not be possible (e.g., soils are too wet). Good results also can be achieved by broadcasting followed by light tillage. There also is some evidence that weed suppression is better in broadcast-seeded cover crops because the random plant distribution offers fewer niches for weeds to exploit.

Seeding rates

Seed weight, germination rate, and relative competitiveness affect seeding rates. Seeding rates for cover crops may vary from those used when the crop is grown for other purposes.

Rates also may vary depending on the specific purpose of the cover crop, the time of year it is planted, and the method of seeding. Suggested rates usually are higher if any of the following situations exist:

- A major goal is increased soil protection.
- You plant later in the year.
- You broadcast rather than drill seeds.
- You use relay interplanting instead of fall planting.

With mixtures, the seeding rate of each crop is reduced in comparison to the rate you would use if the crop were grown alone (monoculture). For example, in legume/cereal mixes, legumes often are planted at two-thirds of their monoculture rate. Cereal rates need to be high enough to protect the soil through the winter, but low enough to let legumes become established and emerge through the cereal canopy during rapid spring growth.

Irrigation

Irrigating fall cover crops allows them to germinate immediately and take advantage of remaining warm, sunny fall weather. The resulting plants provide better soil protection, catch more nutrients, are more frost-hardy, and are more prepared to resume growth in spring.

Inoculation of legume seeds

Legume roots must be colonized by an appropriate rhizobial bacteria in order to convert atmospheric N to plant-available N. There are many strains of rhizobial bacteria, and each works with only a limited number of legumes. Inoculation of legume seed before planting is inexpensive, relatively easy (follow manufacturer's instructions), and often is recommended to assure that suitable rhizobial bacteria are present.

However, in several Oregon trials, no response to inoculation was observed for commonly grown cover crop legumes, including vetches; fava beans; winter peas; and crimson, red, and white clovers. Therefore, inoculation may not be necessary. Poor legume production attributed to the lack of inoculation may be due to fertility, pH, or climatic effects. It is possible that "exotic" legumes may respond to inoculation, although inoculant availability is apt to be a problem.

You can check whether there is a response to inoculation in your fields by planting part of the field with inoculated seed and part with raw (noninoculated) seed. Watch for differences in growth and production.

Relay interplanting

Relay interplanting refers to the practice of planting a cover crop into a standing summer crop (Figures 9–11). Advantages over fall planting are no fall tillage, possibly better N scavenging, and better legume vigor the following spring.

The possibility that relay cover crops may compete with the summer crop for light, nutrients, and water should be considered. Optimally, relay interplant cover crops after the summer crop is well established but early enough so that sufficient light is available for the cover to become established. Trials in the Willamette Valley have shown that cover crops broadcast into established vegetable row crops do not suppress yields of vegetable crops, as long as soil fertility and irrigation are adequate.

Planting into a standing crop makes it more difficult to put the seed below the soil surface.

Often, relay-seeded crops are broadcast or dribbled onto the soil surface immediately before the last cultivation of the summer crop (Figure 12). A broadcaster mounted at the front of the cultivating tractor can do both jobs with one pass. The cultivation buries the seed and also may concentrate it in bands paralleling the row.

Keeping the soil surface moist by increasing irrigation frequency until the cover crop emerges improves establishment.

Relay cover crops have to survive the shade from the summer crop canopy and may be damaged by residual herbicides or summer crop harvesters or smothered by excessive amounts of summer crop harvest residue, resulting in patchy cover crop growth.

Grains, peas, vetches, clovers, and annual rye have been successfully relay interplanted into short statured crops such as broccoli.

Annual ryegrass, red clover, and some subclovers are more adapted for relay interplanting into tall-statured crops such as corn because of their ability to tolerate heavy harvest residues.

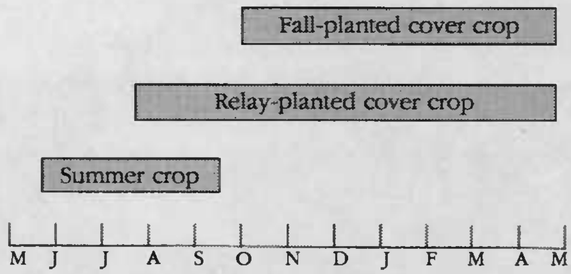


Figure 9.—Fall-planted cover crops are planted after the summer crop has been harvested and a seedbed has been prepared. Relay cover crops are planted into the standing summer crop, usually immediately before the last cultivation. Both fall and relay cover crops are incorporated in spring, allowing time for summer crop seedbed preparation.

Relay cover crops may be ideal for use with silage corn since all of the corn residue is removed, allowing the cover crop full access to the sun in fall. In fields receiving high fertilizer N or manure inputs, a relay interplanted cereal or grass can scavenge N before it is lost by leaching.

Figure 10.—Karridale subterranean clover relay-interplanted in sweet corn.

Figure 11.—Cereal rye relay-interplanted in broccoli.

Figure 12.—Relay interplanting a grain cover crop into broccoli.

Residual herbicide effects

If herbicides are used on the crop preceding a cover crop, it is important to make sure that residual herbicides will not affect cover crop growth. Check herbicide information sheets and, if in doubt, test cover crop germination in pots containing field soil before planting. This is especially important when relay interplanting a cover crop.

Cover crops and conservation tillage

Cover crops have been used successfully to produce surface mulches followed by no-till or reduced tillage planting of the following crop. Although some cover crops winter-kill, and others can be killed by close mowing or flailing in the spring, most need to be killed with herbicide. Flailing may be necessary, even if herbicides are used, to prevent planters from becoming clogged or entangled.

When no-till planting, specially designed heavy planters are required to cut through residue and get the seed in the soil. Often, part of the residue is pushed to the side to allow seedlings to emerge without obstacles. Strip tillage involves tilling narrow strips through cover crop residue into which the summer crop is planted (Figure 13).

Mulches slow soil warming and drying in spring. And while they provide a suitable environment for beneficial insects and earthworms, they also can harbor pests. For example, mulches are an ideal habitat for slugs, especially in western Oregon.

Mowing

Mowing tolerance varies among cover crops and depends on mowing height and stage of growth. Poor mowing tolerance is advantageous for cover crops used in annual systems. For example, many legumes can be killed if mown close to the ground after blooming. However, most cereals and grasses need to be near physical maturity before mowing will kill them, and they rarely are allowed to grow that long.

Figure 13.—Strip tillage.

Killing or suppressing cover crops and spring weeds with herbicides

If you plan to regulate cover crops and spring weeds with herbicides, you should consider factors such as efficacy and cost, as well as environmental conditions that might limit herbicide effectiveness or the ability to get into the field to apply the herbicide. All herbicides must be applied in accordance with label instructions and restrictions.

Glyphosate is very effective on small grain cereals and most winter annual broadleaf weeds. (Redstem filaree is an exception.) Typically, 1 pint to 1 quart per acre is sufficient to kill a cereal cover crop and most weeds.

However, the amount of material that actually reaches weeds under the cover crop canopy is critical to successful kill. Higher application rates increase herbicide contact with understory plants. If the canopy is open, lower rates may be used. Adding a nonionic surfactant improves the effectiveness of many glyphosate products.

In conservation tillage systems, splitting a glyphosate application may be useful and may reduce costs. You can apply a lower rate first (1 pint per acre) to kill only a cereal cover crop, then reapply glyphosate plus a preemergence material immediately after planting to kill surviving weeds and supplement the weed suppression of the mulch. Check the herbicide label for restrictions on cucurbits and other crops.

Glyphosate is not as effective in killing legumes as cereals. Adding a small amount of 2,4-D improves effectiveness, although you must wait at least 30 days to plant broadleaf crops after 2,4-D application. Check the herbicide label for other restrictions that may apply.

Paraquat can be used as a burndown treatment for cover crops. The same generalities apply to paraquat as to glyphosate. However, because the activity is not systemic, regrowth may occur on some cover crops, especially legumes. Paraquat is cheaper, but more difficult to handle, than glyphosate.

Incorporating cover crops

Allow sufficient time between incorporation and planting for the residue to decompose. The time needed varies, depending on the crop, its stage of growth, the total biomass incorporated, residue management, and soil temperature and aeration, but generally about 3 weeks is adequate. Even when succulent cover crops are incorporated, it's best to delay planting several weeks to reduce the risk of damage from certain soilborne pathogens (see "Pest interactions," page 17).

In annual systems, leguminous cover crops often are allowed to grow as long as possible in spring before being killed or incorporated.

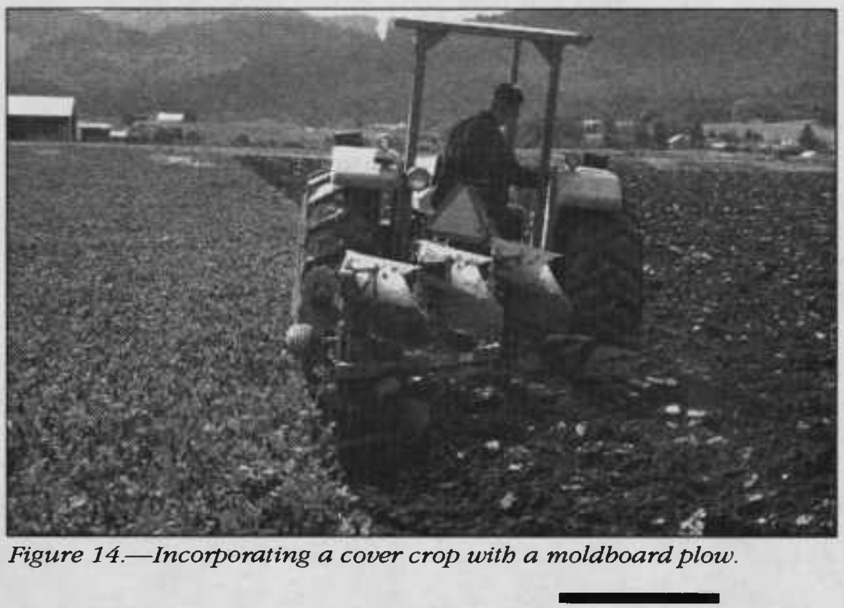


Figure 14.—Incorporating a cover crop with a moldboard plow.

Figure 15.—Disking in a cover crop.

This practice maximizes dry matter production (biomass) and N accumulation.

However, delaying the kill or incorporation date of cereals or grasses may result in excessive biomass production that can be difficult and expensive to manage, delay seedbed preparation, and interfere with N availability to a subsequent crop (See "Residue C:N ratios," page 7). Even legumes that decompose quickly and contribute to plant-available N occasionally produce so much biomass that it becomes difficult to mow and/or incorporate (e.g., crimson clover).

Experience has shown that a range of approximately 2–3 tons/acre of dry matter biomass allows for ease of mechanical soil incorporation. Usually it is desirable for cereals and grasses to be succulent when incorporated to speed decomposition and reduce competition by soil microbes for plant-available N.

It often is necessary to mow, chop, or flail cover crops prior to incorporation, especially if they are tall and have large stalks. Viny legumes such as vetches can become entangled in light tillage equipment if they are not mowed first. Heavy implements, including rotovators, heavy disk harrows, and power spades, have been used successfully without mowing.

Moldboard plowing kills cover crops effectively but places most of the residue in a layer well below the surface (Figure 14). Disking (Figure 15) or chisel plowing leaves the residue closer to the surface and does a better job of mixing it into the soil; however, you may need to herbicide-kill the cover crop before incorporation to prevent grow-back.

Allelopathy

When a plant suppresses germination or growth of another plant by chemical means, it is referred to as allelopathy. Some cover crops release toxins from their roots, which may contribute to weed suppression. Toxic substances also may be produced as some cover crop residues decompose, causing problems for germination and establishment of small-seeded crops such as lettuce. Large-seeded crops and transplants rarely are affected.

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.

Pest interactions

Cover crops can affect weed, insect, nematode, and plant pathogen populations positively and negatively. Cover crop interactions with pests often vary with the specific cover crop cultivar, the type of summer crop, and how each is managed. If you take these interactions into account when choosing a cover crop, you may be able to minimize pest problems and pesticide applications.

Although cover crops often are effective in smothering winter and early spring weeds, they sometimes can become weeds themselves if allowed to go to seed. Hard-seeded cover crops may cause problems if a portion of their seed persists in the soil and germinates at a time when it competes with the summer crop.

Cover crops can worsen disease problems if they act as hosts to plant pathogens or pathogen vectors that can damage the following crop. For example, fusarium root rot or white mold populations can build up in a legume cover crop and increase disease problems in a following legume summer crop. Likewise, staggered planting of cereals can provide a bridge for rusts (e.g., stripe rust) to overwinter or oversummer.

Conversely, cover crops sometimes act as "break" crops, disrupting reproductive cycles, thus reducing populations of pathogenic nematodes, fungi, bacteria, or viruses. Non-host cover crops simply deny pathogens or disease vectors the environment they need to survive.

In other cases, cover crops act on pathogens and disease vectors directly. For example, rapeseed, mustard, canola, and sudangrass residues release nematicidal compounds as they decompose. When planted in rotation with other non-host summer crops, and provided that host weeds are controlled, they can reduce Columbia root-knot nematode damage in potatoes in eastern Oregon.

It should be stressed that the ability of these cover crops to decrease nematode populations is specific to the particular nematode type and to the cropping system as a whole. One can't assume that these cover crops will control other nematodes.

Cover crops differ in their ability to attract and provide suitable overwintering environments for beneficial predatory arthropods (e.g., damsel bugs, staphylinid beetles, ground beetles, lady beetles, big-eyed bugs, lacewings, minute pirate bugs, hover flies, harvestmen, and spiders) as well as pollinating insects. Likewise, they vary in their propensity to harbor aphids and other insects that may damage following crops.

When cover crops are rich in beneficial insects, they may provide an early source of biological control of crop pests, provided that the beneficials survive residue management and seedbed preparation. Some ways to provide habitat for insects until they can move to the newly established summer crop include:

- Providing "tillage refuges" by retaining strips of cover crops during incorporation, killing, or mowing
- Staggering field preparation and planting dates in wide strips
- Reduced tillage methods

Figure 16 compares Carabid beetle (a beneficial predator) populations in clean-tilled broccoli versus a system in which habitat for beneficial insects was retained.

Unfortunately, generalizations are not possible, because tillage refuges also can act as sinks for beneficial insects, drawing them away from the summer crop because they prefer the cover crop environment. Also, spiders that are dispersed by wind are unlikely to be affected by cover crops at all.

Cover crop residue management can affect pathogen transfer to subsequent crops in some cases. For example, incorporating succulent residues often causes a sharp increase in some soilborne pathogen populations, especially damping-off fungi (e.g., *pythium*). If susceptible seed is planted shortly after succulent residue is incorporated, disease incidence may increase.

This problem can be avoided by delaying planting for several weeks after the cover crop has been incorporated, and by ensuring that soil temperature and seedbed preparation are optimal for rapid seedling emergence.

Also, whenever residue is left on the soil surface it creates an excellent environment for beneficial insects, earthworms, and slugs.

Variability of cover crop production

Cover crop productivity is highly variable from year to year. In the Willamette Valley, soil moisture (either too much or too little) seems to limit growth in many situations. Cold weather in early fall or low temperatures without snow cover any time during the winter may damage or kill cover crops. Relatively small differences in planting and harvesting dates can affect total yield considerably.

Cover crop production also can be patchy within a field. Causes include windblown snow that covers some areas and exposes others, soil moisture variability, and, in relay interplanted cover crops, damage from summer crop harvest and residues.

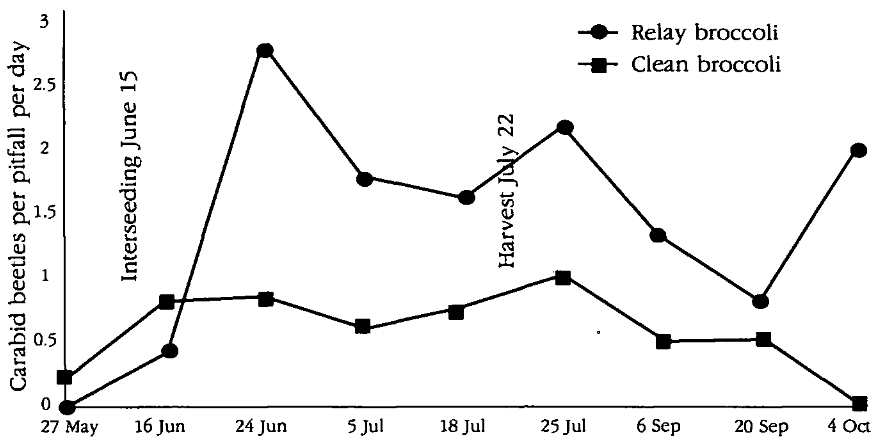


Figure 16.—Carabid beetle population trends in broccoli: relay interplanting versus clean tillage.

Cover Crops in Perennial Systems

Many of the concepts introduced in the section "Cover Crops in Annual Systems" apply to perennial systems as well and will not be repeated here.

Cover crops often are used in orchards, vineyards, berries, and other perennial crops to improve tilth and water infiltration and to reduce erosion, dust, and reflected light (Figures 17 and 18). They also may improve vehicular access, contribute nitrogen, and alter the populations of beneficial and harmful insects and soil organisms.

If you use cover crops in perennial systems where permanent or semipermanent cover is the goal, you can maintain the cover throughout the year by mowing. You can schedule mowing to provide or prevent reseeding, attract beneficial insects, or meet other management goals. Mowing tolerance usually is desirable and varies with the cover crop and the stage of growth.

Vetches and peas may climb trellises; do not use these crops where this could be a problem.

Remember that cover crops may compete for water and nutrients. Cover cropping often is delayed 1 or 2 years after new stock is planted to avoid stressing young trees or vines. Late spring incorporation of cover crops in every other row reduces competition for water and nutrients while still providing many cover cropping benefits. Self-seeding crops are advantageous in this situation.

Sometimes competition for nutrients is advantageous. For example, some wine grape growers use grasses, which typically take up large quantities of nitrogen, to reduce excessive vine growth.

Cover crops usually need to be shade-tolerant when used in perennial systems. Cover crop mixtures often do best in the varied light environment under perennial canopies, as each crop flourishes in the areas best suited for it.

Figure 17.—Cover crop used with Christmas trees.

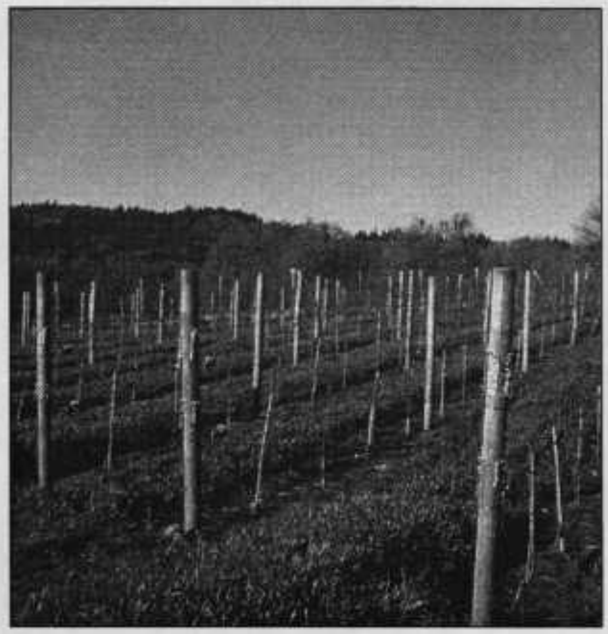


Figure 18.—Cover crop used with wine grapes.

Ambient air temperatures are lower over cover crops than over bare ground. However, if cover crops are mown close to the ground, the difference is small. If frost threatens during critical growing periods, mowing cover crops reduces the risk of frost damage.

Harvesting considerations may be important, especially for nut crops that require a smooth surface for efficient collection. For example, hazelnuts can be picked up from a uniform sod surface but not from a mixture of broadleaf and grass.

A practice known as "mow and blow" is used in orchards and berries. It consists of blowing cereal residue grown between rows into crop rows. The objective is to enhance weed suppression. In a raspberry trial in the Willamette Valley, Wheeler cereal rye provided better weed suppression than Amity oats, possibly due to allelopathic substances released by the cereal rye residue.

Estimating N Contributions to a Subsequent Crop

Generally, the accumulated N in non-legume residues is not available to following crops. However, a portion of the accumulated N in legume residue is. Legume/non-legume mixtures may or may not provide N to subsequent crops. (See "Residue C:N ratio," page 7.)

The amount of N that decomposing legume cover crops supply to a subsequent crop depends on many factors such as:

- The C:N ratio of the cover crop
- The amount of N accumulated in the cover crop
- Residue management
- Weather
- Soil type

To accurately calculate the amount of accumulated N in the cover crop, you would need to determine cover crop moisture and N content in a laboratory. However, by making assumptions about cover crop moisture and N content, you can estimate accumulated N as follows:

1. Sample a representative 16-square-foot area of the cover crop vegetation. Cut all vegetation within the sample area to ground level. Vegetation should be fresh, but not wet with rain or dew. If the field is large or the cover crop is not even, take several samples and either average them or treat them separately.
2. Weigh the sample (in pounds).
3. Multiply by the appropriate factor in Table 1 to find estimated pounds of N per acre in the cover crop.

Table 1.—N factor for various legumes.

Cover crop	N factor
Austrian winter pea	8
Crimson clover	5
Fava bell bean	9
Hairy or lana vetch	9
Karridale subclover	6
Kenland red clover	10

Not all of the N in incorporated residues will be available to the subsequent crop. It's impossible to predict exactly how much will be available even if the N content of the cover crop is known precisely.

However, experience in the Willamette Valley has shown that the "fertilizer equivalency" of incorporated *leguminous* cover crops is approximately one-half of the N in the aboveground portion of the cover crop. That is, fertilizer N applications can be reduced by an amount equal to one-half the N in a leguminous cover crop without reducing yields. See the box below for an example.

Example.—Estimating the N contribution to a following crop

Karridale subclover is cut from a 16 ft^2 area and found to weigh 14 lb

lb N in cover crop/acre = 14 lb x 6 = 84 lb

lb N available to a subsequent crop = 84 ÷ 2 = 42

Fertilizer N applications may be reduced by 42 lb N/acre

Economic Considerations

Several factors probably will change when a cover crop is introduced into a farming system. Examples include:

- Tillage
- Crop yield
- Seed costs
- Labor, water, fertilizer, and pesticide inputs

A short-term economic analysis compares anticipated or past costs with yields, for a system with and without cover cropping, to determine which is more profitable. A long-term economic analysis also might include the benefits from cover crops of reduced soil erosion and nitrate leaching, improved tilth from organic matter additions, and increased biodiversity.

For More Information

OSU Extension publications

The specific cover crop information sheets found on pages 25–50 of this publication also are available individually.

Annual Ryegrass, EM 8691

Barley, Oats, Triticale, Wheat, EM 8692

Buckwheat, EM 8693

Cereal Rye, EM 8694

Common Vetch, EM 8695

Crimson Clover, EM 8696

Fava Bean, EM 8697

Field Pea, EM 8698

Hairy Vetch, EM 8699

Rapeseed, EM 8700

Red Clover, EM 8701

Subterranean Clovers, EM 8702

Sudangrass, EM 8703

To order copies of the above publications, send the title and series number, along with a check or money order for 50 cents for each copy ordered, to

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To order additional copies of this publication, send a request for EM 8704, *Using Cover Crops in Oregon*, along with a check or money order for $5.50, to the above address.

We offer discounts on orders of 100 or more copies of a single title. Please call 541-737-2513 for price quotes.

World Wide Web

Orchard floor management information—htpp://www.orst.edu/dept/hort/weeds/floormgt.htm

OSU Extension Service publications—eesc.orst.edu (Choose "Educational Materials Catalog.")

The University of California, Davis cover crop information—http://www.sarep.ucdavis.edu/sarep/ccrop/

OSU Extension cereals Web page—http://www.css.orst.edu/crops/cereals/home.htm

Research publications

Publications summarizing OSU cover crop research are being developed on the following topics: pests, water quality, tillage and residue management, and soil quality and fertility. For information about availability, contact the OSU Department of Crop and Soil Science at:

Extension Soil Science
Oregon State University
ALS 3017
Corvallis, OR 97331

Annual Ryegrass *(Lolium multiflorum)*

R. Sattell, R. Dick, R. Karow, D. McGrath, and E. Peachey

Annual ryegrass is an erect, robust cool-season bunch grass that reaches a height of 3 to 4 feet. Plants are yellowish-green at the base and have 12-inch long glossy leaves. This species has a heavy, extensive, fibrous root system.

Annual ryegrass has small seeds (approximately 190,000 seeds/lb) that germinate rapidly. Seedlings quickly establish a ground cover and are very competitive. Annual ryegrass flowers in late May to early June and matures seed by late June to early July.

Environmental preferences and limitations

Annual ryegrass is tolerant of a wide range of soils and climates but is best adapted to valley and coastal areas with long seasons of cool, moist weather. It tolerates cold and can germinate in cooler soils than can most other cover crops. Annual ryegrass can grow on sandy soils but does best on heavier clay or silty soils with adequate drainage.

Although well-drained soils are preferred, annual ryegrass tolerates extended wet periods and temporary flooding. In a cover crop screening trial in the mid-Willamette Valley, 6-inch-tall annual ryegrass was observed flooded with 2 to 4 inches of water for 11 days with no ill effect.

Annual ryegrass tolerates pH from 5 to 8, with the optimum between 6.0 and 7.0.

Annual ryegrass is moderately shade-tolerant. It has been grown successfully in orchards during the winter when trees are bare; and when relay-interplanted into sweet corn, it survives intense shading from the corn canopy.

Uses

Annual ryegrass can be used as a cover crop in annual or perennial cropping systems, or as forage, hay, or a nurse crop for legumes. It often can be grown under conditions where other cover crops fail. Because it establishes quickly and grows throughout the fall and winter, it is an excellent choice for soil protection and weed suppression.

Annual ryegrass is suitable as a cover crop in grass waterways or riparian areas subject to flooding because it tolerates wet soils and temporary flooding.

It also commonly is used on poor soils or on sandy or rocky soils, where it normally produces better growth than do cereal species. It is a good choice for fast, temporary cover on exposed areas with minimal seedbed preparation, such as construction and burned areas.

Annual ryegrass has been used successfully as a relay-planted cover crop in both short- and tall-statured summer crops. Compared to cereal grains, its smaller seed allows better seed-soil contact under marginal seedbed conditions, and it is better at emerging from thick harvest residue (e.g., sweet corn).

Annual ryegrass is a heavy N feeder and can be used to scavenge N from the soil during the fall and winter, therefore reducing losses caused when rains leach nitrate below the root zone.

Dry matter and N accumulation

In a mid-Willamette Valley replicated trial over 3 years, annual ryegrass planted in mid-September accumulated a maximum of 4.8, minimum of 1.3, and average of 2.7 tons dry biomass/acre and a maximum of 76, minimum of 21, and average of 40 lb N/acre by mid-April. Very little or none of the N is available to the following crop due to the high C:N ratio of residues.

Management

Seeding rates vary depending on the intended use and the seeding technique. In general, relatively high rates of seeding are recommended, despite the relatively small seed size. When used as a cover crop, seeding

Quick facts: Annual ryegrass

Common names	Annual ryegrass
Hardiness zone	6 (see Figure 1)
pH tolerance	5–8; optimum is 6.5
Best soil type	Clayey or silty soils with adequate drainage
Flood tolerance	High
Drought tolerance	Moderate
Shade tolerance	Moderate
Mowing tolerance	High
Dry matter accumulation	Kill at 2–3 tons/acre
N accumulation	45 lb/acre at 3 tons/acre
N to following crop	Very little or none
Uses	Winter cover crop. Use in areas prone to flooding, to scavenge N, as relay-interplanted cover in tall-statured crops.
Cautions	In annual rotations, manage to prevent volunteer reseeding. Can be serious weed in grass seed crops.

rates range from 9–40 lb/acre. Use higher rates when broadcasting and when soil protection is important. Seed is widely available.

Suggested fall planting dates are from mid-September to mid-October. Best stand establishment is obtained when annual ryegrass is drilled ½ to ¾ inch deep into a firm, well prepared seedbed. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover the seed. If the soil is dry, irrigate or plant before a fall rain.

When relay interplanting, broadcast into a standing summer crop immediately before the final cultivation. Increase irrigation frequency while the annual ryegrass is germinating for more even establishment. Annual ryegrass will germinate on the soil surface if adequate moisture is maintained.

In annual rotations, kill or incorporate annual ryegrass in spring with sufficient time for decomposition to occur before planting the summer crop. Excessive dry matter production can interfere with residue management, spring planting, and N availability to the following crop, so annual ryegrass usually is killed or incorporated when still somewhat succulent.

*Figure 1.—Oregon plant hardiness zone map. Annual ryegrass normally will survive in **Zone 6** or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Higher rates of herbicide are required to kill annual ryegrass than cereal grain cover crops. Consult your county agent of the OSU Extension Service for recommended rates. Always apply herbicides in accordance with label instructions and restrictions.

Annual ryegrass often is grown in mixtures with legumes. When seeded with legumes, annual ryegrass provides early protection of the soil, suppresses weeds, and acts as a nurse crop. However, due to its vigorous growth, annual ryegrass may smother companion legumes. Reduce annual ryegrass seeding rates to decrease annual ryegrass competition for light, water, and nutrients.

When used in perennial systems such as orchards and vineyards, annual ryegrass can reseed itself if mowing schedules permit seed production. If a temporary cover is desired, you should kill, incorporate, or mow annual ryegrass before seed is mature.

Annual ryegrass is likely to tolerate mowing unless flailed at ground level in very dry conditions, but even then it may survive.

Pest interactions

Annual ryegrass is very vigorous and competes well with most weeds, especially when seeded with legumes. It harbors few aphids or beneficial insects.

Annual ryegrass can become a weed problem, especially in certified contaminant-free grass seed crops, when plants that escape herbicide and field treatments in spring produce seed. This problem can be minimized by careful field operations, especially at field edges.

For more information

This section on annual ryegrass also is available individually as EM 8691. To order copies, send your request and 50 cents per copy to:

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BARLEY, OATS, TRITICALE, WHEAT

(Hordeum vulgare, Avena sativa, Triticosecale X, Triticum aestivum)

R. Sattell, R. Dick, R. Karow, D. Kaufman, J. Luna, D. McGrath, and E. Peachey

Cereal grains are grasses and may have a prostrate, semierect, or erect physical stature. All have fibrous root systems.

Barley, oats, triticale, and wheat are each comprised of hundreds of varieties whose growth characteristics vary considerably. Since there is considerable overlap in growth characteristics among these grains, they are discussed together here.

New varieties constantly are being developed to meet the needs of grain producers. Usually, the seed available for cover cropping is limited to seed marketed for grain production and changes from year to year. Although these varieties have not been produced specifically for cover cropping purposes, they are adapted to Oregon's climate and soils.

Specialty varieties that are well adapted to cover cropping may be difficult to purchase if they are not popular varieties in your local area. Plan ahead and secure specialty seed sources early.

Uses

Cereal grains generally are used as fall-planted cover crops. They protect the soil surface, smother weeds, improve soil tilth, and scavenge nitrogen from the soil before it is leached below the root zone by winter rains.

Cereal grain cover crops also have been successfully relay-interplanted into short-statured summer crops (e.g., broccoli, cauliflower). That is, they are planted into a standing summer crop, usually at the time of the final cultivation. Cereal grains do not seem to be appropriate for relay planting into tall-statured summer crops such as sweet corn, because they do not tolerate shade and heavy harvest residue.

Winter-killed or herbicide-killed cereal grain cover crops produce protective surface mulches, which may be followed by no-till or reduced-tillage planting of the following crop.

Cereal grains often are planted in mixtures with legumes. When they are, they act as nurse crops in the fall and provide structural support to viny legumes in the spring.

When planted between berry rows, cereal grains suppress weeds, increase infiltration, and improve vehicular access.

Dry matter and N accumulation

The potential dry matter and N accumulation of a cereal grain cover crop depends on the variety planted. However, provided that the cereal grain is adapted to the area and survives the winter, the dry matter and N accumulation probably depend more on planting and kill dates than on the variety used.

Excessive dry matter production can slow soil warming and drying in spring, clog planters, and reduce N availability to following crops. Experiments in the Willamette Valley suggest that a yield of approximately 2–3 tons dry matter/acre provides the benefits of cover cropping without the problems caused by excessive dry matter. Yields as low as 1–1.5 tons/acre are desirable if direct seeding into herbicide-killed grain without tillage in spring.

Although cereal grains are capable of accumulating large amounts of N in their tissues, in general very little or none of the accumulated N is available to subsequent crops due to the relatively high carbon:nitrogen ratio of residues. The ratio of young and succulent cereal grains is intermediate but increases greatly in mature plants that contain high percentages of cellulose and lignin.

Management

Plant winter cereal grain cover crops from September 15 to

Quick facts: Barley, oats, triticale, wheat

Hardiness zone	Varies (see Figure 1)
pH tolerance	Varies
Best soil type	Varies
Flood tolerance	Varies
Drought tolerance	Varies
Shade tolerance	Varies
Mowing tolerance	High until maturity
Dry matter accumulation	Kill at 2–3 tons/acre in vegetable rotations
N accumulation	60 lb/acre at 3 tons/acre
N to following crop	Very little or none
Uses	Use as winter cover crop to protect soil, smother weeds, scavenge N, and improve tilth. Often planted with legumes.
Cautions	May provide overwintering habitat for cereal diseases that attack nearby cereal fields the following spring.

October 15 to increase winter hardiness and maximize winter soil protection. Note, however, that they may be planted any time of year in western Oregon and are a good choice as a late-sown cover crop.

Spring cereal susceptibility to winter-kill varies considerably, even among varieties of a particular species, and usually depends largely on planting date. Early planting dates increase the likelihood of winter-kill. Many spring cereals survive the winter in western Oregon when planted after September 21.

Best results are obtained when cereal grains are drilled into a firm, well-prepared seedbed. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover the seed.

Suggested seeding rates vary with seed size, germination rate, and planting method. Generally a rate of 70–90 lb/acre is adequate, but winter weed suppression can be improved considerably by increasing those rates by 50 percent. A seeding rate of 45 seeds/ft^2 is good for weed suppression—seeding rates can be calculated after measuring the average seed weight. Reduce seeding rates when planting in mixtures with legumes.

Figure 1.—Oregon plant hardiness zone map. Hardiness of barley, oats, triticale, and wheat varies. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Immediately after the summer crop harvest, there may be sufficient moisture near the soil surface for cereal grains to germinate without irrigation. If the soil is dry, irrigating speeds germination and fall growth. Where irrigation is not available, plant before a fall rain.

Relay-interplanted cereal grains are broadcast into a standing summer crop, usually before the final cultivation, which incorporates the seed into the soil. Grains may go to seed before winter if relay-interplanted too early. Increasing irrigation frequency during cover crop establishment can improve the stand.

Kill and/or incorporate cereal grains in spring when total aboveground dry matter is about 2–3 tons/acre, and plants still are relatively succulent. Generally, incorporation should occur a minimum of 3 weeks before planting to allow sufficient time for residues to decompose.

Moldboard plows are more effective at killing cereal grains than disks, but they also place the residue in a layer well below the soil surface. Disking or chisel plowing keeps residues closer to the surface, but the cover crop may need to be herbicide-killed first to prevent grow-back.

Consult your county agent of the OSU Extension Service for herbicide recommendations. Always apply herbicides in accordance with label instructions and restrictions.

Mowing usually doesn't kill immature cereal grains. Although mowing may kill cereal grains that are approaching physical maturity, they rarely are allowed to grow that long.

Pest Interactions

When used for weed suppression between rows of berries, mow fall-planted cereal grains before seed matures. Residues and stubble continue to suppress weeds throughout harvest.

Cereal grain cover crops may provide habitat for overwintering diseases (e.g., stripe rust) that may attack nearby grain fields the following spring.

Varieties/cultivars

Late-maturing and short-statured varieties may decrease the likelihood of excess dry matter production and offer more flexibility in the timing of spring residue management operations.

The physical stature of cereal grains varies from fully erect to nearly prostrate. Erect or semierect varieties work best as nurse or companion crops when planted in mixtures with legumes. Prostrate varieties quickly cover the soil surface, maximizing soil protection.

For more information

This section on cereal grains also is available individually as EM 8692. To order copies, send your request and 50 cents per copy to:

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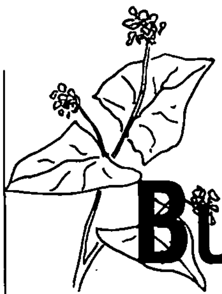

BUCKWHEAT *(Fagopyrum esculentum/Fagopyrum sagittatum)*

R. Sattell, R. Dick, R. Karow, and D. McGrath

Buckwheat is a fast-growing, warm-season, succulent, broad-leaved annual attaining a height of 2 to 4 feet. It has one main stem with several smaller branches. Leaf shape is roughly triangular, and flowers are white, pink, or red. Seeds are of two types depending on the variety: large and dark-colored with triangular-shaped sides, or smaller and gray-colored, with a rounder shape. The root system is fibrous, has a relatively large volume, and is concentrated in the plow layer.

Buckwheat germinates within days of planting, grows rapidly, begins to flower in 4 to 5 weeks, and may continue to flower for several more weeks. Seed matures 2 to 3 weeks after flowering.

Environmental preferences and limitations

Buckwheat can germinate and grow at temperatures as low as 45°F, but optimal growth occurs at 55°F or higher. It is very frost-sensitive and does not survive even light frosts. Buckwheat has a low water requirement and does not do well in wet soils. It can tolerate poor fertility and a wide range of soil pH, but is not shade-tolerant.

Uses

Buckwheat is used as a warm-season cover crop. Its rapid germination and growth cycle make it ideal for use in rotations that otherwise would leave fields bare during short periods of late spring or summer. Buckwheat is an excellent choice in these situations to smother weeds, protect the soil surface, and provide insect habitat.

There is a market in Oregon for buckwheat seed, which is used for human and animal consumption. If circumstances warrant it, a buckwheat cover crop can be allowed to mature, and then harvested.

Buckwheat flowers provide a source of nectar for honeybees and native pollenizers. Buckwheat pollen is a food source for many insects, and seeds are a food source for ground-dwelling birds including pheasant and quail.

Buckwheat is not likely to increase soil organic matter content much because dry matter production is relatively low and tissues are succulent and decompose very rapidly when incorporated. However, buckwheat can improve short-term soil tilth and has been used to prepare fields for transplants.

Buckwheat is particularly efficient at taking up phosphorus from the soil and storing it in its tissues. There is some evidence that incorporating buckwheat residues can increase phosphorus availability to the following crop.

Dry matter and N accumulation

Dry matter production and N accumulation of buckwheat are relatively low. The N in incorporated residues is not likely to be available to following crops. However, because decomposition is rapid, incorporated residues do not reduce N availability for following crops.

Management

Buckwheat may be planted in spring or early summer. When buckwheat is planted in late summer, decreasing day length forces it to flower soon after it emerges, preventing further growth.

Cover crop seeding rates are approximately 40–45 lb/acre, which is higher than the rates suggested for maximum seed production. Increase seeding rates if using varieties with larger seeds or if broadcast seeding.

Drill buckwheat seed to a depth of ½ to 1 inch, or broadcast and incorporate it with a light disking.

Quick facts: Buckwheat

Common names	Buckwheat
Hardiness zone	10, i.e., no frost tolerance (see Figure 1)
pH tolerance	Wide range; optimum is 6.0–7.0
Best soil type	Wide range; tolerates poor fertility
Flood tolerance	Low
Drought tolerance	Moderate
Shade tolerance	Moderate
Mowing tolerance	Low
Dry matter accumulation	Less than 1 ton/acre
N accumulation	Low
N to following crop	Very little or none
Uses	Use as spring or early to mid-summer cover crop to smother weeds and improve tilth. Rapid growth, easy incorporation, and fast decomposition allow use during short fallow periods.
Cautions	Requires warmth. No frost tolerance. Will flower soon after emerging when planted in late summer, limiting growth.

You can grow two or more buckwheat crops successively by planting a crop immediately after incorporating the previous crop.

Buckwheat has a low water requirement. Afternoon wilting does not necessarily mean that soil moisture needs to be increased. Often the plants revive during the night with no ill effects, only to wilt again the following afternoon.

Buckwheat generally is mown or incorporated within 2 weeks of first flower to prevent production of viable seed that could cause a weed problem in following crops. Residues are easily incorporated with a disk. They decompose rapidly and rarely interfere with planting subsequent crops.

Figure 1.—Oregon plant hardiness zone map. Buckwheat normally will survive in ***Zone 10*** *or any warmer zone; thus it is not winter-hardy in Oregon. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Pest interactions

Buckwheat's rapid growth makes it an excellent choice for smothering weeds during the warm season.

Buckwheat flowers are attractive to bees and beneficial predatory insects such as hoverflies, predatory wasps, insidious flower bugs, and *Scoliidae*. The tarnished plant bug, a pest, also has been observed to be abundant on buckwheat.

Varieties/cultivars

'Tempest' and 'Tokyo' are older varieties of buckwheat. They have small seeds and mature in midseason. 'Mancan' and 'Manor' are newer varieties developed in Canada that have a vigorous growth habit as well as larger seeds, stems, and leaves. Semidwarf varieties that resist lodging also have been developed.

For more information

World Wide Web

Orchard floor management information—http://www.orst.edu/dept/hort/weeds/floormgt.htm

OSU Extension Service publications—eesc.orst.edu

The University of California, Davis cover crop information—http://www.sarep.ucdavis.edu/sarep/ccrop/

Oregon Cover Crop Handbook

This section on buckwheat also is available individually as EM 8693. To order copies, send your request and 50 cents per copy to:

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CEREAL RYE *(Secale cereale L.)*

R. Sattell, R. Dick, R. Karow, D. Kaufman, D. Hemphill, J. Luna, and D. McGrath

Cereal rye is an erect annual grass with greenish blue, flat blades and an extensive fibrous root system. It resembles wheat, but usually is taller (3–5 ft) and tillers less. Flowering is induced by 14 hours of light in spring. Vegetative growth stops when reproduction begins.

Compared to other cereal grains, cereal rye grows faster in fall and winter and produces more dry matter per unit area as a winter cover crop. Mature residues tend to have high C:N ratios and high percentages of lignin and cellulose that are slow to decompose.

Environmental preferences and limitations

Cereal rye grows best on well-drained loamy soils but is tolerant of both heavy clays and droughty, sandy soils. It often grows in infertile soils where other cereal grains fail. Optimum soil pH is 5.0–7.0, but pH in the range of 4.5–8.0 is tolerated.

Cereal rye is the most winter-hardy of all cereal grains, enduring temperatures as low as -30°F once established. It can germinate and grow at temperatures as low as 33°F; however, optimal temperatures are much higher.

Cereal rye tolerates drought better than do the other cereal grains, in part because of its extensive root system. It grows best with ample moisture, but excessive moisture during the fall and winter suppresses vegetative growth. Cereal rye does not tolerate flooding.

Snow is readily trapped by the cereal rye plant, providing insulation from cold weather and increasing water availability in dry climates.

Uses

Cereal rye may be used as a cover crop, grain, hay, or pasture. It is one of the best cover crops where soil fertility is low and/or winter temperatures are extreme. Cereal rye is an excellent choice as a late-sown cover crop. In western Oregon it may be planted any time of the year.

Because it establishes rapidly in cool weather and grows throughout the winter, cereal rye is excellent for protecting the soil from wind and water erosion, scavenging soil-N before it is leached below the root zone, and suppressing weeds.

Cereal rye's extensive root system makes it among the best cover crops for improving soil structure. Incorporating mature residues can improve water infiltration and aeration and add substantial quantities of organic matter to the soil.

Cereal rye has been used successfully in Oregon as a relay-interplanted cover crop in short-statured crops such as broccoli and cauliflower.

Dry matter and N accumulation

In a mid-Willamette Valley replicated trial over 4 years, cereal rye planted in mid-September accumulated a maximum of 5.3, minimum of 1.3, and average of 3.6 tons dry matter/acre and a maximum of 125, minimum of 29, and average of 86 lb N/acre by mid-April.

Due to cereal rye's relatively high carbon:nitrogen (C:N) ratio, very little or none of the accumulated N is available to the following crop.

Management

Suggested seeding rates vary from 60 to 100 lb/acre. Use higher rates when drilling into a rough seedbed, broadcasting, seeding late in the fall, relay interplanting, or controlling erosion. In general, seed is drilled into a prepared seedbed, or broadcast and tilled lightly. Seed is inexpensive and readily available.

Excessive amounts of spring residue produced by cereal rye can delay planting and actually decrease

Quick facts: Cereal rye

Common names	Cereal rye, rye
Hardiness zone	3 (see Figure 1)
pH tolerance	4.5–8.0; optimum is 5.0–7.0
Best soil type	Wide range, tolerates poor fertility
Flood tolerance	Low
Drought tolerance	High
Shade tolerance	Moderate
Mowing tolerance	High until maturity
Dry matter accumulation	Kill at 2–3 tons/acre
N accumulation	70 lb/acre at 3 tons/acre
N to following crop	None
Uses	Survives in cold, droughty, and/or infertile soils. Use to protect soil, smother weeds, scavenge N, and improve tilth. Often planted with legumes.
Cautions	Do not use in fields where conditions do not allow early spring field operations to kill cereal rye, or there may be excessive dry matter accumulation.

the availability of N to subsequent crops. To avoid these problems, cereal rye often is killed with an herbicide or incorporated when less than 18 inches high and still somewhat succulent. However, wet weather may prevent timely field operations, resulting in larger amounts of spring residue than desired.

If cereal rye is incorporated when less than 12 inches tall, or if incorporation is not thorough, an application of herbicide may be needed to prevent grow-back.

Cereal rye can be killed with an appropriate herbicide. Consult your county agent of the OSU Extension Service for recommendations. Follow all herbicide label instructions and restrictions.

In general, cereal rye cannot be killed by mowing except when nearly mature, and it rarely is allowed to grow that long.

Cereal rye has performed well when planted in mixtures with legumes. During the fall and winter, cereal rye protects the soil, scavenges soil-N, and acts as a nurse crop for legumes. In spring, cereal rye provides structural support for climbing legumes. The relatively high N content of legumes reduces the overall C:N ratio of cereal rye/legume mixtures, and minimizes problems involving nitrogen availability to the following crop.

Figure 1.—Oregon plant hardiness zone map. Cereal rye normally will survive in ***Zone 3*** *or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

When used for weed suppression in berries, cereal rye planted between the rows may be mowed before seed matures and then blown into the row to suppress weeds there as well. This practice is referred to as "mow and blow." In Willamette Valley raspberry trials, cereal rye provided better weed suppression than Amity oats.

Cereal rye can become a volunteer weed and should be used with caution in rotations with other grains to avoid contamination.

There is evidence in Oregon that a pure stand of cereal rye causes a 5–10 percent decrease in sweet corn and broccoli yield (only crops tested). However, this effect disappears when cereal rye and a legume are planted in a mix.

Pest interactions

Cereal rye produces several compounds in its plant tissues and root exudates that apparently inhibit germination and growth of weeds and crops. These allelopathic effects, together with cereal rye's ability to smother other plants with cool weather growth, make it an ideal choice for weed control.

However, allelopathic compounds may suppress germination of small-seeded vegetable crops as well if they are planted shortly after the incorporation of cereal rye residue. Large-seeded crops and transplants rarely are affected. There is some evidence that the amount of allelopathic compounds in tillering plants is lower than in seedlings.

High densities of Bird Cherry oat aphids have been observed in cereal rye during late winter and early spring. These aphids carry viruses and may cause a problem if other grains are grown nearby.

However, Bird Cherry oat aphids do not affect vegetable plantings. Generalist predators thrive in the spring using these grain aphids as a food source, then move to other nearby crops as cereal rye approaches maturity.

Varieties/cultivars

New short-statured and late-maturing varieties produce less dry matter and allow more flexibility in the scheduling of spring field residue management operations.

An alternative to cereal rye is short-statured triticale, which has the hardiness of rye but produces less dry matter.

For more information

This section on cereal rye also is available individually as EM 8694. To order copies, send your request and 50 cents per copy to:

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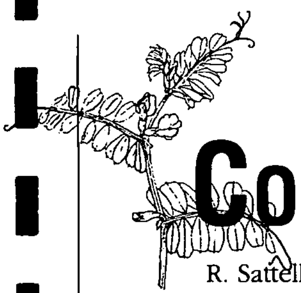

Common Vetch *(Vicia sativa L.)*

R. Sattell, R. Dick, J. Luna, D. McGrath, and E. Peachey

Common vetch is a viny, succulent, annual legume attaining a height of 24 inches when planted alone. It grows taller when planted with a tall companion crop that provides structural support for climbing. Stems are thin, branched, and usually smooth. Leaves are composed of 4 to 10 paired leaflets, terminate with a tendril, and usually are smooth. Leaflets are broader and appear more succulent than those of hairy vetch. Common vetch has a taproot that can reach depths of 3 to 5 feet.

Common vetch flowers from April to May and ripens seed from mid- to late June. Flowers are violet-purple or sometimes white. Relatively large (approximately 7,000 seeds/lb), smooth, spherical seeds develop in small brown pods. Seeds are brownish, dull gray, or black. Unlike hairy vetch, common vetch is not hardseeded and therefore is less likely to become a weed problem if plants escape at field edges or go to seed before incorporation.

The winter growth rate of common vetch is intermediate and is greater than that of hairy vetch in western Oregon. In general, however, growth is slow during cool weather, and rapid in warm spring temperatures.

Environmental preferences and limitations

Common vetch is moderately resistant to cold. It usually overwinters in western Oregon where winters are mild and minimum annual temperatures are above 10°F. It is likely to winter-kill in eastern Oregon.

Common vetch grows on a wide range of soils. It does well on loams, sandy loams, or gravelly soils, as well as on fine-textured clay soils as long as there is good drainage. Although common vetch tolerates short periods of saturated soils, it does not tolerate extended flooding.

Common vetch tolerates pH of 5.5–8.2, but optimum pH is 6.5. Common vetch is somewhat shade-tolerant but does not do well when relay interplanted into tall-statured vegetable crops such as sweet corn.

Uses

Common vetch is used as a cover crop, green manure, pasture, silage, and hay. Its high dry matter and nitrogen accumulation, and the absence of hard seeds, make it an excellent winter leguminous cover crop in annual vegetable rotations. When planted alone, it can provide substantial amounts of N to the following crop.

Common vetch offers excellent spring weed suppression. It also grows well in mixtures with cereal grains that can provide both cool-weather weed suppression and fall N scavenging.

Common vetch has been used successfully as a cover crop in vineyards and orchards. In vineyards, common vetch is less likely to climb trellises than hairy vetch.

Dry matter and N accumulation

Fall planting date, weather, and choice of companion cereal crop, if any, can influence the quantity of vetch dry matter and N accumulation by spring. Since much of vetch's growth occurs in April and May, the longer the crop is allowed to grow before killing it in the spring, the more N is accumulated in plant tissues.

The N content of dry vetch residues varies from 2.5 to 3.2 percent. Nitrogen quantities in above-ground biomass of vetch grown in mixtures with cereal cover crops in the Willamette Valley range from approximately 50 lb/acre in mid-April to 120 lb/acre in mid-May.

Quick facts: Common vetch

Common names	Common vetch, spring vetch
Hardiness zone	8 (see Figure 1)
pH tolerance	5.5–8.2; optimum is 6.5
Best soil type	Wide range with adequate drainage
Flood tolerance	Low
Drought tolerance	Low
Shade tolerance	Moderate
Mowing tolerance	Before flowering: high. During flowering: moderate if mown high, low if mown close
Dry matter accumulation	2–3 tons/acre
N accumulation	50–120 lb/acre
N to following crop	Approximately half of accumulated N
Uses	Use as winter cover crop in annual rotations and in orchards and vineyards to smother spring weeds, fix N, and improve tilth. Often grown with cereal grains.
Cautions	May climb trellises.

Management

Suggested monoculture seeding rates are 60–75 lb/acre. When grown with cereals, reduce the rate to 40–50 lb/acre. Suggested seeding dates for maximum winter-hardiness range from mid-September to mid-October.

Best stand establishment is obtained when seed is drilled ¼ to 1 inch deep into a firm, well prepared seedbed. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover the seed. If the soil is dry, irrigate or plant before a fall rain.

Common vetch roots need to be colonized by an *appropriate* strain of rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Generally, inoculation of seed is not necessary in Oregon because the bacteria are present in the soil. If you choose to inoculate, you might plant a small section of the field with raw (non-inoculated) seed and watch for differences in growth.

Common vetch tolerates close mowing before flowering and high mowing during flowering. Close mowing during peak flowering may kill common vetch.

*Figure 1.—Oregon plant hardiness zone map. Common vetch normally will survive in **Zone 8** or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Mowing before incorporation in spring prevents tillage implements from becoming entangled by the viny stems. Flailed vetch/cereal cover crops also have been used as a weed-suppressive, moisture-conserving mulch in strip-tillage systems.

Vetch residues are succulent and decompose quickly. The decomposition rate for residues from cereal/common vetch mixtures varies depending on the relative percentage of each.

In western Oregon, planting common vetch in mixtures with a cereal greatly improves winter weed suppression compared to a monoculture of either. Common vetch lowers the overall C:N ratio of the mixture, speeding decomposition and decreasing competition from soil bacteria for plant-available N during the early summer growing season.

Some spring cereal varieties are likely to winter-kill if planted in early September, allowing the vetch to grow without competition in spring. Winter-kill susceptibility varies greatly among varieties. Cereals or grasses that do not winter-kill provide structural support for common vetch vines, preventing them from rotting by reducing their contact with the soil.

Pest interactions

Incorporation of succulent common vetch residues often causes a sharp increase in soil-borne pathogen populations, especially damping-off fungi (e.g., *pythium*). If susceptible seed is planted shortly after incorporation, disease incidence may increase. Avoid this problem by waiting several weeks after residue incorporation to plant, and by ensuring that soil temperature and seedbed preparation are optimal for rapid summer crop seedling emergence.

In a study in southern Oregon, orchards with vetch cover crops were particularly prone to outbreaks of twospotted spider mite (*Tetrany-chus urticae* Koch). Application of herbicides increased the movement of mites into trees.

Common vetch has extrafloral nectaries on its stipules, the leaf-like structures at the base of the leaf petioles. Extrafloral nectar is available to short-tongued insects that do not have access to the nectar of legume flowers. Both beneficial and pest insects (e.g., lygus bug) feed on extrafloral nectar.

Varieties/cultivars

Common vetch usually is available on a generic basis; however, the variety 'Willamette' has been reported as having special cold tolerance.

For more information

This section on common vetch also is available individually as EM 8695. To order copies, send your request and 50 cents per copy to:

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Crimson Clover *(Trifolium incarnatum L.)*

R. Sattell, R. Dick, D. Hemphill, J. Luna, and D. McGrath

Crimson clover is an erect annual legume that grows up to 2.5 feet tall. Its foliage is light-green and covered with soft hairs. In spring, crimson clover may be identified by the oblong, bright crimson-colored flower, carried at the end of erect, hairy flower stems. The root system consists of a central taproot and fibrous branch roots. Seeds are small (90,000–150,000/lb).

Crimson clover generally is planted in the fall. During the fall and winter, it grows slowly, the leaves forming a low rosette clump. It puts on most of its growth in spring, when tall, erect flower stems emerge and develop leaves at numerous nodes. Flowering is induced when day length exceeds 12 hours. Crimson clover reseeds well if allowed to mature and if sufficient moisture is available. Many varieties have high proportions of hard seed.

Environmental preferences and limitations

Crimson clover does not survive extreme heat or cold and grows best in cool, humid weather. It cannot endure much drought and does not do well on poorly drained soils. Moist soil is essential for germination and establishment.

Crimson clover is adapted to soils of low fertility and has an intermediate lime requirement. It can tolerate pH ranging from 4.8–8.2 but does better at pH closer to 6.5. It grows on a wide range of soil types as long as drainage is good; however muck or extremely acid soils do not support good growth.

Crimson clover is moderately shade-tolerant.

Uses

Crimson clover may be used as a cover crop, green manure, pasture, or hay. It often is used as a winter annual cover crop in annual rotations. It has been used successfully in reduced-tillage farming systems, and in orchards and vineyards where it can be managed to reseed itself.

It may be relay-interplanted into vegetable crops by broadcasting immediately before the final cultivation. However, Willamette Valley trials where crimson clover was relay interplanted into sweet corn have produced mixed results. Intensive shade, seedling water stress, and heavy harvest residue often result in very thin stands. Surviving clover may flower in fall, reducing its winter-hardiness.

Dry matter and N accumulation

In a mid-Willamette Valley replicated trial over 5 years, 'Common Dixie' crimson clover planted in mid-September accumulated a maximum of 4.5, minimum of 0.9, and average of 2.8 tons dry matter/acre and a maximum of 157, minimum of 55, and average of 108 lb N/acre by mid-April.

Management

Suggested seeding rates for crimson clover range from 15–25 lb/acre. Best stand establishment is obtained when crimson clover is drilled ½ to ¾ inch deep into a firm, well-prepared seedbed. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover seed. If the soil is dry, irrigate or plant before a fall rain.

Plant crimson clover early enough so that the stand is established at least 6 weeks before the first frost to prevent frost heaving damage and winter-kill. Plant prior to October 1 in western Oregon.

Crimson clover roots need to be colonized by an *appropriate* strain of

Quick facts: Crimson clover

Common names	Crimson, scarlet, Italian, and incarnate clover
Hardiness zone	6 (see Figure 1)
pH tolerance	4.8–8.2, optimum is 6.5
Best soil type	Wide range with adequate drainage
Flood tolerance	Low
Drought tolerance	Low
Shade tolerance	Moderate
Mowing tolerance	High if mown higher than 4 inches
Dry matter accumulation	3 tons/acre
N accumulation	110 lb/acre
N to following crop	Approximately half of accumulated N
Uses	Use as winter cover crop in annual rotations and self-seeding cover in perennial systems to smother spring weeds, fix N, and improve tilth. Often grown with cereal grains. Use hard-seeded varieties if irrigation is not available.
Cautions	Needs moist soil to germinate, and seedlings do not tolerate drought. Can become weed in following crop.

rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Inoculating seed with the proper rhizobia bacteria ensures that the bacteria will be present when the seed germinates. Use fresh inoculant, protect it from heat and light, and apply it to seeds just before planting according to the manufacturer's directions. Cover broadcasted seed with soil to protect inoculant from sunlight.

You may not need to inoculate if the appropriate rhizobia bacteria already are present in the soil. You can find out by planting a section of the field with raw (non-inoculated) seed and watching for differences in growth.

Seedlings are not drought-resistant and may die if dry fall weather follows germination, and irrigation is not available. Varieties that have high percentages of hard seed (e.g., 'Common Dixie') work best in this situation because ungerminated seeds remain in the soil and germinate when rains begin again.

Crimson clover often is grown in mixtures with cereal grains, annual ryegrass, and less commonly, with other legumes. Seeding rates of clover and the companion crop are reduced from their monoculture rate, but generally the seeding rate of crimson clover is reduced less than that of the companion crop.

Figure 1.—Oregon plant hardiness zone map. Crimson clover normally will survive in ***Zone 6*** *or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Once established, crimson clover should be mowed or grazed no closer than 3 to 5 inches. Mowing or grazing can improve growth and reduce lodging.

Crimson clover can be killed with an herbicide. Consult your county agent of the OSU Extension Service for recommendations. Follow all herbicide label instructions.

Crimson clover often is mown or flailed before incorporation with a moldboard plow or disk. Stems become very tough if allowed to reach maturity, slowing field operations. It's best to incorporate residues about 3 weeks before planting to allow time for decomposition.

When self-reseeding is desired in orchards and vineyards, the use of hardseeded varieties increases success. Plan mowing schedules to allow seed to reach maturity because crimson clover flowers are carried at the top of the plant. Likewise, closely control grazing to prevent removal of too many flowers.

Pest interactions

Crimson clover flowers produce a large quantity of nectar and attract bees and beneficial insects, including lady beetles and minute pirate bugs.

Crimson clover is more resistant to diseases than are most alternative clovers, tolerating viral diseases unless sowing occurs in midsummer.

In general, crimson clover is tolerant of weeds.

Varieties/cultivars

Common varieties of crimson clover germinate rapidly with a minimum of hard seed. The varieties 'Dixie,' 'Autauga,' 'Auburn,' 'Chief,' and 'Kentucky' were developed to self-reseed and have a high proportion of hard seed. They are most appropriate for fall planting when irrigation will not be used. 'Common Dixie' crimson clover is widely available in Oregon.

For more information

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Fava Bean *(Vicia faba L.)*

R. Sattell, R. Dick, and D. McGrath

Fava bean, actually a vetch, is an erect, leafy, winter or spring annual legume, growing from 2 to 6 feet tall. One or more thick, unbranched stems grow from the base of the plant. Compound leaves are composed of two to six large, broad, fleshy leaflets that have no tendrils. White flowers with black or dark purple markings occur alone or in groups. Large, flat, oblong seeds (500–3,000/lb) develop in pods.

Fava bean has a deep taproot from 1 to 3 feet in length.

Environmental preferences and limitations

Cold tolerance among fava bean cultivars varies, but most varieties winter-kill at temperatures below 15°F, and even the most winter-hardy winter-kill at temperatures below 10°F. Fava bean grows during cool weather when other vetches and clovers are relatively dormant, but does not tolerate heat well.

Fava bean can grow on a wide range of soils, from loams to clays, and under a variety of drainage conditions. However, it does not tolerate extended periods of saturated soils; and drought, especially at flowering, reduces seed production drastically.

Fava bean tolerates a wide range of pH (4.5 to 8.3), although low pH may delay the development of root nodules, thus preventing the plant from converting atmospheric nitrogen to plant-available forms.

Uses

Fava bean is used as a winter or spring cover crop, green manure, silage, forage, hay, and vegetable. It is capable of producing large amounts of dry matter and accumulating large quantities of nitrogen (N), part of which is available to subsequent crops.

The large, deep taproot is ideal for opening up heavy, compacted soils. And although incorporated leaves decompose rapidly, stem residues persist longer and help to loosen clayey soils.

Fava bean is ideal for use in home gardens because it is easy to incorporate by hand or with small equipment.

Dry matter and N contributions

Dry matter and N accumulation in fava bean depends on the variety and can be highly variable. In a mid-Willamette Valley field trial planted in mid-September, a large-seeded cultivar winter-killed the year it was planted, and small-seeded cultivars winter-killed 2 of the 4 years they were planted. The years the small-seeded cultivars survived, they produced 4.6 and 2.1 tons dry biomass/acre and accumulated 202 and 83 lb N/acre by mid-April.

Note that the variety 'Banner bean' was planted just 30 miles to the south of the field trial during the same years and survived the winters, probably due to its greater cold tolerance.

Management

In areas of western Oregon where minimum annual temperatures are above 15°F, plant winter-hardy varieties in September or the first week of October. Plant in early spring where temperatures are colder.

Seeding rates for fava bean are 80–200 lb/acre for cultivars with smaller seeds (the Willamette Valley trial used 125 lb/acre) and 150–300 lb/acre for cultivars with larger seeds.

Best stand establishment is obtained by planting 1 to 3 inches deep (to moisture) into a firm, well-prepared seedbed, using a drill set to

Quick facts: Fava bean

Common names	Fava bean, broadbean, windsorbean; bell, horse, tick, or field bean
Hardiness zone	8 or 9 (see Figure 1)
pH tolerance	4.5–8.3; optimum near 7.0
Best soil type	Wide range
Flood tolerance	Low
Drought tolerance	Low
Shade tolerance	No information
Mowing tolerance	Low
Dry matter accumulation	3.5 tons/acre
N accumulation	140 lb/acre
N to following crop	Half of accumulated N
Uses	Large taproot and persistent stem residues loosen compacted soils. Grows well in cool weather and fixes large amounts of N.
Cautions	Many varieties winter-kill some years in hardiness zone 8.

30-inch rows or a common corn planter. The distance between plants in the row should be approximately 6 inches. Well-drained seedbeds, cool weather, and moderate moisture all favor good stand establishment. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover the seed. If the soil is dry, irrigate or plant before a fall rain.

Because high seeding rates can make planting a fava bean cover crop expensive, some growers allow part of their fava bean cover crop to go to seed. Harvested seed provides stock for the following year's cover crop.

Fava bean roots need to be colonized by an *appropriate* strain of rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Inoculating seed with the proper rhizobia bacteria ensures that the bacteria will be present when the seed germinates. Use fresh inoculant, protect it from heat and light, and apply it to seeds just before planting according to the manufacturer's directions. Cover broadcast seed with soil to protect inoculant from sunlight.

Fava bean can tolerate high mowing but does not withstand close mowing or grazing.

Figure 1.—Oregon plant hardiness zone map. Fava bean normally will survive in ***Zone 8*** *or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

The best time to incorporate fava bean is at the beginning of blossom. Flailing or mowing before incorporation usually is necessary to break up the tall stalks.

Fava bean often is mixed with other legumes or cereals for use as a cover crop, green manure, forage, or silage.

Pest interactions

Pure stands of fava bean do not do a good job of suppressing weeds unless they are sown very densely. Planting fava bean in mixtures with other legumes or grasses improves weed suppression.

Many beneficial insects, including predatory wasps and lady beetles, are attracted to the nectar of flowering fava bean.

Fava bean also has extrafloral nectaries on its stipules, the leaf-like structures at the base of the leaf petioles. Extrafloral nectar is available to short-tongued insects that do not have access to the nectar of the legume flowers. Both beneficial and pest insects (e.g., lygus bug) feed on extrafloral nectar.

Fava bean is susceptible to aphid damage, especially from the bean aphid. Although aphids usually do not affect fava bean's utility as a cover crop, they can cause considerable damage to the seed. Broadbean weevils also can reduce seed yields.

Fava bean may be a host for the root-knot nematode (*Meloidogyne* spp.), so it should not be used in rotations with potatoes. Use of fava bean as a break crop has been reported to reduce the incidence of take-all in wheat.

Varieties/cultivars

Large-seeded varieties, usually grown as a vegetable, are classified as *Vicia faba* var *major*, and often are referred to as broadbeans or windsor-beans.

Small-seeded varieties (var *minor, equina, faba,* and *paucijuga*), referred to as bell, horse, tick, or field beans, are used more commonly as animal feed, cover crops, and green manures. They seem to be better suited as winter cover crops in western Oregon because they are less susceptible to winter-kill. The variety 'Banner bean' is the most cold-tolerant variety planted in Oregon, surviving temperatures as low as 10°F.

For more information

This section on fava bean also is available individually as EM 8697. To order copies, send your request and 50 cents per copy to:

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Fax: 541-737-0817

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Field Pea

(Pisum sativum L. or *Pisum sativum* L. ssp. *arvense* (L.) poir.)

R. Sattell, R. Dick, D. Hemphill, and D. McGrath

Field pea looks very similar to garden pea. It is a climbing annual legume with weak, viny, and relatively succulent stems. Vines often are 4 to 5 feet long, but when grown alone, field pea's weak stems prevent it from growing more than 1.5 to 2 feet tall.

Leaves have two leaflets and a tendril. Flowers are white, pink, or purple. Pods carry seeds that are large (4,000 seeds/lb), nearly spherical, and white, gray, green, or brown. The root system is relatively shallow and small, but well nodulated.

Growth is slow during winter but increases rapidly in warm spring weather.

Environmental preferences and limitations

Field pea requires cool, moist growing conditions and can withstand heavy frost once established. It does not grow well in hot weather and is not suitable as a summer cover crop. Germination occurs at temperatures as low as 40°F, although optimal temperatures for germination and growth are between 60 and 70°F.

Field pea grows well on a wide range of soils; however, waterlogged soils and temporary flooding are not tolerated. Field pea prefers well-limed soils with a pH near 7.0, but is reported to tolerate soil pH as low as 4.2 and as high as 8.3.

Field pea is not shade-tolerant and shows little salinity tolerance.

Experiments in the Willamette Valley have shown that field pea stands were more erratic and less vigorous than other vetches and clovers tested. This poorer performance may be due in part to field pea's low tolerance for waterlogged soils or its susceptibility to water-associated root diseases.

Uses

Field pea can be used as a cover crop, green manure, forage, hay, and silage. Hay is good quality, but pea is more succulent than vetches and more difficult to cure. Regrowth after mowing or grazing is poor.

When grown alone and incorporated or killed in spring, field pea residues decompose rapidly and can contribute nitrogen (N) to a following crop. Field pea has no hard seeds, is easy to kill, and does not escape to become a weed.

Field pea often is planted in mixtures with cereal grains. The cereal protects the soil during winter, when field pea growth is slow, and provides a support for vines to climb, keeping pea vegetation off the ground where it is more likely to rot. Rapid spring field pea growth suppresses spring weeds and reduces the overall C:N ratio of spring residues, speeding the decomposition process and preventing competition by soil microbes for plant-available N.

Field pea is not a good choice for relay interplanting. It is not likely to withstand harvest traffic, nor is it able to emerge from heavy harvest residues.

Dry matter and N accumulation

In a mid-Willamette Valley replicated trial over 5 years, Austrian winter pea planted in mid-September accumulated a maximum of 3.3, minimum of 0.8, and average of 1.7 tons dry matter/acre and a maximum of 202, minimum of 28, and average of 104 lb N/acre by mid-April.

Management

Early fall planting generally is preferred because larger overwintering plants are more winter-hardy, provide more soil protection, and are better able to withstand insect damage in the spring. However, warmer temperatures in early fall also

Quick facts: Field pea

Common names	Field pea, Austrian winter pea
Hardiness zone	7 (see Figure 1)
pH tolerance	4.2–8.7; optimum near 7.0
Best soil type	Wide range with adequate drainage
Flood tolerance	Low
Drought tolerance	Moderate
Shade tolerance	Low
Mowing tolerance	Low
Dry matter accumulation	1.7 tons/acre
N accumulation	100 lb/acre
N to following crop	Half of accumulated N
Uses	Use as a winter annual cover crop to smother spring weeds, fix N, and improve soil tilth. Often grown with cereal grains. Easily killed and incorporated. Will not escape and become a weed.
Cautions	Will not tolerate wet soils.

increase seedling susceptibility to soil pathogens. Field peas planted in late fall do not grow to appreciable size until spring and are more prone to winter-kill by cold or diseases.

Suggested seeding rates vary from 70–160 lb/acre. Increase seeding rates for larger seeds, later plantings, or if planting into rough seedbeds.

Optimally, drill seed into a smooth seedbed to a depth of 1 to 2 inches. Place seeds deeply if necessary to reach available moisture in non-irrigated soils, and shallowly in irrigated soils or if fall rains have begun. You can broadcast seed, but the plants will be vulnerable to lodging and rotting if not planted with a nurse crop. It's best to till lightly after broadcasting to put the seed below the surface.

Winter pea roots need to be colonized by an *appropriate* strain of rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Inoculating seed with the proper rhizobia bacteria ensures that the bacteria will be present when the seed germinates.

Use fresh inoculant, protect it from heat and light, and apply it to seeds just before planting according to the manufacturer's directions. Cover broadcast seed with soil to protect inoculant from sunlight.

Figure 1.—Oregon plant hardiness zone map. Field pea normally will survive in ***Zone*** *7 or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

You may not need to inoculate if the appropriate rhizobia bacteria already are present in the soil. You can find out by planting a section of the field with raw (non-inoculated) seed and watching for differences in growth.

Field pea normally is killed or incorporated in spring at the beginning of bloom. When grown alone, succulent residues are incorporated easily with a disk and decompose very rapidly, releasing accumulated N for use by the following crop.

Pest interactions

Incorporating succulent field pea residues often causes a sharp increase in soil-borne pathogen populations, especially damping off fungi (e.g., *pythium*). If susceptible seed is planted shortly after incorporation, you may have more problems with this disease. Avoid this problem by waiting several weeks between residue incorporation and planting, and by ensuring that soil temperature and seedbed preparation are optimal for rapid seedling emergence.

Field peas are not an appropriate cover crop to grow in rotation with a cash crop legume because they are susceptible to many of the same diseases, allowing pathogen populations to grow quickly.

Field pea harbors high densities of aphids and aphid predators such as syrphid flies and seven-spotted lady beetles. Field pea flowers attract bees and native pollenizers.

When used as a break crop, field pea can reduce the incidence of take-all in wheat.

Generally, field pea does not grow enough in the fall to out-compete and reduce weeds and is a poor competitor in areas with abundant winter weed growth.

Varieties/cultivars

Seed generally is available on a generic basis as field or Austrian winter pea.

For more information

This section on field pea also is available individually as EM 8698. To order copies, send your request and 50 cents per copy to:

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HAIRY VETCH *(Vicia villosa)*

R. Sattell, R. Dick, J. Luna, and D. McGrath

Hairy vetch is a hardy, viny, annual or biennial legume, attaining a height of 24 inches when planted alone and higher when planted with a tall companion crop that provides structural support for climbing.

Thin, branched stems can reach more than 8 feet long. Compound leaves are made up of 8 to 24 paired, narrow leaflets. Leaves terminate with a tendril used for climbing. Despite its name, stems and leaves can be hairy or smooth. Hairy vetch has a taproot that extends 1 to 3 feet deep.

Fall-planted hairy vetch flowers in April and ripens seed in May–June.

Groups of 10 to 40 small, long, blue flowers hang from one side of a long flower stem. Spherical seeds (approximately 28,000/lb) are smaller than common vetch seeds. They develop in small pods and usually are grayish or black. Hairy vetch is hardseeded.

Environmental preferences and limitations

Hairy vetch tolerates cold well and is more winter-hardy than common vetch. If well-established in fall, it tolerates frozen soils, remaining dormant until spring. It grows slowly in the mild winters of western Oregon. Warm spring temperatures bring rapid growth.

Hairy vetch can be grown in soils with pH ranging from 4.9 to 8.2 but does best when pH is from 6.0 to 7.0. It can thrive in acid soils where clover and alfalfa do not grow well.

Hairy vetch does best on sandy or sandy loam soils but grows on most soil types if drainage is good. It tolerates some temporary flooding. In a mid-Willamette Valley trial, small hairy vetch plants survived after being completely covered with water for 9 days in February 1996. However, stand quality and growth generally decline if there are long periods of flooding or saturated soils. Hairy vetch is somewhat shade-tolerant and more drought-resistant than the other vetches.

Uses

Hairy vetch is used as a cover crop, green manure, pasture, silage, and hay. It is capable of accumulating large amounts of dry matter and nitrogen. When planted alone as a winter cover crop in annual vegetable rotations, it can provide substantial amounts of nitrogen (N) to a following crop.

Hairy vetch offers excellent spring weed suppression and grows well in mixtures with cereal grains that can provide cool-weather weed suppression, erosion control, and fall N-scavenging.

Hairy vetch has been relay interplanted into vegetable crops successfully. However, when relay interplanted into sweet corn, intense shade and heavy harvest residue result in very thin stands.

Hairy vetch is used as a self-seeding cover in orchards, usually as part of a mix. It also has been used in vineyards, but is more likely to climb trellises than is common vetch.

Dry matter and N accumulation

In a mid-Willamette Valley replicated trial over 5 years, hairy vetch planted in mid-September accumulated a maximum of 3.9, minimum of 0.9, and average of 2.2 tons dry matter/acre, and a maximum of 252, minimum of 72, and average of 139 lb N/acre by mid-April.

Management

To increase winter hardiness, plant hairy vetch between mid-September and mid-October, about 4 to 6 weeks before the first frost.

Recommended seeding rates vary from 25–60 lb/acre. Use lower rates when drilling and higher rates when broadcasting, drilling into a rough seedbed, or relay interplanting.

Drill seed into a firm seedbed from ¾ to 1½ inches deep depending on soil moisture. If broadcasting,

Quick facts: Hairy vetch

Common names	Hairy vetch, woolypod vetch, winter vetch
Hardiness zone	4 (see Figure 1)
pH tolerance	4.9–8.2; optimum is 6.0–7.0
Best soil type	Wide range if drainage is adequate
Flood tolerance	Moderate
Drought tolerance	Moderate
Shade tolerance	Moderate
Mowing tolerance	Before flowering: high. During flowering: moderate if mown high, low if mown close.
Dry matter accumulation	2.2 tons/acre
N accumulation	140 lb N/acre
N to following crop	Half of accumulated N
Uses	Winter cover crop in rotations or selfregenerating cover in orchards to smother spring weeds, fix N, and improve tilth. Often grown with cereal grains. Tolerates frozen soil.
Cautions	Can become a weed in annual rotations due to hard seed or when plants escape spring field operations and go to seed. Avoid in vineyards—may climb trellises.

follow with a light disking to incorporate seed. If seed is relay planted, you can broadcast it before the final cultivation. If you plant before the fall rains begin, the crop will benefit from irrigation during germination and early growth.

Hairy vetch roots need to be colonized by an *appropriate* strain of rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Generally, it's not necessary to inoculate seed in Oregon because the bacteria are present in the soil. If you choose to inoculate, you might plant a small section of the field with raw (non-inoculated) seed and watch for differences in growth.

Usually, hairy vetch is incorporated when it begins to flower. Due to its rapid spring growth, delaying incorporation just 1 or 2 weeks can increase dry matter and N accumulation considerably.

Mowing before incorporation prevents tillage implements from becoming entangled by the viny stems. In general, flail and rotary mowers work well. Incorporation without mowing can be done with rotovators, heavy disk harrows, or power spaders. Vetch residues are succulent and decompose quickly.

*Figure 1.—Oregon plant hardiness zone map. Hairy vetch normally will survive in **Zone 4** or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Hairy vetch tolerates close mowing before flowering and high mowing during flowering. Close mowing during peak flowering may kill it.

In western Oregon, planting hairy vetch in mixtures with a cereal improves winter weed suppression.

Some spring cereal varieties are likely to winter-kill if planted in early September, allowing the vetch to grow without competition in spring. Winter-kill susceptibility varies greatly among varieties. Cereals or grasses that do not winter-kill provide structural support for hairy vetch vines, preventing them from rotting by reducing contact with the soil.

Hairy vetch lowers the overall C:N ratio of vetch/cereal mixtures, speeding decomposition and decreasing competition from soil bacteria for plant-available N during the early summer growing season.

Because of hairy vetch's hard seeds and ability to reseed, it can become a serious weed problem in annual vegetable rotations. Many growers prefer to use common vetch because it has fewer hard seeds.

On the other hand, the tendency to reseed is beneficial when hairy vetch is used as part of a permanent cover in orchards. When mowing in spring, let some strips go to seed.

Pest interactions

Incorporation of succulent common vetch residues often causes a sharp increase in soil-borne pathogen populations, especially damping-off fungi (e.g., *pythium*). If susceptible seed is planted shortly after incorporation, you may have more problems with this disease. Avoid this problem by waiting several weeks between residue incorporation and planting. Also, be sure that soil temperature and seedbed preparation are optimal for rapid crop seedling emergence.

Hairy vetch sustains relatively high densities of seven-spotted lady beetle and bigeyed bugs, which prey on agricultural pests. However, the mowing that typically is needed before incorporation is likely to kill or disperse most of these insects. Using conservation-tillage methods or leaving remnant strips of hairy vetch may help protect beneficial insects.

Hairy vetch can harbor aphids and tarnished plant bug. The tarnished plant bug probably causes little damage to the cover crop but may disperse to become an orchard pest.

Hairy vetch is susceptible to root-knot nematodes (*Meloidogyne* spp.) and soybean cyst nematodes (*Heterodera glycines*). Its use may result in a buildup of these nematodes, resulting in losses to subsequent susceptible summer row crops such as potatoes.

Varieties/cultivars

'Madison' was developed in Nebraska and is very cold-tolerant. The cultivars 'Auburn,' 'Oregon,' and 'Lana,' formerly classified as *Vicia dasycarpa,* are more heat-tolerant and do well in areas with mild winters, such as western Oregon.

For more information

This section on hairy vetch also is available individually as EM 8699. To order copies, send your request and 50 cents per copy to:

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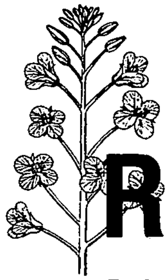

RAPESEED *(Brassica campestris/Brassica napus)*

R. Sattell, R. Dick, R. Ingham, R. Karow, D. Kaufman, and D. McGrath

Rapeseed is a large, stemmy, winter or spring annual. It is related to mustard, cabbage, broccoli, cauliflower, and turnip. *B. campestris* is primarily a spring annual, and *B. napus* a winter annual, although both have winter and spring varieties.

Rapeseed grows from 3 to 5 feet tall. It has bright yellow, four-petaled flowers, a deep taproot, and a fibrous near-surface root system. Seeds are small (90,000–150,000/lb), round, and brown-black.

Environmental preferences and limitations

Rapeseed does well on a wide variety of well-drained soils. It prefers a pH between 5.5 and 8.3 and is moderately tolerant of saline soils. It will not tolerate poorly drained or flooded soils, especially during establishment.

Rapeseed is able to grow at relatively low temperatures. The minimum soil temperature for planting is 45°F, and the maximum is 85°F. Winter hardiness is excellent if plants reach a rosette size of six to eight leaves before the first killing frost. If they experience a hard frost or wet soils before they reach this stage, losses are likely. The small taproot of young seedlings is susceptible to breakage by frost heaving. Rapeseed is very sensitive to planting date in all areas. In western Oregon, rape crops have failed entirely when planted after October 1.

Uses

Rapeseed is grown for its oil and meal, and as a cover crop. Rapid fall growth captures part of the available soil nitrogen, which otherwise might be lost to leaching, and provides good ground cover over winter.

Rapeseed produces large amounts of biomass and is good at suppressing weeds. Its root system can help loosen plow pans and improve soil tilth.

Dry matter and N accumulation

In a mid-Willamette Valley replicated trial over 4 years, Dwarf Essex rapeseed planted in mid-September accumulated a maximum of 4.8, minimum of 0, and average of 2.6 tons dry matter/acre and a maximum of 136, minimum of 0, and average of 67 lb N/acre by mid-April. The crop failed entirely 1 year due to a late planting date and cold, wet fall weather.

Management

When you plant rapeseed, the seedbed should be smooth, firm, and packed. However, overtilling can cause crusting that interferes with emergence.

The recommended seeding rate is 5–8 lb/acre if drilled, and higher if broadcast. Drill seed in 6–10 inch wide rows, no deeper than ¾ inch. If moist soil is deeper than ¾ inch and irrigation is not available, use a hoe opener to push dry soil aside to allow deep placement, but shallow soil coverage of seed.

Most grain drills can be used. Alfalfa calibration settings usually work if rapeseed calibrations are not provided.

Seeding should occur from mid-August to mid-September so that plants achieve the six- to eight-leaf stage before cold weather begins. Fall irrigation, if necessary, speeds up establishment and improves crop stand and winter hardiness.

Incorporate rapeseed during spring bloom. It usually needs to be mowed or chopped before being turned under. Due to the relatively low C:N ratio of rapeseed residue, decomposition is rapid (except for fibrous stems), and soil organisms involved in the decomposition process do not compete with the following crop for N.

Volunteer rapeseed can cause problems harvesting some green vegetables and seed crops. Separation of rapeseed residues is difficult because the bulk density of stems and/or the size and shape of pods are similar to the harvested crop (e.g., green beans, dry sugar beet seed). Rapeseed can be a serious weed in sugar beet seed production.

Quick facts: Rapeseed

Common names	Canola, rape, rapeseed, summer turnip
Hardiness zone	7 (see Figure 1)
pH tolerance	5.5–8.3
Best soil type	Well-drained
Flood tolerance	Low, especially during establishment
Drought tolerance	High
Shade tolerance	No information
Mowing tolerance	Low
Dry matter accumulation	3 tons/acre
N accumulation	80 lb/acre
N to following crop	Very little or none
Uses	Use to break up plow pans, smother weeds.
Cautions	Will not survive in saturated soils during establishment; plant before September 15 in western Oregon.

The percentage of hard seed varies among varieties. Canola varieties have fewer hard seeds than industrial varieties. Hard seed may be acceptable for self-reseeding covers in orchards and vineyards.

Rapeseed may be sensitive to residual herbicides, including sulfanated ureas and triazines.

Production restrictions

Rapeseed production is regulated in Oregon and other Pacific Northwest states. The Oregon Department of Agriculture (ODA) has established rapeseed production districts. In order to grow rapeseed, even as a cover crop, you may need to "activate" the production district in your area. Before you seed, check with ODA or your county office of the OSU Extension Service about possible production restrictions. Much of the Willamette Valley is a restricted production zone due to potential cross pollination between rapeseed and other brassica seed crops.

Pest interactions

Rapeseed normally competes well with weeds, especially grasses. When followed by a cereal crop, volunteer rapeseed can be killed with broadleaf herbicides.

Rapeseed fits well into rotations with non-brassica crops; it is immune to many of the diseases that attack them. However, rapeseed itself is susceptible to pathogens that can build up in the soil rapidly. Therefore, plant rapeseed in the same field only once every 4 years.

Other brassica crops also are susceptible to the diseases of rapeseed. If brassica crops are part of the summer rotation, you probably should not use rapeseed as a cover crop. Rapeseed is susceptible to sclerotinia stem rot, which also infects potatoes, beans, and carrots. Be sure to consider sclerotinia effects on crops in your rotation system.

Flea beetles can seriously damage seedlings. If flea beetles are a problem during establishment, you may need to use seed insecticide treatments or foliar sprays.

A winter rapeseed cover crop can be used as part of a rotation to lower soil populations of Columbia root-knot nematode (*Meloidogyne chitwoodi*), which infects potatoes. Rapeseed is a non-host of Columbia root-knot nematode, and its decomposing residues release nematicidal compounds. The best rotational control before potato involves planting summer non-host crops for 2 years, and then a winter rapeseed cover crop. Incorporate rapeseed in mid-March of the spring potatoes are to be planted.

Note that the ability of rapeseed to decrease nematode populations is specific to the nematode type. For example, Dwarf Essex has not successively reduced the populations of root lesion or dagger nematodes in berry field trials.

Using rapeseed as a break crop in wheat can greatly reduce the incidence of the disease take-all (*Gaeumannomyces graminis*).

Rapeseed flowers have been observed to attract several species of hoverflies (Syrphidae), the larvae of which are predators on aphids.

Varieties/cultivars

Canola is a term for rapeseed varieties that contain low levels of both erucic acid (in their oil) and glucosinolates (in their meal). These characteristics increase palatability for human and animal consumption. Oil from other varieties generally is used only for industrial purposes.

All varieties grow similarly and provide biomass and N uptake. However, industrial types are most likely to reduce nematode populations. This effect results from their higher levels of glucosinolate, which is believed to be the active agent in nematicidal activity.

For more information

This section on rapeseed also is available individually as EM 8700. To order copies, send your request and 50 cents per copy to:
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Figure 1.—Oregon plant hardiness zone map. Rapeseed normally will survive in **Zone** *7 or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

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Red Clover *(Trifolium pratense)*

R. Sattell, R. Dick, D. Hemphill, and D. McGrath

Red clover is an herbaceous perennial or biennial legume with erect, leafy stems that originate from a thick crown and terminate with a flower head. Height at maturity is about 2 feet.

Leaves are composed of three oblong leaflets that usually have light-colored "V" markings at their center. Both leaves and stems usually are hairy.

Flowers are pink-purple or magenta. Seeds are small (approximately 240,000 seeds/lb), oblong, and yellow, reddish-brown, or dark gray.

Red clover has a branched taproot and extensive surface roots.

When used in annual rotations, fall and winter growth is slow, but spring growth is rapid.

Environmental preferences and limitations

Red clover grows well on loams, silt loams, and sandy loams as well as on clayey soils. It can survive winter temperatures as low as -30°F and tolerates temporary waterlogging, but cannot survive prolonged waterlogging or flooding. The optimum pH range is 6.6–7.6, but a range of 4.5–8.2 is tolerated.

Uses

Red clover is used successfully in Oregon as a fall-planted cover crop and green manure in rotations with vegetable crops. It also is used as a relay interplanted cover crop (i.e., planted into a standing crop) and makes excellent forage, hay, and silage, although it should not be used as sheep pasture during breeding season because its high concentrations of estrogen-like compounds may cause infertility.

Red clover residues can supply significant amounts of nitrogen (N) to subsequent crops, and the large, deep taproot is effective for loosening soils and cycling nutrients to the surface. Vigorous spring growth is effective for suppressing weeds.

Dry matter and N accumulation

In a 5-year trial in the mid-Willamette Valley, 'Kenland' red clover planted in mid-September accumulated a maximum of 3.3, minimum of 0.2, and mean of 1.7 tons dry matter/acre, and a maximum of 168, minimum of 10, and mean of 83 lb N/acre by mid-April.

Management

Suggested fall planting dates are from mid-September through early October, or earlier if irrigation is available or soils are moist.

Seeding rates for use as a cover crop vary from 15 to 25 lb/acre. Drill seed into a fine seedbed at a depth of ½ inch for best stand establishment. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover seed.

Red clover roots need to be colonized by an *appropriate* strain of rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Inoculating seed with the proper rhizobia bacteria ensures that the bacteria will be present when the seed germinates.

Use fresh inoculant, protect it from heat and light, and apply it to seeds just before planting according to the manufacturer's directions. Cover broadcast seed with soil to protect inoculant from sunlight.

You may not need to inoculate if the appropriate rhizobia bacteria already are present in the soil. You can find out by planting a section of the field with raw (non-inoculated) seed and watching for differences in growth.

Quick facts: Red clover

Common names	Red clover
Hardiness zone	4 (see Figure 1)
pH tolerance	4.5–8.2; optimum near 7.0
Best soil type	Wide range
Flood tolerance	Moderate
Drought tolerance	Moderate
Shade tolerance	Moderate
Mowing tolerance	High if mown higher than 5 inches
Dry matter accumulation	1.7 tons/acre
N accumulation	85 lb/acre
N to following crop	Half of accumulated N
Uses	Use as relay-interplanted or winter annual cover crop in rotations, or as a cover in orchards to smother spring weeds, fix N, and improve soil tilth. Often grown with cereal grains. Tolerates frozen soils.
Cautions	May become weed in annual crop rotations.

When relay interplanting, broadcast seed into a standing vegetable crop before the final cultivation. Increase irrigation frequency to keep the soil surface moist until the clover is established under the summer crop canopy (about 2 weeks).

Red clover has performed well when relay interplanted into short-statured crops. When relay interplanted into tall-statured crops such as sweet corn, intense shade, heavy harvest residue, and harvest traffic result in patchy stands. However, red clover appears to be better adapted to these adverse conditions than the vetches, peas, or crimson clover, accumulating as much as 1½ tons dry matter/acre and 80 lb N/acre by the end of April in the Willamette Valley.

In western Oregon, red clover generally is allowed to grow until at least mid-April, because nearly all dry matter and N accumulation occur in spring with the onset of warm weather. Incorporating red clover residues approximately 3 weeks before the summer crop is planted maximizes red clover spring growth while minimizing pythium problems (see below).

When grown alone, red clover's succulent residues are incorporated easily with a moldboard plow or disk and decompose very rapidly, releasing part of the accumulated N for use by the following crop.

Figure 1.—Oregon plant hardiness zone map. Red clover normally will survive in ***Zone 4*** *or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Red clover often is planted with a cereal grain companion crop that is able to scavenge N and protect the soil during fall and winter. Plant companion crops at approximately one-half, and clover at two-thirds, of their monoculture seeding rate. If the companion crop is too dense in spring, grazing or clipping it before clover stems begin to grow confers a competitive advantage to the clover.

Red clover can be killed with an appropriate herbicide. Consult your county agent of the OSU Extension Service for herbicide recommendations. Follow all label restrictions.

Pest interactions

Red clover is not an appropriate cover crop to grow in rotation with a cash crop legume because they are susceptible to many of the same pathogens, allowing pathogen populations to grow quickly.

Incorporation of succulent red clover residues often causes a sharp increase in soil-borne pathogen populations, especially damping-off fungi (e.g., *pythium*). If susceptible seed is planted shortly after incorporation, you may have more problems with disease. Avoid this problem by waiting several weeks between residue incorporation and planting, and by ensuring that soil temperature and seedbed preparation are optimal for rapid summer crop seedling emergence.

Varieties/cultivars

Cultivated red clovers are grouped as early flowering or late flowering types. 'Mammoth Red' is one of the most common late flowering, or single cut, varieties, and is used at high elevations or where the growing season is short. It is a winter-hardy biennial that grows in a round clump without flowering stems the first year.

The early flowering types, also called 'Medium Red' or double cut (because they can be cut several times in a year for hay), comprise the majority of red clovers sown in Oregon. They produce tall, erect flowering stems with leaves at the nodes, the spring after they are planted. Although they are perennials, early flowering red clovers most often are treated as winter annuals (turned under or killed in spring) when used as a cover crop. Seed often is marketed simply as "Medium Red clover" and, if locally produced, may be well adapted.

'Kenland' red clover has been used successfully in the Willamette Valley as both a fall-planted and relay-interplanted cover crop. It is resistant to Sclerotinia crown rot and is tolerant of waterlogged soils. 'Kenland' red clover is nearly dormant during late fall and winter but grows rapidly in spring with the onset of warmer temperatures.

For more information

This section on red clover also is available individually as EM 8701. To order copies, send your request and 50 cents per copy to:

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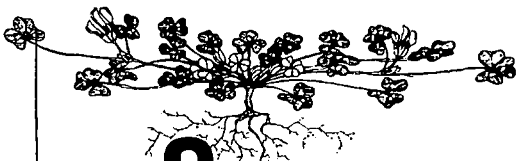

Subterranean Clovers

(Trifolium subterraneum)

R. Sattell, R. Dick, D. Hemphill, and D. McGrath

Subterranean clovers are cool-season annual legumes that grow in circular clumps 6–15 inches tall. Leaves and stems usually are slightly hairy. Their long, slender stems are prostrate and non-rooting, often forming a thick, intertwined mat over the soil surface.

Inconspicuous, self-fertilized, white flowers are located under the leaves. As the seed develops, the flower stem bends to the ground, eventually pushing the seed below the soil surface. Seed size is relatively large for clovers—approximately 70,000 seeds/lb.

These clovers have a taproot and many fibrous branching roots. Generally, the root system of subclovers is larger and contains more nitrogen (N) than other clovers. Approximately 40 percent of the N in a subclover plant is below ground.

Fall and winter growth is slow. Nearly all dry matter production occurs in spring, when subclover grows rapidly. Most varieties mature in May, but maturity dates vary widely. Percentage of hard seed also varies among varieties.

Environmental preferences and limitations

Subterranean clovers do well in Mediterranean climates of cool, wet winters and hot, dry summers. They tolerate temperatures down to approximately 5°F. Although they prefer well-drained soils, many varieties do well on waterlogged soils. 'Karridale' subclover in the mid-Willamette Valley was observed to survive a week of complete flooding.

Subclovers may be grown on loam to clay soils. Tolerance to soil pH varies among varieties, but in general the species is best adapted to moderately acid or neutral soils. Subclovers often respond to liming. Decreased development of N-fixing root nodules has been observed on soils of pH 5.0 or lower, and iron deficiency may be a problem on soils with high pH.

Subterranean clovers have moderate shade tolerance.

Uses

Subclovers are used for forage and hay and have been used successfully in Oregon as fall-planted and relay-interplanted cover crops in annual rotations. They are capable of accumulating substantial amounts of N, a portion of which is available to the following crop. Rapid growth suppresses weeds in spring.

Although subclovers' mat of creeping stems is suitable for erosion control, ground cover usually is not complete before winter rains begin. Growing subclover in mixtures with grasses or cereals that exhibit fast fall growth increases fall N-scavenging and winter soil protection. However, dense stands of grass or cereal compete with subclover for light in spring.

Subclovers' low growth habit, relative shade tolerance, and ability to reseed make them ideal for use as a cover in vineyards and orchards, where they often are planted in mixtures of grasses and/or other legumes. Unlike most other clovers, subclovers can produce seed under close grazing or mowing. Mowing before flowering actually increases seed yield.

Dry matter and N contributions

In a Willamette Valley trial, cover crops were planted in mid-September and sampled in mid-April. 'Karridale' subclover produced 1.1–3.3 tons dry biomass/acre (average 2.4) and 37–159 lb N/acre (average 114) during the 3 years it was grown. 'Mt. Barker' subclover was planted 2 years and yielded 0.6 and 2.8 tons dry biomass/acre, and 35 and 135 lb N/acre. 'Northam' subclover also was planted

Quick facts: Subterranean clovers

Common names	Subclover or subterranean clover
Hardiness zone	7 (see Figure 1)
pH tolerance	5.5–7.5; optimum is 6.5
Best soil type	Wide range
Flood tolerance	Moderate to high
Drought tolerance	High
Shade tolerance	Moderate
Mowing tolerance	High even when mown close to the ground
Dry matter accumulation	2.5 tons/acre
N accumulation	115 lb/acre
N to following crop	Half of accumulated N
Uses	Excellent for perennial systems where close mowing is practiced. Use as relay-interplanted or winter annual cover crop in annual rotations to smother spring weeds, fix N, and improve soil tilth.
Cautions	Can be a serious weed in annual vegetable rotations

2 years and yielded 2.6 and 3.6 tons dry biomass/acre and 114 and 132 lb N/acre.

Management

Best stand establishment is obtained by drilling into or broadcasting over a smooth, firm seedbed. Drill in narrow rows to a depth of ½ inch. Cover broadcast seed using a harrow or similar implement and roll if soil is dry. Drilling in narrow rows or broadcasting decreases competition between clover seedlings and creates a solid mat of growth more quickly than drilling in wide rows. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover the seed. If possible, irrigate dry soils to hasten germination and increase fall growth; otherwise plant before a fall rain.

Subclover roots need to be colonized by an *appropriate* strain of rhizobia bacteria to be able to convert atmospheric nitrogen into plant-available forms. Inoculating seed with the proper rhizobia bacteria ensures that the bacteria are present when the seed germinates. Use fresh inoculant, protect it from heat and light, and apply to seeds just before planting according to the manufacturer's directions. Cover broadcast seed with soil to protect inoculant from sunlight.

Figure 1.—Oregon plant hardiness zone map. Subterranean clovers normally will survive in ***Zone*** *7 or any warmer zone. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

You may not need to inoculate if the appropriate rhizobia bacteria already are present in the soil. To find out, plant a section of the field with raw (non-inoculated) seed and watch for differences in growth.

In western Oregon, subclover generally is allowed to grow until at least mid-April because nearly all dry matter and N accumulation occur in spring with the onset of warm weather. Incorporate subclover residues with a disk approximately 3 weeks before planting the summer crop to allow time for decomposition.

When relay-interplanting, broadcast seed into a standing vegetable crop before the final cultivation. Increase irrigation frequency to keep the soil surface moist until the subclover is established (about 2 weeks).

Relay interplanting subclovers into sweet corn has produced mixed results in the Willamette Valley. Intense shade, seedling water stress, and heavy harvest residue often result in very thin stands. Varieties differ in their ability to withstand these adverse conditions. In a Willamette Valley trial, 'Karridale' subclover produced 1½ tons dry matter/acre and 80 lb N/acre (in above-ground plant material) when allowed to grow until May 1.

Mixtures of subclovers sometimes are planted when a self-seeding cover is desired so that the most adapted varieties will reseed. If you want subclover to reseed, remove vegetation in fall by close mowing or intensive grazing to make space for new plants.

Subclover can be killed with an appropriate herbicide. Consult your county agent of the OSU Extension Service for herbicide recommendations. Follow all label restrictions.

The subclover varieties used in Oregon do not have high estrogen levels, so they do not reduce lambing percentages when used for sheep pasturage. Neither will subclovers cause bloat.

Pest interactions

Subclovers can suppress weeds to some extent with their thick cover if a closed canopy is maintained. Close mowing or intensive grazing gives an advantage to the subclover. Subclovers themselves can become weeds in annual crop rotations.

Subclovers are subject to damage by root rot of the fungi *Pythium, Fusarium,* and *Rhizoctonia;* and to the viral diseases clover stunt, bean yellow mosaic, and red leaf. They also are susceptible to the fungus *Kabatiella caulivora,* which causes "clover scorch." Their low, dense growth is ideal for slugs.

Varieties/cultivars

'Karridale' subclover tolerates wet conditions and is resistant to all of the root rot fungi and viral diseases described above. It has outperformed 'Mt. Barker' in western Oregon.

For more information

This section on subterranean clovers also is available individually as EM 8702. To order copies, send your request and 50 cents per copy to:
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SUDANGRASS *AND SORGHUM-SUDANGRASS HYBRIDS*

(Sorghum bicolor L.)

R. Sattell, R. Dick, R. Ingham, R. Karow, and D. McGrath

Sudangrass and sorghum-sudangrass hybrids are frost-sensitive, warm-season, erect annual grasses. They can grow from 6–8 feet tall and produce large amounts of dry matter if planted in the summer well before the first frost. Their root systems are fibrous.

Environmental preferences and limitations

Sudangrass and sorghum-sudangrass hybrids require warm weather to grow, and winter-kill with the first hard frost. Minimum air temperature for growth is 60°F, and optimum temperatures are from 75 to 90°F. Sudangrass and sorghum-sudangrass hybrids do best in southwestern Oregon, the Columbia River basin, and the Snake River basin. They also have been grown successfully as cover crops in the Willamette Valley, although cool night temperatures may reduce growth.

Although maximum growth occurs with ample moisture, sudangrass and sorghum-sudangrass hybrids are drought-tolerant. They also tolerate mowing, high pH, salinity, and partial shade.

Uses

Sudangrass and sorghum-sudangrass crosses are used as warm-season cover crops, forage, and silage. When used as a cover crop, their fibrous roots and organic matter contributions improve soil structure; and their rapid, dense growth suppresses weeds.

When sudangrass and sorghum-sudangrass crosses winter-kill, they form a dense mat that protects the soil surface and reduces weed emergence until the residues decompose. The partially decomposed residues are incorporated easily in spring. Growers have successfully used no-till and strip-till methods in combination with short-term residual herbicides to plant into the mulch formed by winter-killed sudangrass.

Note that although sudangrass and sorghum-sudangrass hybrids produce high-quality forage, at certain times they can poison livestock. Young plants and plants stressed by drought or light frost may contain hydrocyanic (HCN) acid, which is toxic to livestock. Do not graze young plants or regrowth following drought or frost stress.

Dry matter and N accumulation

Sudangrass and sorghum-sudangrass crosses are capable of producing large amounts of dry matter. However, the amount of dry matter produced depends on how long they grow before being killed or winter-killed, and if the soil is dry, whether or not they are irrigated.

N content is low, in the range of 1 to 2 percent of dry matter. Although the total amount of N accumulated in plant residues may be considerable, because of the high C:N ratio, very little or none of the N is available to subsequent crops.

Management

Seeding rates for cover cropping range from 20–60 lb/acre. Best stand establishment is obtained by drilling seed to a depth of approximately 1 inch in a smooth, well-prepared seedbed. Although row spacing generally does not affect yield, narrow rows are better for cover cropping purposes. Alternative seeding methods that can reduce seedbed preparation but require higher seeding rates are: drill into a rough seedbed prepared by disking, or broadcast over a rough or smooth seedbed and then disk lightly to cover the seed.

Quick facts: Sudangrass

Common names	Sudangrass
Hardiness zone	10, i.e., no frost tolerance (see Figure 1)
pH tolerance	Tolerates high pH, but optimum is near neutral
Flood tolerance	Low
Drought tolerance	High
Shade tolerance	No information
Mowing tolerance	High
Dry matter accumulation	May be very high but depends on kill date
N accumulation	May be high but depends on kill date
N to following crop	Very little or none
Uses	Use as summer annual cover crop to suppress weeds and improve soil tilth. May be planted in late summer and allowed to winter-kill.
Cautions	Needs hot weather to grow. Large amounts of dry matter require a long time to decompose sufficiently before planting subsequent crop.

Dry matter accumulation is very sensitive to planting date. During a normal year in western Oregon, sudangrass and sorghum-sudangrass crosses planted in early August (following beans for example) and irrigated will attain heights of 6-8 feet before they winter-kill. But if they are planted in early September without irrigation they will grow to only 2 feet tall, and if planted in late September they will grow to only 6 inches tall before they winter-kill.

Sudangrass and sorghum-sudangrass planted in mixtures with legumes in early fall (early September in western Oregon) will winter-kill, forming a mulch that protects the soil surface during the winter but allows the legume to grow without competition in the spring. Planting too early can result in large amounts of residue that may smother the legume, and planting late results in minimal winter soil protection.

Sudangrass and sorghum-sudangrass crosses may be planted in the spring after soil temperatures reach 60°F, and killed or incorporated in early summer. If you plan to incorporate residues soon after the plants are killed, chop or flail them first. Succulent residues from young plants decompose quickly. However, residues from older, larger plants decompose slowly due to their high carbon:nitrogen ratio. When large amounts of residue are incorporated, N availability to the succeeding crop may decrease due to microbial competition for plant-available N during decomposition. You can reduce this problem by planting a mixture of sudangrass and legumes in spring, planting a legume following incorporation, delaying planting the succeeding crop until residues have decomposed, or adding fertilizer N.

N availability to succeeding crops is not likely to be a problem if you incorporate residues that have been decomposing over the winter, or if you leave residues on the soil surface as a mulch rather than incorporating them.

*Figure 1.—Oregon plant hardiness zone map. Sudangrass normally will survive in **Zone 10** or any warmer zone; thus, it is not winter-hardy in Oregon. (Extracted from the USDA's national plant hardiness zone map, based on average annual minimum temperature in °F.)*
Zone 4 = -30 to -20; Zone 5 = -20 to -10
Zone 6 = -10 to 0; Zone 7 = 0 to 10
Zone 8 = 10 to 20; Zone 9 = 20 to 30

Pest interactions

Sudangrass and sorghum-sudangrass hybrids do not become weeds as long as they are not allowed to go to seed. Vigorous growth by these species smothers summer weeds. However, if air temperature is cool, growth is slow, and competition from weeds may be a problem.

Sudangrass cover crops can be used as part of a rotation to lower soil populations of Columbia root-knot nematode (*Meloidogyne chitwoodi*), which infects potatoes. Sudangrass varieties 'Trudan' and 'Sordan 79' are non-hosts of Columbia root-knot nematode (other varieties are poor hosts), and sudangrass residues release nematicidal compounds as they decompose. Incorporate sudangrass after it has been stressed (e.g., first frost or drought) to increase HCN production and maximize the nematicidal effect. Rotational control before potato often involves planting non-host summer crops for 1 or more years, as well as controlling host weeds and using sudangrass cover crops. Note that the ability of sudangrass to decrease nematode populations is specific to the nematode type.

Varieties/cultivars

Besides common sudangrass, many sudangrass and sorghum-sudangrass hybrids are available. 'Piper' is a sudangrass variety that is widely available, has been used in Oregon for many years, grows to a height of 8 feet, and is low in HCN.

'Trudan 8' is a sorghum-sudangrass cross that is widely available and has been used in Oregon for many years.

For more information

This section on annual sudangrass and sudangrass-sorghum hybrids also is available individually as EM 8703. To order copies, send your request and 50 cents per copy to:

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