

# Organic Alfalfa Management Guide

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On the cover (left to right): Wayne Platt, Jr. (consultant) and Eric Nelson (grower) of Pendleton, Oregon, discuss organic alfalfa pest issues. (Photo by E. Patrick Fuerst)

# Organic Alfalfa Management Guide

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## Introduction

This bulletin is a companion to another Washington State University (WSU) extension bulletin, “Crop Profile for Alfalfa in Washington” (1), which covers practices for conventional irrigated alfalfa production, many of which are similar to organic practices, including irrigation management, harvesting, storage, quality, and details on insect, disease, nematode, and vertebrate pests. We also recommend “Alfalfa’s Potential in Dryland Crop Production,” a WSU publication on conventional dryland alfalfa production (2). Additional resources related to organic alfalfa production are provided at the end of this report and at the WSU Organic Agriculture web site (<http://csanr.wsu.edu/Organic/>). We request your feedback on this bulletin. Please complete the evaluation form provided on the last page.

This bulletin has been developed in response to requests from Washington organic dairy producers who face shortages of certified feed for their herds, and to supplement the limited information available on organic production practices for alfalfa and other agronomic crops in the Pacific Northwest. Washington produced 4500 acres of certified organic alfalfa in 2008, a 60% increase from the previous year, yet clearly has the potential to produce much more.

Several aspects of organic alfalfa production differ from conventional production. It is critical to follow rules established by the USDA National Organic Program (NOP) (see Resources section), as discussed further below. Pests, weeds, and fertility must be monitored more intensively in an organic production system and timing of most operations—including planting, cutting, and fertilizing—is especially crucial to help manage weeds and pests. It is essential to be proactive and develop plans for managing weeds, pests, and fertility before planting any organic crop.

Not only is organic alfalfa in high demand by the organic livestock industry, but alfalfa also serves as a critical transitional and soil-building crop. Alfalfa also contributes positively to soil structure, biodiversity, and carbon sequestration. In dryland environments, alfalfa’s deep root system enables it to compete effectively against annual and perennial weeds for water and nutrients. Its large roots can penetrate plow pans and utilize stored soil moisture. A vigorous and dense stand of alfalfa will shade the underlying soil and limit weed seed germination and growth. Haying prevents many weeds from going to seed, which helps deplete the weed seed bank in the soil and reduce future weed problems. *Rhizobium*-inoculated alfalfa converts atmospheric nitrogen (N) into forms that can be used by subsequent crops. Decomposition of the alfalfa root system typically contributes about 100 lb/acre N to the soil after one year, and an additional 50 lb/acre N in the second and third years. Significantly less N is added in alfalfa-grass mixtures than in pure alfalfa. Alfalfa will also draw down excess phosphorus (P) and potassium (K) in soils where high rates of manure have been applied in the past for production of crops with high N demands such as vegetables and cereals.

## The Role of Alfalfa in Organic Transition

Alfalfa is one of the best options for making the three-year transition to certified organic production. WSU organic transition research conducted near Pullman showed that alfalfa was equal to or better than many other transition cropping systems in terms of weed control, soil fertility, organic wheat yield following alfalfa, and overall economics. We recommend obtaining “transitional certification” in order to assure that agronomic practices and record-keeping are in compliance and to facilitate the final organic certification. There are special

considerations prior to establishing a stand for organic transition. Avoid fields that have recently been planted to transgenic crops (also called genetically engineered [GE] or genetically modified organisms [GMO]) since volunteers may cause additional delays in certification. When planting alfalfa for transition, this is the last opportunity to apply fertilizers, herbicides, and other prohibited substances that are not allowed during or after the transition to certified organic production. Before establishing the alfalfa, it is possible to apply enough P for the life of the stand because P is effectively stored in the soil (see Nutrient Management section). When beginning the transition, fungicide-treated seed can be planted and herbicides can be applied; however, the three-year transition period for organic certification begins after the last application of a prohibited material. If weeds are a serious problem in the first growing season, consider using an herbicide and delaying certification to ensure long-term control of weeds.

## **Preserving Your Certification**

When planting organic alfalfa, make absolutely sure that both the seed and the inoculant are not transgenic; this would void organic certification for the life of the stand. Growers who are just beginning organic production, and growers who produce both organic and conventional crops, must be diligent in following the rules of organic production. Mistakes could be costly and lead to loss of certification for up to three years, depending on the severity of the infringement. Make sure you thoroughly understand the NOP rules and talk with your certifier and other experts if you have any question whether certain practices would infringe upon the rules. Consult lists of approved and prohibited substances published by the Washington State Department of Agriculture (WSDA), Organic Materials Review Institute (OMRI), and the NOP. The National Center for Appropriate Technology (NCAT) and ATTRA (National Sustainable Agriculture Information Service) also have published helpful resources on organic regulation, certification, and transition (see Online Resources).

All equipment must be clean and free of prohibited materials prior to entering organic fields. Drills (or aircraft, for aerial seeding) must

be cleaned and free of fertilizers, insecticides, or fungicides that can be carried over on seed or in hoppers. Cleaning procedures must be documented. Conventionally produced, untreated seed can be used if organic seed is commercially unavailable (see details, below), but documentation to track the search for organic seed is required. Check approved and prohibited materials lists for approved inoculants and ingredients. Balers must be free of conventional hay, and any bales containing conventional hay must be separated from the organic stack. Organic and conventional bales must be stored in separate facilities. Manure, composts, and other soil amendments must be managed to maintain or improve soil organic matter and must not contaminate crops or water. Composting techniques must meet the requirements described in the NOP rules. Check with your certifying agent or other resources to determine time limitations between manure applications and crop harvest. Furthermore, soil or plant micronutrient testing is required to document deficiencies before allowed micronutrients can be applied. Biosolids from sewage treatment are prohibited.

## **Establishment**

### **Variety Selection and Seed Quality**

Numerous, non-transgenic (non-GMO) alfalfa varieties are available. Most alfalfa varieties are developed for irrigated or higher rainfall hay production but many of these varieties perform suitably on dryland sites. Alfalfa varieties developed for dryland production, such as 'Shaw,' 'Ladak,' 'Vernal,' and 'Wrangler' are very hardy plants with excellent drought tolerance but tend to yield less in irrigated sites. We strongly recommend that growers consider alternatives to older varieties to gain the benefits of pest resistance and other traits. Consult the irrigated Alfalfa Variety Trials conducted by WSU and sanctioned by the Washington State Hay Growers Association (see Online Resources). Varieties that rank in the top 10–20% over three years should be given strong consideration. The National Alfalfa Alliance and the North American Alfalfa Improvement Conference provide up-to-date information on alfalfa varieties including information on pest resistance, fall dormancy,

winter-survival ratings and links to state trials (see Online Resources).

Alfalfa varieties vary considerably in winter-hardiness. Since winter-hardiness ratings are not available for many varieties, growers commonly rely upon fall dormancy (FD) ratings. Most newer alfalfa varieties with FD ratings of 4–5 are sufficiently winter-hardy to survive in all parts of Washington. However, if selecting among older varieties, FD 2 varieties are adapted for the northern, short-season environments (typically only one cutting); FD 3–4 for the Columbia Basin and Palouse (typically two or more cuttings); and FD 5 for Walla Walla and longer-season, irrigated environments (three or more cuttings). It is especially important to consider varieties with resistance to specific insect and disease pests that are common in your area, including aphids in dryland production and *Verticillium* wilt, *Phytophthora* root rot, bacterial wilt, stem and root-knot nematodes, pea aphid, blue alfalfa aphid and spotted alfalfa aphid in irrigated production.

Organically certified seed must be planted unless the variety you need is not commercially available; in the latter case only untreated seed is allowed. Seed may be treated with organically approved materials, such as a biological fungicide. Alfalfa is sometimes scarified to improve germination. Acid scarification would disqualify this seed for use in organic fields. Scarification using hot water or mechanical techniques is acceptable. Starting with clean alfalfa seed is paramount in weed management. Use untreated seed certified by the Washington State Crop Improvement Association (WSCIA) or seed that satisfies WSCIA certification requirements. Inspect the seed tag for the date of the last germination test, weed seed percentage, and hard seed content. Hard seed content should be less than 20%. Hard seed does not readily absorb water and germinate.

## Field Selection

Field selection is critical. Choose a field with low populations of weed species that would be unacceptable in high quality alfalfa (see Weeds). Alfalfa prefers deep, well-drained soils with pH close to neutral and receiving at least 10 inches of annual precipitation or irrigation. It does well

in both heavy clay soils and light sandy soils under irrigation. Acidic soils should be avoided but many newer varieties tolerate pH as low as 5.5. Soil surveys can assist you with identifying shallow soils or water tables (see Resources). Alfalfa does not tolerate saturated conditions for long periods so soils with flooding or very shallow water tables should be avoided. If only portions of the field are persistently wet, plant these to a forage like orchardgrass. Bottomlands or subirrigated flats are often the most productive sites for dryland alfalfa because the soil is usually deep and water accumulates in these areas. However, poorly drained bottomlands with wetland vegetation such as smartweeds (*Polygonum* spp.), wild iris (*Iris* spp.), and sedges (*Cyperus* spp.) should be avoided because these plants indicate prolonged wet soil conditions. Alfalfa is generally not produced for hay on steep hillsides due to limitations associated with harvest. However, grazing alfalfa can be managed on steep hillsides using reduced- or no-till methods of establishment to reduce erosion hazards.

## Controlling Weeds at Establishment

In the year preceding alfalfa, annual hay or green manure crops can help to manage weeds and improve the seedbed. Annual hay crops such as hooded barley or oats can be grown in dryland situations. Cereals can also be grown for grain, provided residues will not interfere with planting alfalfa. In irrigated areas, planting spring peas before alfalfa is an excellent way to prepare a field. The peas are harvested in late July followed by minimum tillage and planting. Volunteer peas can provide protection from wind erosion or blowouts during the August establishment period.

A conservation tillage implement, such as the undercutter (Figure 2A) should be used to control annuals and suppress perennials prior to establishment. Alternatively, in irrigated areas, the weed seed bank can be depleted by repeated irrigation and light tillage before alfalfa is planted. Weed seedlings can also be destroyed by flaming with a propane burner followed by direct seeding of the alfalfa; however, flaming is relatively ineffective on grasses. After this, flaming should be avoided until after one full harvest so that the alfalfa crown is fully developed.

## Field and Seedbed Preparation

Pre-plant cultivation is among the key tools available for weed management in the establishment year. Many dryland alfalfa growers fall disk or fall plow a field to control weeds, incorporate fertilizer, and improve decomposition of the previous crop. In the spring, the field can be lightly cultivated with or without a harrow to control emerging weeds and volunteer grain. Multiple spring tillage operations could delay planting and cause excessive drying. Alternatively, fallowing in the preceding year will help control weeds and create a smooth seedbed which can be directly seeded in the spring. Alfalfa requires good seed-to-soil contact, so firming the soil with a roller, packer, or landplane is often needed prior to seeding to ensure good contact. The soil surface should be firm enough that a person's heel will not sink deeper than a half-inch. Some growers pack both before and after seeding. Alfalfa can also be no-till seeded. No-till fields tend to be very firm which is desirable for good emergence as long as the ground is not too rough; straw and chaff from the preceding crop should be removed or evenly spread at harvest. Heavy chaff windrows will impede planting and contribute to volunteer grain that competes with alfalfa seedlings.

## Seeding

Clean all seeding equipment to remove prohibited substances before planting. Alfalfa should be planted  $\frac{1}{4}$ – $\frac{1}{2}$ -inch deep; slightly deeper planting ( $\frac{5}{8}$  inch) is possible in sandy soils. Planting any deeper results in poor stands. Alfalfa should be planted into moist soils; dormant seedlings into dry soil are rarely successful. Alfalfa germinates rapidly when the seed is moist and soil temperatures are above 40°F.

## Drills

Drills like those made by Brillion Farm Equipment, Inc. are ideal for small-seeded crops like alfalfa; however these drills are not always available. While grain drills are common throughout the region they are not the best choice for seeding alfalfa. Grain box openers distribute too much alfalfa seed, even at the lowest setting. Seed diluents such as rice hulls, cracked grain, or vermiculite may overcome this

problem. Calibrating conventional grain drills using such seed diluents is a little more involved but not overly difficult. Conventional grain drills with a legume box are better suited for seeding alfalfa.

Regardless of what type of drill is selected, depth control is critical. Double-disk drills may be equipped with depth bands to prevent the disks from cutting too deep. Some growers will remove all of the down pressure on the springs controlling the disk cutting depth. Others will increase the down pressure on the press wheels in order to lift the drill and prevent deep cutting. Setting the depth by use of stops on the hydraulic rams that lift the drill is not advised. Hoe-type drills are less suited for seeding alfalfa.

## Broadcast

Air delivery drills and airplanes have been used to seed alfalfa. Rolling before *and* after broadcast seeding is usually best. If the soil was packed before broadcasting, seed placement may be improved by light harrowing before packing the second time. The rule of thumb is to double the seeding rate for broadcast plantings. This is because less seed will be placed in good contact with the soil, and depth of placement is variable. Broadcasting on loose soils followed by harrowing will place much of the seed too deep.

## Seeding Rate

Selecting the right seeding rate is one of the major keys to success. Conventional alfalfa seeding rates vary considerably, and many irrigated alfalfa growers use 15–24 lbs/acre. Dryland alfalfa seeding rates are lower, usually 6–12 lbs/acre, sometimes planted in two passes in different directions. Organic growers indicate that higher seeding rates provide improved weed suppression, denser stands, better leaf-to-stem ratios, and better first-year hay quality.

## Time of Planting

Late-summer planting is often preferred in irrigated areas because, in the first production year, more forage is produced and weed pressure is reduced compared to spring planting. Some irrigated growers prefer delayed spring planting to minimize weed problems. Also, if a field is heavily infested with winter annual weeds like

downy brome (cheatgrass), spring planting may be preferred. Summer and early fall seeding should be restricted to fields that can be irrigated every 3–4 days until established. Seedling-stage alfalfa is susceptible to temperatures below 20°F. Fall seeding in dryland environments is not recommended because plants will germinate too late and winter-kill. Early spring planting is preferred in dryland environments since soil moisture is normally adequate and temperatures are favorable for alfalfa establishment. However, some producers wait for a spring weed flush to occur and then seed after the weeds have been controlled. The impact of weeds can be lessened by frequent clipping, but the clipping height should be greater than six inches so that the alfalfa can become established.

### **Inoculation**

In order to fix atmospheric N, the roots of alfalfa and other legumes must develop nodules infected with *Rhizobia* bacteria. *Rhizobia* may be present in the soil, especially if alfalfa has been grown on the site in the recent past, but N fixation rates, productivity, and competitiveness with weeds may be further improved with newly-inoculated seed. Verify that your inoculant is organically approved. *Rhizobia* are sensitive to heat and should be stored in a cool place until ready for use. Pre-inoculated seed is usually available from seed dealers but should not be stored for long periods. If pre-inoculated seed is not available, inoculate seed before planting. The inoculant packet will consist of fine peat moss containing the bacteria. Light sprinkling of a sweet organic drink containing sugar or honey onto the seed immediately before mixing helps the inoculant stick to the seed.

### **Nurse Crops**

Nurse or companion crops are often used in spring planting situations to increase first-year forage yield and provide additional competition with weeds. However, years of experience and trials have shown that dryland nurse crops actively compete with alfalfa seedlings and reduce alfalfa stand density and yield. On irrigated sandy soils, a companion crop may be justified to protect alfalfa from wind damage. Also, an acceptable alfalfa stand may be attained in summer or fall establishment under irrigation if

the seeding rate of the companion is low, such as 10–15 lbs/acre of oats, with the intent that the companion will protect seedling alfalfa and then winter-kill.

### **Grass Mixtures**

Although pure alfalfa grown for dairy feed commands a higher price than grass-hay mixtures, mixtures may be a better choice if grassy weeds are a problem, if soil N is high, or if a recent application of manure or compost is likely to stimulate weeds. Mixtures are common in many dryland situations to help fill voids in the stand and reduce weed pressure. Mixtures will also cure approximately one day faster if the hay is not conditioned. Alfalfa-grass mixtures should also be considered for fields that will be left in hay for five years or more, fields with excessively wet or shallow soils, and fields that will be grazed. Grasses are often inter-seeded as an alfalfa stand thins out, but grass establishment will usually be improved by seeding at the same time as alfalfa.

When planting a mixture, the alfalfa seeding rate depends somewhat on the grower's objectives. If alfalfa is the preferred forage and the grass is added only to fill voids and compete with weeds, then the alfalfa seeding rate should be left unchanged. If a grass-alfalfa mixture is preferred, in pastures for example, growers commonly use no more than 2–4 lbs/acre of alfalfa seed depending on potential bloat problems if grazed. Grasses emerge and grow at about the same rate as alfalfa so they compete less than annual nurse crops. Some grasses, like timothy and orchardgrass, can be mixed and planted with alfalfa. Most other grasses should not be mixed, and research has shown that alternate row seeding or cross seeding is the best way to plant. Alternate row seeding can be accomplished by taping shut the odd numbered openers on the grain box where the grass will be added, and taping shut the even numbered openers on the legume box where the alfalfa will be added. Cross seeding involves seeding the grass first followed by seeding the alfalfa at a different angle, or broadcasting alfalfa (see previous discussion).

In irrigated mixtures, blends that include timothy, orchardgrass, and improved (endophyte-free) tall fescue are often planted. Under dryland conditions, the choice of grasses will depend

upon rainfall zone, competitiveness of the grass, and what types of animals will be fed. Meadow brome and 'Latar' orchardgrass are very palatable to cattle and can easily be grown in the higher rainfall zone of eastern Washington. Smooth brome, creeping foxtail, and improved tall fescue are also good choices for cattle in the higher rainfall zone. Pubescent wheatgrass and higher yielding crested grasses such as 'CD-2' and 'Hycrest' are less palatable but more drought tolerant and may be better choices in the intermediate rainfall zone. 'Nordan' crested wheatgrass, intermediate wheatgrass, and Siberian wheatgrass are even more drought tolerant, mature earlier, and would be most useful in the low rainfall zone where there is one cutting. Of these three, Siberian wheatgrass cultivars 'Vavalov' and 'Vavalov II' have the best forage quality. These grasses are stiff-stemmed and hold the hay off of the ground, thereby helping hay cure in the windrow.

The competitiveness of the grasses with alfalfa should also be considered. Under irrigation, addition of N may be necessary in grass-legume stands to ensure the grass remains competitive with alfalfa. Grasses will be more competitive where soil N is high, for example if manure is applied for fertility. Smooth brome is an aggressive rhizomatous (i.e., spreads by underground stems) grass that can crowd out a stand of alfalfa after several years in dryland production. Pubescent wheatgrass and intermediate wheatgrass also have rhizomes but are somewhat less aggressive. Rhizomatous grasses have the advantage of being able to fill voids that develop as a stand thins.

## **Nutrient Management**

### **Alfalfa Nutrient Needs**

Each ton of dairy quality (pre-bloom) alfalfa hay contains approximately 80 lbs of nitrogen (N), 60 lbs of potash ( $K_2O$ ), 15 lbs of phosphate ( $P_2O_5$ ), 5 lbs of sulfur (S), 0.05 lb each of zinc (Zn), iron (Fe), manganese (Mn) and boron (B), 0.1 lb copper (Cu), and 0.006 lb molybdenum (Mo). Alfalfa is capable of obtaining N from the atmosphere and does not require supplemental N sources. The remaining nutrients, however, must come from soil reserves or fertilizer sources.

Organic alfalfa growers must be creative and proactive to meet alfalfa fertility needs. Applying manure immediately before planting may stimulate weed germination and competition. Applying manure or compost to rotational crops builds soil reserves of nutrients. Phosphorus (P) can effectively be stored in the soil this way. However, very high levels of potassium (K) can result in high concentrations of K in the hay ("luxury consumption"). Sulfur is mobile in soil so high levels may lead to loss through leaching. Finally, certain micronutrients such as boron can be toxic in high doses and can be subject to leaching or luxury consumption.

Soil and tissue testing are reliable tools for determining alfalfa nutrient needs. See related guides for sampling methods and nutrient management recommendations for alfalfa based on soil and tissue testing (3). Use soil testing as a guide to fertility needs prior to establishing a new stand of alfalfa. Use soil or tissue testing when making decisions about fertilizing an existing stand and/or to diagnose suspected nutrient deficiency problems. Several commercial laboratories in the Pacific Northwest analyze soil and plant tissue samples for agriculture (4). Many of these same labs will also analyze nutrient content of manure and compost.

Before establishing a stand of alfalfa, sample soil to determine the amount of P, K, and other nutrients needed. In many organic rotations, use of manure on annual crops preceding alfalfa will leave high concentrations of nutrients available in the soil. Most forms of organic nutrients can be broadcast on an established stand of alfalfa if a need is defined; however, P is more effective if incorporated before stand establishment. Consider applying sufficient P for a 2–3-year supply based on expected yield and crop P removal rates (15 lbs  $P_2O_5$  per ton of hay). If manure or compost is used as a nutrient source, basing applications on P needs of alfalfa will often meet or exceed the requirements for K and micronutrients.

### **Organic Nutrient Sources**

Table 1 contains a partial list of fertilizer materials and the specific nutrients they supply. Only certain formulations or brands of organic nutrients meet certification standards. Check

with your certifying agent, the WSDA, and/or other national certification programs to ensure the type and brand of fertilizer material you select meets appropriate standards. A soil or tissue test is required to document the need before micronutrients are applied under organic management.

Select organic fertilizer sources based on nutrient(s) needed and the cost per unit of nutrient. Organic fertilizer sources vary widely in nutrient concentration, availability, and cost per unit of nutrient due to factors such as the material of origin, processing requirement, unit (package) size, and transportation distance. A useful spreadsheet is available to calculate the cost per unit of nutrient for organic fertilizers (see Online Resources). Commercial organic fertilizers are generally much more expensive than bulk materials such as composts and manures. For this reason and where available, composts and manures should constitute the foundation of an organic fertility program. The nutrient content of composts and manures should be tested to determine actual nutrient concentrations. Organic materials also vary in the rate of release of nutrients they contain. When calculating application rates of organic nutrients, assume 75% of the phosphorus and 85% of the potassium and micronutrients is available.

Table 2 lists average N, P, and K contents of common animal manure and compost sources. Historically, manure was notorious for containing

weed seeds. Today, expectations of cattle herds to produce higher milk and meat yields have led to feeding high quality hays, grains, and by-products that are nearly free of weed seeds. The quality of the feed source will determine the weed seed content of manure. Consequently, manure from horse and sheep enterprises can contain far more weed seeds than manure from dairy, beef feedlots and poultry. Composting can reduce the viability of many weed seeds if done properly, but will not totally eradicate seeds. Salinity (soluble salts) can also be a concern with manure. Salts become concentrated in manure during storage or composting. Manure salinity is a minor concern at normal application rates if applications are made in the fall after alfalfa stands enter dormancy.

While alfalfa does not require supplemental N, it will utilize N from compost and manure sources and in turn reduce N acquired through biological fixation. The rates of manure applied for alfalfa production do not pose a significant risk to groundwater contamination or affect long-term potential for N-fixation potential by alfalfa. However, N in manure can stimulate the growth of weeds so it may be preferable to apply manure at times when a weed flush can be controlled, such as in preceding crops or in the fall when followed by weed control practices discussed below. Fall application, when the soil is dry, also minimizes compaction from equipment. Lower rates (<10 tons/acre) of manure can also be applied during the growing season between

**Table 1. Partial list of organic nutrient sources approved by the WSDA, NOP, and/or the OMRI (as of October 2007). Organic growers are strongly encouraged to check with their certifying agent before acquiring any nutrient source to verify that it meets WSDA organic standards.**

Nutrient	Approved sources†
Phosphorus	Rock phosphate (mined)
Potassium	Potassium sulfate or sulfate of potash (mined) Potassium magnesium sulfate (mined)
Sulfur	Gypsum Elemental sulfur Potassium sulfate or sulfate of potash (mined) Potassium magnesium sulfate (mined)
Micronutrients	Boron (various forms) Zinc, iron, copper, or manganese sulfates Kelp (contains various micronutrients)

†For many of these sources, only specific brands may be approved for organic production in Washington. Consult the WSDA organic materials list for approved brand name products, and the NOP list of approved materials and OMRI for additional organic nutrient sources (see Online Resources).

**Table 2.** Typical nutrient content, solids content, and bulk density of animal manures and composts.† Check with your certifying agent regarding any restrictions regarding allowed sources and required delays before cutting.

Type	N	P <sub>2</sub> O <sub>5</sub>	K <sub>2</sub> O	Solids	Density
	lbs per ton "as is" (under typical storage)			---%---	lbs/cubic yard
Broiler with litter	73	64	66	70	900
Laying hen	37	57	47	40	1400
Sheep	18	9	35	28	1400
Beef	12	6	17	23	1400
Dry stack dairy	9	4	19	35	1400
Separated dairy solids	5	2	3	19	1100
Horse	9	6	16	37	1400
Poultry compost	17	39	23	45	(no data)
Dairy compost	12	12	26	45	(no data)

†Adapted from Fertilizing with Manure, A. Bary, C. Cogger and D. Sullivan (2004), Pacific Northwest Extension Bulletin 0533 (5) and Using Manure and Compost as Nutrient Sources for Fruit and Vegetable Crops, C. J. Rosen and P. M. Bierman (2005), University of Minnesota Extension Bulletin M1192 (6).

cuttings, but check organic restrictions regarding delays between application and cutting.

## Weeds

### Know Your Weeds

Weeds that seriously degrade hay quality should be distinguished from weeds that reduce yields but have little effect on quality. One of the best weed identification resources is "Weeds of the West" (7).

Weeds that reduce alfalfa hay quality are especially troublesome for organic growers. Dairy operators demand hay be free of weeds that are poisonous, injurious to livestock, unpalatable, or that reduce milk quality. Weeds that are not palatable to livestock and thus reduce alfalfa hay value include Rattail fescue (*Vulpia myuros*) and ventenata (*Ventenata dubia*; also known as wiregrass). These two grassy weeds are becoming more common in dryland eastern Washington. Common tansy (*Tanacetum vulgare*) and mayweed chamomile (*Anthemis cotula*; also known as dog fennel) are pungent broadleaf weeds that dairy producers find objectionable. Winter annuals such as downy brome (*Bromus tectorum*; also known as cheatgrass) and shepherd's purse (*Capsella bursa-pastoris*) are objectionable and can compete seriously with alfalfa, being particularly troublesome in late summer plantings under irrigation. Downy brome seeds can also injure the eyes and mouths of livestock. The sharp



**Figure 1.** Downy brome, one of the most common weeds in alfalfa. (Photo by E. Patrick Fuerst)

barbs of yellow starthistle (*Centaurea solstitialis*) make it unpalatable to most livestock; this weed is also toxic to horses. Common groundsel (*Senecio vulgaris*) is toxic to cattle and horses and can be a problem in new alfalfa stands, especially in irrigated areas. It is an annual weed that germinates year-around. In late-summer alfalfa seedings, common groundsel can become established, flower during the winter and removed with the first cutting. Close clipping of the weed during the early spring before the alfalfa begins substantial growth and after the weed has flowered will reduce the contamination. The parasitic weed, dodder (*Cuscuta* spp.) is relatively rare in Washington, but where present hay must be quarantined and alfalfa and clover production discontinued.

Rhizomatous perennial weeds such as Canada thistle (*Cirsium arvense*) and rush skeletonweed (*Chondrilla juncea*) can drastically reduce the commercial value of the hay. Rhizomatous weeds tend to be very persistent and take considerable time and effort to control. One or two years of fallow or intensive management using annual hay crops or green manure followed by one or more undercutter (Figure 2A) passes may be required. These weeds tend to grow as patches so the entire field may not require fallowing. In irrigated areas with frequent cutting (3–5 harvests per season), a good stand of alfalfa can eliminate Canada thistle over a period of 3–4 years. Similar results have been observed with dryland alfalfa in Montana.

Many weeds are problems in alfalfa simply because they reduce yields even though they may not seriously reduce hay quality. Such weeds include wild oats (*Avena fatua*), volunteer smooth brome, and field bindweed (*Convolvulus arvensis*;

also known as creeping jenny and morning glory). If wild oats were a problem in previous crops, they can seriously impair establishment of spring-seeded alfalfa. Although smooth brome is a forage grass, it is very aggressive and can crowd out alfalfa, as previously discussed. Field bindweed has a very deep root system, and this weed is very competitive in dryland fields.

### Weed Management in Mature Stands

A vigorous alfalfa stand competes well with weeds. Many annual weeds including downy brome can be controlled by timely mechanical disturbance of the upper two inches of soil in the late fall and/or early spring, depending on when weeds are germinating. The smaller the weeds are, the better the control will be. Implements that have been used include the skew treader (Figure 2B), the Triple-K (Figure 2C), the rotary harrow (Figure 2D), the spring-toothed harrow, or



**Figure 2.** Tillage implements discussed in this bulletin: (A) Undercutter, conservation tillage implement useful for weed management before establishment and for terminating the alfalfa stand; (B) skew treader, (C) Triple-K, and (D), Phillips rotary harrow. The spike-toothed harrow (not shown), skew treader, Triple-K, and rotary harrow are options for in-crop weed management as discussed in the text. Photos by William Schillinger (undercutter), John Kugler (skew treader and triple-K), and E. Patrick Fuerst (Phillips rotary harrow).

a light disk. With a relatively low intensity tillage operation like the spring-toothed harrow, optimal weed control may be obtained by making two passes, with the second operation perpendicular to the first. However, only a single pass should be used with more aggressive operations. Overly aggressive cultivation will damage alfalfa roots, making them more prone to root diseases. Early cutting is advised if downy brome is present; cut pre-bloom if necessary. During the growing season, flaming immediately after cutting will kill weed seedlings without seriously harming established alfalfa. However, alfalfa re-growth will be delayed about 7–10 days. Be aware that excess irrigation resulting in standing water or poor drainage conditions will put stress on alfalfa and favor the weeds.

## Pest Management

### Insects

The Washington State Alfalfa Crop Profile (1) provides photographs of many alfalfa insects as well as a discussion of biological and cultural management tactics. Here, we will briefly review biological and cultural approaches to pest management in general, and the alfalfa weevil and aphids in particular. Because there are relatively few approved and economical options for in-crop pest management in organic alfalfa, variety selection is of critical importance, as previously discussed.

Managing insect pests in an organic system requires greater attention to monitoring alfalfa insects so that timely harvests and other control measures can minimize the impact. Growers should learn to survey and identify pests and beneficial insects (“beneficials”) (Table 3) by talking to other growers and their county Extension educator.



**Figure 3.** Alfalfa weevil larva. (Photo by Clemson University—USDA Cooperative Extension Slide Series, Bugwood.org)

Ladybeetles, minute pirate bugs, and lacewing larvae are some of the commercially available beneficials; however, there is little evidence that such releases are effective in alfalfa. Alfalfa crops harbor such diverse communities that introductions seem unlikely to succeed. Conservation of naturally occurring beneficials may be an alternative strategy. Natural populations of beneficials are more likely to remain in the area when growers maintain places that remain uncut, manage harvests so that there is always some habitat for beneficials, or plant additional species that harbor beneficials (9). However, we have too little information available at this time to recommend these practices because such insectaries may benefit pests more than beneficials. Weeds in borders surrounding alfalfa should be controlled because they are overwintering sites for alfalfa weevil.

**Table 3.** Alfalfa pests and their predators.

Alfalfa Pest	Predators
Alfalfa Weevil	Big-eyed Bug, Damsel Bug, Assassin Bug, Lacewing Larva, Ladybeetle, Spiders, Parasitoid Wasps
Caterpillars	Big-eyed Bug, Damsel Bug, Assassin Bug, Lacewing Larva, Spiders, Minute Pirate Bug, Parasitoid Wasps
Aphids	Big-eyed Bug, Damsel Bug, Lacewing Larva, Ladybeetle, Minute Pirate Bug, Parasitoid Wasps

Adapted from *Organic Alfalfa Production*, M. Guerenra and P. Sullivan (2003, ATTRA (8)).

As a group, insect pests can reduce harvests directly by consuming forage or indirectly by causing delayed re-growth, which affects the number and date of subsequent cuttings. Insect pest problems are generally worse after a mild winter. When adult aphids, alfalfa weevil, or clover root curculio overwinter, populations can increase rapidly in the spring. For some insect pests, Neem baits and sprays or *Bacillus thuringiensis* (Bt) are available. Consult with allowed vs. prohibited substances as indicated by WSDA, OMRI and the NOP (see Online Resources). Pesticides approved for organic production may only be used when the management options described in the farm plan are found to be insufficient to prevent or control the target organism.

### **Alfalfa Weevil and Aphid Management**

***Cultural.*** Many varieties express resistance to aphids; however, there are no varieties that are considered resistant to alfalfa weevil. Mowing weeds, brush and other vegetation near alfalfa fields reduces over-wintering habitat. Spring grazing when alfalfa is in the early bud stage has been shown to decrease the weevil population, as weevil larvae and unhatched eggs are consumed by the animals. If the field is within two weeks of harvest, early cutting is practiced. During the haying operations, insects are shaken from the plants and fall to the ground and are killed as they are exposed to the sun or eaten by ground beetles and other ground-active predators. Surviving aphids and weevil larvae hiding under the windrow will be exposed after raking the hay. Flaming after the first harvest will kill aphids, weevils, and their larvae.

***Monitoring the Alfalfa Weevil.*** The following practices were developed for monitoring conventional alfalfa and may need to be adapted for organic systems. Monitoring is practiced if there is a history of weevil damage and a potentially high over-wintering population. Sample alfalfa fields on a weekly basis beginning in the spring. Collect 50 stems at random, choosing stems no more than 8 inches long, and then vigorously shake them within a container to dislodge any insects. Count the insects thus collected. An economic threshold has been established at 1.5–2 larvae per stem. Count insect-damaged terminals as well: 20 out of 50 damaged

terminals (40%) indicate an economic threshold.

When the alfalfa plants are 8–10 inches tall, a standard sized sweep net (15 inches) is used to determine larval populations. Sweep nets may underestimate the true population, as small larvae are difficult to dislodge from the plant terminals. For populations exceeding the economic threshold, management options include early harvest to save the crop or flaming immediately after harvest.

### **Vertebrate Pests**

Pocket gophers and voles can be serious problems in alfalfa and they are very difficult to control once established (1). Both types of rodents can reduce yields. Furthermore, soil from gopher mounds can contaminate hay and seriously reduce its value. Gophers feed on alfalfa taproots whereas voles feed on surface root tissue and crowns. Pocket gophers become more prevalent when hay is grown for many years.

Gophers and voles are difficult to control in alfalfa fields because they often rapidly reinvade following control measures. Flood irrigation may temporarily reduce numbers. Sulfur dioxide (smoke bombs) and Vitamin D3 are approved for organic rodent control when the need is documented (see NOP 7 CFR 205.601(g)(1) (2)). Legal trapping options are restricted in Washington; a permit for lethal trapping can be obtained from the Washington Department of Fish and Wildlife. However, trapping is time-consuming for large acreages. As for using commercially available repellents, we recommend some skepticism concerning claims about their effectiveness.

Longer-term rodent management strategies should be considered. Shorter rotations that involve deep tillage will destroy tunnel systems and kill some gophers. Rotation to cereals and other crops with fibrous roots will reduce the population. Reinvansion may be reduced by removing nearby unmanaged vegetation along fencerows and ditch banks. Both gophers and voles are active during the winter months, so mowing or grazing vegetative cover may increase rodent mortality by increasing exposure to predators. Predators, including dogs, cats, skunks, coyotes, foxes, badgers, weasels, rattlesnakes,

gopher snakes, hawks, and especially owls, eat gophers and voles. Providing nesting habitat and perches may encourage raptors to take up residence near the field.

## Terminating Alfalfa Stands

Stand termination requires tillage. The conventional practice is to plow down or disk a stand of alfalfa. However, an alternative that conserves energy and soil would be to use the undercutter (Figure 1A). The undercutter has been used successfully in dryland alfalfa research, tilling once in the fall and again in the spring before planting. Alfalfa residues decompose readily after tillage and do not interfere with succeeding crops. However, the crown and tap root may break down more slowly and can interfere with operation of implements like tined weeders in the succeeding crop.

## Economics

Like many organic crops, organic alfalfa hay prices will vary widely from year to year. Small shifts in demand or supply can cause large price changes due to the relatively small size of this market. Top quality organic alfalfa hay typically commands a premium over higher quality conventional hay, but the market situation varies considerably from year to year.

We estimated returns for both irrigated and dryland organic alfalfa production (Tables 4–6). Further detail is available in the flexible spreadsheets that accompany this bulletin, available online <http://csanr.wsu.edu/Publications/FarmMgmtEconomics.htm>. Producers can tailor the spreadsheets to reflect their particular operation. These economic budgets include all costs associated with the capital, labor, and land resources used to raise the crop (10). Alfalfa establishment costs were amortized at a 7% interest rate over the life of the stand. Also, we assumed that all haying operations were performed by the owner-operator rather than a custom haying operation. Sufficient cow manure to meet P fertility needs during the life of the stand was applied before establishment.

The application rate was 1.25 tons/acre per ton of alfalfa removed over the life of the stand. However, as previously discussed, applying manure to preceding crops is preferred in order to utilize N while leaving P and other nutrients required by alfalfa.

Irrigated production was assumed to take place under center pivot irrigation in the Columbia Basin with a three-year stand life, using fall establishment following small grain production (Table 4). Establishment costs of \$1,011 per acre are amortized as previously discussed. Cow manure was applied at 30 tons/acre in the summer prior to establishment. Large (1500-lb) bale production had an average annual return over total costs of \$752/acre, assuming a price of \$250/ton, while small (2-tie) bale production was slightly more profitable at \$767/acre under these same price assumptions due to lower production costs for small bales. A higher price for small bales produced under irrigation may be warranted, due to the retail demand potential for high quality organic small bales (11). Table 4 does not include any revenue for the first year as we assume alfalfa is established in the fall after a small grain harvest. Establishment costs are prorated over the productive life of the stand (see spreadsheet).

In dryland production, the stand life was assumed to be five years with over 15 inches of precipitation (two cuttings per year), and ten years with less than 15 inches of precipitation (one cutting per year) (Tables 5 and 6). These assumptions can be changed in the accompanying spreadsheets. The higher rainfall zone received 28 tons/acre of cow manure while the lower rainfall zone received 25 tons/acre of manure in the fall prior to establishment. Returns over total costs are negative in the establishment year for both rainfall zones, due to the high costs of applying manure for the life of the stand. Average annual returns over total costs during alfalfa production were \$337/acre in the lower rainfall zone and \$509/acre in the higher rainfall zone, assuming a price of \$250/ton. Losses incurred during the establishment year were prorated over the productive life of the stand.

**Table 4. Irrigated alfalfa: Annual returns over variable and total costs for organic alfalfa with a three-year stand in the Columbia Basin, WA using a center pivot irrigation system.**

	Yield (ton/ acre)	Price (\$/ton)	Revenue (\$/acre)	Total Variable Costs (VC) (\$/acre)	Total Cost (TC) of Operation (\$/acre)	Returns over VC (\$/acre)	Returns over TC (\$/acre)
Fall Establishment*	N/A	N/A		\$995	\$1,011	N/A	N/A
Large Bale (1-ton) Production	8.0	\$250	\$2,000	\$344	\$1,248	\$1,656	\$752
Small Bale Production	8.0	\$250	\$2,000	\$336	\$1,233	\$1,664	\$767

\*Alfalfa establishment costs are amortized over the life of the stand. These figures are for informational purposes only.

**Table 5. Dryland alfalfa, higher rainfall: Annual returns over variable and total costs for a five-year stand of dryland organic alfalfa, assuming round bale production and two cuttings per year for areas with higher than 15 inches of annual precipitation in eastern Washington.**

	Yield (ton/ acre)	Price (\$/ton)	Revenue (\$/acre)	Total Variable Costs (VC) (\$/acre)	Total Cost (TC) of Operation (\$/acre)	Returns over VC (\$/acre)	Returns over TC (\$/acre)
Alfalfa Establishment (1st year)*	2.5	\$250	\$625	\$812	\$931	-\$187	-\$306
Alfalfa Production (Years 2–5)	3.5	\$250	\$875	\$177	\$366	\$698	\$509

\*Losses incurred during the alfalfa establishment year are amortized over the years of full production. These figures are for informational purposes only.

**Table 6. Dryland alfalfa, lower rainfall: Annual returns over variable and total costs for a ten-year stand of dryland organic alfalfa, assuming round bale production and one cutting per year for 12- to 15-inch precipitation zones in eastern Washington.**

	Yield (ton/ acre)	Price (\$/ton)	Revenue (\$/acre)	Total Variable Costs (VC) (\$/acre)	Total Cost (TC) of Operation (\$/acre)	Returns over VC (\$/acre)	Returns over TC (\$/acre)
Alfalfa Establishment (1st year)*	1.5	\$250	\$375	\$894	\$994	-\$519	-\$619
Alfalfa Production (Years 2–10)	2.5	\$250	\$625	\$117	\$288	\$508	\$337

\*Losses incurred during the alfalfa establishment year are amortized over the years of full production. These figures are for informational purposes only.

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## Resources

### General Organic Agriculture Resources

WSU organic agriculture internet resources  
<http://csanr.wsu.edu/Organic/>

ATTRA—National Sustainable Agriculture Information Service, National Center for Appropriate Technology (NCAT)  
<http://attra.ncat.org/organic.html>

### Alfalfa Cultivar Comparisons

Washington State Hay Growers Association and Washington State University, *Alfalfa Variety Yield Trials*  
<http://www.wa-hay.org/publications>

National Alfalfa and Forage Alliance. *Winter Survival, Fall Dormancy and Pest Resistance Ratings for Alfalfa Varieties*. 2007–2008 ed.  
<http://www.alfalfa.org/pdf/NAFA%2007-08%20Varieties%20Leaflet.pdf>

North American Alfalfa Improvement Conference  
<http://www.naic.org/>

### Organic Rules, Certification, Allowed and Prohibited Substances

Washington State Department of Agriculture, Organic Food Program <http://agr.wa.gov/FoodAnimal/Organic>

USDA National Organic Program  
<http://www.ams.usda.gov/AMSV1.0/ams.fetchTemplateData.do?template=TemplateA&navID=NationalOrganicProgram&leftNav=NationalOrganicProgram&page=NOPNationalOrganicProgramHome&acct=nop>

Organic Materials Review Institute  
<http://www.omri.org/>

USDA-NOP. *Electronic Code of Federal Regulations, Title 7 Agriculture, Part 205 National Organic Program, Subpart G Administrative, The National List of Allowed and Prohibited Substances*. United States Government Printing Office.  
<http://ecfr.gpoaccess.gov:80/cgi/t/text/text-idx?c=ecfr;sid=75efb24326a56b8ac84453d3a0589e09;rgn=div5;view=text;node=7%3A3.1.1.9.30;idno=7;cc=ecfr>

### Soil Survey and Fertility Resources

USDA-Natural Resource Conservation Service, Washington Soil Survey Data  
[http://www.or.nrcs.usda.gov/pnw\\_soil/wa\\_reports.html](http://www.or.nrcs.usda.gov/pnw_soil/wa_reports.html)

USDA-Natural Resource Conservation Service, Web Soil Survey  
<http://websoilsurvey.nrcs.usda.gov/app/>

Organic Fertilizer Calculator  
<http://smallfarms.oregonstate.edu/organic-fertilizer-calculator>

## Evaluation Form

We would greatly appreciate your feedback on this Organic Alfalfa Management Guide. Please take a few minutes to complete the following evaluation form. This information will help us assess the guide's effectiveness as well as make necessary changes in the future.

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1. How much did you know about organic alfalfa management before reading the *Organic Alfalfa Management Guide*?

- Nothing       A little       A moderate amount       A lot

2. How much did you learn by reading the *Organic Alfalfa Management Guide*?

- Nothing       A little       A moderate amount       A lot

3. Do you expect to change your practices based on information provided in the *Organic Alfalfa Management Guide*?

- No  
 Yes      →      If yes, how do you plan to change your practices?

4. What did you find most helpful about the *Organic Alfalfa Management Guide*?

***Please continue*** ➔

5. What suggestions do you have for improving the *Organic Alfalfa Management Guide*?

6. Do you grow alfalfa on your farm?

No

Yes → How many acres of the following types of alfalfa do you grow on your farm?

\_\_\_\_\_ acres of certified organic alfalfa  
\_\_\_\_\_ acres of organically managed (but not certified) alfalfa or in-transition-to-certified-organic alfalfa  
\_\_\_\_\_ acres of conventional alfalfa

For how many years have you grown alfalfa? \_\_\_\_\_ years

7. Is there anything else you would like to tell us about your farm operation and/or the *Organic Alfalfa Management Guide*?

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THANK YOU for taking the time to complete this evaluation form.

Mail completed survey to:

E. Patrick Fuerst  
Department of Crop & Soil Sciences  
Washington State University  
Pullman, WA 99164-6420



Use pesticides with care. Apply them only to plants, animals, or sites as listed on the label. When mixing and applying pesticides, follow all label precautions to protect yourself and others around you. It is a violation of the law to disregard label directions. If pesticides are spilled on skin or clothing, remove clothing and wash skin thoroughly. Store pesticides in their original containers and keep them out of the reach of children, pets, and livestock.

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