EB2004

ORCHARDGRASS HAY PRODUCTION GUIDE for the COLUMBIA BASIN of WASHINGTON

John L Kugler, WSU Grant/Adams County Extension

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Figure 1.
An estimated 25,000 ac of orchardgrass hay is produced in Washington State each year.

IMPORTANCE TO THE STATE ECONOMY

The estimated 25,000 ac of orchardgrass hay produced each year in Washington State (Fig. 1) generate approximately $15 million in annual state revenue. Much of this hay comes from small production units of less than 500 ac per farm.

The dry climate of Washington's Columbia Basin (where most of the hay is grown) is excellent for irrigated grass hay production where rapid curing of the cut hay retains natural color. Grass hay that is baled and stored without sun and weather damage brings a $30 to $50 premium in price. In today's market, aesthetic factors such as blue-green foliage color, a pleasant aroma of the hay in the bale, and freedom from dust and molds often outweigh nutritional factors.

Columbia Basin growers have developed marketing relationships with western Washington feed stores for the supply of high quality orchardgrass hay. About 80% of the hay is sold as feed for pleasure horses, with the less perfect hay as supplemental feed for mature beef cows. Although some dairymen use orchardgrass for pasture and silage, they seldom purchase it because alfalfa hay is $20 to $30/tn lower in price.

A secondary but significant market is hay for export to the Pacific Rim. About 10,000 to 12,000 tn per year are double compressed and sold for horse consumption in Japan, adding $2.5 million to Washington's economy. Some Washington orchardgrass is also shipped to the Midwest and eastern U.S. racehorse farms.

PLANT CHARACTERISTICS

Orchardgrass ***(Dactylis glomerata L.)*** is a perennial, cool-season bunchgrass adapted to the northern tier of the U.S. and southern Canada. As its name implies, it tolerates shade well. Unlike Kentucky bluegrass or bromegrass, orchardgrass does not spread by rhizomes. It grows from the center of the crown outward. A mature single clump (or bunch) of orchardgrass may reach a diameter of 10 in. If not properly and regularly grazed or hayed, the crop will form distinct clumps with greater spacing between plants, giving a tufted appearance to the field. Clumpy plants will become rank and produce less acceptable hay.

Orchardgrass recovers rapidly from cutting because new growth is initiated from the base of the leaf blade and sheath (unlike smooth brome where new shoots originate from the crown), and at the internode, which permits orchardgrass to be harvested from three to four times per season in the Columbia Basin. In comparative tests near Royal City, Washington, orchardgrass out-yielded all other cool season grasses, including fescue, brome, timothy and perennial ryegrass (Table 1).

Orchardgrass requires vernalization to produce seed heads, which occurs over the winter during short day lengths when temperatures range between 35°F and 50°F followed by a period in the spring of long days and a temperature range of 62°F to 91°F. Thus, the first harvest will have seed heads, whereas later cuttings will have very few. Orchardgrass will winterkill in the Columbia Basin when plants are under drought stress and low winter temperatures (12°F or lower) persist for a short time with no snow cover. Winterkill is exacerbated when plants are stressed by low fertility and cutting too close to the ground.

Table 1.
Comparison of grass species for 2-yr 100% dry matter forage yields at Royal Slope, WA.

Grass species	2001	2002	2-yr total
		tn/ac	
Orchardgrasses	8.1	6.2	14.3
Timothy	7.8	6.2	14.0
Fescues	7.8	5.0	12.8
Bromes	7.0	3.5	10.5
Perennial ryegrasses	6.5	2.8	9.3
Diploids	6.4	2.8	9.2
Tetraploids	5.9	2.8	8.7
Indiangrasses	7.5	5.8	13.3
Big Bluestems	6.3	5.3	11.6
Switchgrasses	7.2	4.8	12.0

SOIL REQUIREMENTS

Orchardgrass is widely adapted to many soil types. It persists better than timothy in droughty or wet soils, although it prefers well-drained soils and can persist well in low to moderately high pH soils. Orchardgrass is often planted in soils low in organic matter.

STAND ESTABLISHMENT

Seedbed Preparation

Optimal stands of orchardgrass result from seedbeds that are moist, firm, uniform, and free from large amounts of residue from previous crops. Pre-plant incorporation of fertilizer is better than topdressing after stand establishment. Plowing may not be necessary if the planting follows dry peas, beans, or other annual crops that leave little residue.

Planting

Variety Choice

Orchardgrass varieties vary in maturity (early, intermediate, and late), winter hardiness, pest resistance, color, and forage potential. Based on data collected on a limited number of varieties tested near Royal Slope, Washington, early and intermediate maturity varieties out-yield late-maturating varieties in the Columbia Basin when harvested at the stage when the earliest varieties are heading (1).

Currently, consumers prefer orchardgrass with a blue-green color as opposed to a bright green color. Varieties inherently differ in color, which is unrelated to degrees of greenness expressed as a result of nitrogen or sulfur fertility.

Forage quality in terms of nutritional feeding value (protein and fiber concentrations) is gaining importance in the marketplace. Comparative tests on a limited number of varieties indicate only minor genetic differences in forage quality between varieties.

Timing

Orchardgrass can be planted either in the spring or fall. August plantings are the most cost-effective because there is less competition from weeds at this time of year, and allows for full production the following year. Late September plantings are sometimes successful but risky, as seedling orchardgrass is susceptible to injury by freezing temperatures.

Seeding Methods

Drilling is the preferred seeding method because seed is placed at a uniform depth (¼ to ½ in) and provides good seed-soil contact. However, the use of no-till drills with minimum tillage, as well as broadcast seeding, has also been successful. Firming the soil with a packer after broadcast seeding will enhance seedling establishment. Seeding by airplane is rare because orchardgrass seed is light and bulky.

Orchardgrass is often seeded into declining alfalfa stands. It occupies space between alfalfa plants and prevents weed encroachment. In some cases, mixed stands are allowed to continue until the alfalfa portion is depleted so that a pure stand of orchardgrass remains (Fig. 2), but some horse owners appreciate the added protein provided by the alfalfa in mixed grass/legume hay.

Figure 2.
Orchardgrass is often inter-seeded into declining alfalfa stands.

Seeding Rate

The seeding rate for well-prepared soil is 8 to 10 lb PLS (Pure Live Seed)/ac. With rough ground or seedbeds with moderate crop residues, it is best to increase the rate to 12–15 lb PLS/ac (2,3). It is also advisable to inspect the seed tag for the germination and purity percentages and adjust the rate as necessary. For example, 10 lb of seed that has 80% germination and is 90% pure contains (10 X 0.8 X 0.9 = 7.2) 7.2 lb (PLS) or 72%. So if the desired seeding rate is 10 lb PLS/ac, the adjusted planting rate would be (10/0.72 = 13.9) or 13.9 lb seed/ac. A successfully established stand is considered to have 24 to 36 plants per sq ft at the 3 to 4 leaf stage.

Germination

Orchardgrass requires 20 to 30 d for germination under field conditions, thus irrigation management to maintain moist soil conditions at this time is critical for good stand establishment. Once the majority of shoots have emerged from the soil, it is less critical to maintain a moist soil surface. Irrigation frequency can be scaled back to maintain moist soil to a depth of 6 to 12 in.

GROWING AND HARVESTING

Fertility

Orchardgrass demands high nutrient input for economically viable hay production. All fertilizer applications should be based on soil tests. Compared to the cost of over or under-applying needed crop nutrients, a $40 soil test is minor. The sample should be composed of 20 to 30 cores randomly selected from the entire field. However, in fields where the soil texture and topography are highly variable, 5 to 10 cores should be in taken in each identifiably different area. An annual 6-tn/ac yield of hay is average for the Columbia Basin, but some growers can produce greater than 8 tn of hay/ac/yr.

Nitrogen (N). Annual N applications often range between 250 to 350 lb/ac. Orchardgrass has the ability to utilize large amounts of N. Oregon researchers have measured actual uptake of over 650 lb N/ac/yr in field experiments using manure as fertilizer (5); however, adding N at this level is not economical for the Columbia Basin orchardgrass hay grower. Nitrogen fertilizer should be added as soon as orchardgrass begins to grow in the spring. In practice, many growers apply 90 to 100 lb N/ac just prior to the first irrigation, and then apply the same amount after the second harvest, and third if they are harvesting four times. With overhead irrigation, some mixture (say 75%) of the N is applied in the dry form, followed by fertigation of the remaining portion to make more N available when the plant needs it and to reduce the risk of leaching N below the root zone.

Orchardgrass has the ability to store toxic levels of nitrates when certain stress conditions such as drought and frost are coupled with high rates of N fertilization. Ruminants are prone to nitrate toxicity because nitrates break down in the rumen to form nitrites. When absorbed into the bloodstream, nitrites interact with oxygen-carrying hemoglobin in red blood cells to form methemoglobin, which interferes with the blood in transporting oxygen, and can cause death when nitrate concentrations are high. Table 2 shows relative risks to ruminants of increasing nitrate N concentration in forage (4). Forage can be tested by soil and tissue testing laboratories (wet chemistry) for about $10 per sample.

Table 2.
Feeding recommendations of forages with various levels of nitrates.

Concentration of Nitrate Nitrogen ppm (Dry Basis)	Comment
Less than 350	Generally safe for all conditions and livestock.
350–1130	Generally safe for non-pregnant livestock. Potential early-term abortions or reduced breeding performance. For bred animals, limit use to 50% of the total ration.
1130–2260	Limit feed to 25–50% of ration for non-pregnant livestock. Do not feed to pregnant animals: may cause abortions, weak calves, and reduced milk production.
Greater than 2260	Do not feed. Acute symptoms and death.

Phosphorous (P). Irrigated orchardgrass removes approximately 4.8 lb P (11 lb P_2O_5) per tn of dry matter. Thus, a 6-tn/ac crop will remove 29 lb P/ac (66 lb P_2O_5). Only about 1/3 of applied P is readily available to crops, thus an annual application of 90 to 100 lb P_2O_5 would satisfy the crop's requirement if the soil test indicates a deficiency. A soil test result of bicarbonate P less than 12 parts per million (ppm) indicates a need for P_2O_5 application. A rule of thumb is to apply 11 lb P (25 lb P_2O_5)/ac for every ppm in the soil below 12. The best time to supplement P is in the early fall when roots are regenerating and growing points for the next year's tillers are being formed.

Potassium (K). Orchardgrass is a luxury consumer of K. Oregon researchers measured K uptake in manure experiments in orchardgrass in excess of 570 lb/ac. Irrigated orchardgrass removes approximately 60 lb K/tn of dry matter. Thus, a 6-tn/ac crop will remove 360 lb K/ac (430 lb K_2O/ac). A soil ppm level below 150 indicates a need for K_2O application. A rule of thumb is to apply 2 lb K (2.4 lb K_2O)/ac for every ppm in the soil below 150. Soil P and K level should be checked every fall.

Sulfur (S). Sulfur is taken up by the plant as sulfate. Usually the S requirement can be supplied by using a sulfated form of N or K such as ammonium sulfate (24% S) or sulfate of potash (18% S). However, S can also be applied as elemental S. One tn of orchardgrass contains about 6 lb of S; thus a 6-tn/ac crop will remove approximately 36 lb S. General recommendations call for adding 40 to 60 lb S/ac/yr. A rule of thumb is to apply 3.5 lb S/ac for every ppm below 13 (as measured in the top 2 ft of soil).

Calcium (Ca) and Magnesium (Mg). Columbia Basin soils normally contain adequate Ca and Mg for optimal orchardgrass growth. Soils recently acidified from years of N fertilization may be low in Ca, but this can be overcome by liming. If Mg is low, dolomitic limestone should be used. Liming with 1–2 tn/ac (based on 100-score lime) should be considered when soil pH falls below 5.6.

Irrigation

Orchardgrass will enter drought-induced dormancy when plants are subject to low soil moisture and high heat until adequate moisture is available. Even though 80% of the root mass is located in the top 3 in of soil (6), orchardgrass will remove water from a soil depth of 2.5 to 3.0 ft. Irrigation should occur when soil moisture reaches from 75 to 80% of field capacity and should bring the top 12 in of soil to field capacity. The wilting point is about 50% of field capacity. Total seasonal water use is approximately 32 to 42 in depending on soil type and weather conditions. Moisture monitoring technology has become affordable for many growers, who have the option of purchasing their own equipment or subscribing to a monitoring service.

Managing for Environmental Factors that Impair Production

Weeds

In well-managed stands of orchardgrass, competition prevents weeds from establishing; however, when needed, there are several herbicides available that are compatible with orchardgrass cultivation (7). With the exception of glyphosate to kill vegetation prior to planting, there are no pre-plant incorporated herbicides approved for use on orchardgrass.

- 2,4-D amine, dicamba (Banvel or Clarity) or dicamba + 2,4-D (Weedmaster or Pasturemaster) will control most small annual broadleaf weeds; however, there are pre-harvest and pre-grazing restrictions with these chemicals (listed on the herbicide labels) of which growers should be aware. Dicamba can damage (or kill) trees and shrubs.
- Clopyralid (Stinger, Transline) and aminopyralid (Milestone) are used for annual, biennial, and perennial broadleaf weeds. There are no grazing or haying restrictions after applying Stinger or Milestone, but orchardgrass must be well-established prior to application to avoid phytotoxicity. Hays from fields treated with clopyralid (or manure from animals fed clopyralid-treated hay) should not be used as mulch, as the active ingredient remains toxic to certain crops. Do not use aminopyralid-treated plant residues (including hay or straw from treated areas) or manure from animals that consumed forage from treated areas within the previous 3 d in compost or mulch that will be applied to areas where susceptible broadleaf plants may be grown. Clopyralid + 2,4-D (Curtail) controls many broadleaf weeds and is used to control persistent perennial weeds such as Canada thistle ***(Cirsium arvense L.)***.
- Metsulfuron (Ally or Cimarron) controls a wide range of broadleaf weeds and there are no grazing restrictions associated with its use. The label should be consulted for rate per acre limitations. There are some plantback restrictions, especially in dryland agriculture with peas or lentils. Metsulfuron offers some pre-emergence activity for partial control of downy brome or cheatgrass ***(Bromus tectorum L.)***.

Herbicide choices continually change. It is important to read and follow pesticide labels.

Insects and Nematodes

Several invertebrate pests attack orchardgrass, although they rarely require treatment. These include grasshoppers, aphids, spider mites, cutworms, wireworms, plant bugs, beetles, root-knot nematode and lesion nematode. Orchardgrass contains the endophytic fungus, ***Neotyphodium chilense*** (previously named ***Acremonium chilense****;* 8) that prevents some insects and nematodes from inflicting heavy feeding damage. Unlike those of endophyte-infected fescue that cause health problems in ruminants, this endophyte associated with orchardgrass is not known to adversely affect livestock.

Insecticides Used in Orchardgrass Cultivation (9):

- Carbaryl (Sevin) and malathion control grasshoppers, cutworms, and cereal leaf beetle.
- Bt ***(Bacillus thuringiensis)*** manages the small larvae of cutworms and armyworms.

Orchardgrass can support large populations of barley root-knot nematode ***(Meloidogyne naasi)****,* and is also a host for the Columbia root-knot nematode ***(M. chitwoodi)*** and both common species of the lesion nematodes ***(Pratylenchus penetrans*** and ***P. neglectus****;* 10). No economic data are available to characterize actual losses from nematode infection. Crop rotation to non-host crops is the only known control option.

Disease

Orchardgrass is susceptible to several leaf pathogens, including rusts and mildews (3). These are usually expressed in humid climates and seldom seen in eastern Washington. However, the following have been observed in the Columbia Basin:

- Brown stripe or leaf streak is caused by ***Scolecotrichum graminis*** (11). This fungus causes small lesions on leaf blades that appear water-soaked. They soon become olive gray in color when wet. When dry they fade to a deep, dull gray or purplish brown. Later, the lesions extend down along the edges of the leaf several inches, becoming brown with a grayish-white to light brown center. Finally, parallel rows of prominent, olive-gray dots appear on the upper leaf surface. Each dot is a cluster of the fungi's spore-bearing structures (conidiophores). The disease is encouraged by high N fertilization and appears during the second and third harvests. It affects many grasses, including timothy and some cereals. There are no known controls.
- Rhizoctonia blight caused by ***Rhizoctonia solani*** is a soil-borne fungus that attacks orchardgrass, fescues, timothy, and ryegrasses. It may attack roots, the crown, stems, and leaves. Symptoms appear as large, irregular tan blotches with dark brown borders on leaves and leaf sheaths. Blotches grow to girdle the stem. The fungus spreads from leaf to leaf under high humidity or overhead irrigation. Less frequent irrigation with more volume of water per irrigation may slow the spread of the disease.
- Orchardgrass mottle virus ***(OrMV; Oulema melanopus)*** is vectored by the cereal leaf beetle. It causes severe mottling of foliage. Given the recent invasion of eastern Washington by the cereal leaf beetle, this disease may increase in occurrence. Some resistance has been found in locally adapted varieties (Pizza, Justus) in the Pacific Northwest.
- Stripe rust occurs in late summer and fall. It can reduce forage quality by increasing acid detergent fiber (ADF) by 6 to 8%. It is caused by the fungus ***Puccinia striformis.*** The spores produced are lemon-yellow to orange in color and may cause respiratory illness in livestock. There are no chemical controls. Good fertility and irrigation management may prevent serious outbreaks.

Rodents

The pocket gopher (***Thomomys talpoides***; Fig. 3) and meadow vole (***Microtus sp***.; Fig. 4) are the principle rodent pests of orchardgrass. Once established in a field or adjoining areas, pocket gophers are difficult to control and almost impossible to eliminate. Populations do vary from year to year or between spans of years depending on predation by raptors, coyotes, and other predators. Gophers remain active during the winter months.

Pocket gophers attack roots in the top 24 in of soil and have been known to consume top growth in aboveground excursions, but the animals spend very little time on the surface. Mounds of soil 12 in high or more are brought to the surface by pocket gophers during tunneling (Fig. 5). They can damage harvest machinery, and when mixed with hay, reduce marketability.

Pocket gophers prefer irrigated cropland where food sources are plentiful; however, they will inhabit field edges, ditch banks, and waste areas adjacent to fields, making these areas a source for migrating juveniles. They become more prevalent when hay is grown in an extended stand. Shorter rotations that involve deep tillage destroy tunnel systems and kill some gophers; however, some always survive to rebuild the infestation.

Kim and Kevin McPartland

Figure 3.
*Northern pocket gophers **(Thomomys talpoides)** stuff their cheeks (pockets) with food.*

Figure 4.
*Meadow voles **(Microtus sp.)** feed both above and below ground.*

Figure 5.
Gopher mounds can damage harvest machinery and reduce hay marketability.

Gophers can be managed with poisonous baits. Baiting machines are designed to create artificial burrows that intersect natural runs of gophers (Fig. 6) and drop strychnine-coated oat bait into the new runways.

Voles feed both above and below ground, although they rarely burrow below 6 in. They make runs above ground for short distances from their nest and will decimate large patches (6 ft in diameter) of orchardgrass by feeding on crown and root tissue. As with gophers, meadow vole populations vary over years and between spans of years, and remain active during the winter months. Voles are adept at tunneling under snow cover and dead plant growth and inflict much of their damage to grass stands during the winter. Voles can be controlled with zinc phosphide baits in pastures, but its use is not labeled for orchardgrass hay.

Figure 6.
Gopher baiting machines insert poisoned bait in underground furrows.

Abiotic Factors

First-year stands of orchardgrass are especially sensitive to damage from high heat (95 to 105°F) and humidity (sometimes called "scald") caused by windrows covering plants for extended periods (5 to 7 d). Young plants are especially vulnerable and often killed (Fig. 7). This condition may also be associated with infection by ***Rynchosporium orthosporum***, also called leaf scald.

Harvest Management

Orchardgrass is cut with swathers or hay bines and either left in windrows to cure or immediately spread with tedders for faster drying (Figs. 8 and 9). Cutting height should be 3 to 4 in from the crown. It is very important to avoid cutting too close to the ground as the remaining stubble contains stored energy in the form of complex carbohydrates (fructans) the plant uses for regrowth.

Curing takes between 3 to 7 d during the growing season. The first cutting, with its stems and heads, usually requires 7 d to dry before baling. Whereas alfalfa can be baled with moisture levels up to 18% without mold or heating, grass hays cannot. Some growers assert that they prefer the moisture tester not even register when recently baled hay is tested. However, the safe upper limit for moisture in orchardgrass at baling is approximately 13%. Growers who ted immediately after swathing claim that curing is shortened by 1 d.

Most orchardgrass is packaged in 2-tie bales destined for the domestic horse market. The first cutting usually occurs during the last half of May, with subsequent harvests at 32 to 40 d intervals. Columbia Basin growers take from 3 to 4 cuttings. The last cutting should be timed to allow 5 to 6 in of regrowth before growth stops in the fall.

Forage quality in terms of feeding value is strongly determined by the stage of maturity of the grass. Crude protein and Relative Forage Quality (RFQ) in the vegetative stage is approximately 19% and 125, respectively. At heading, crude protein drops to 16% and the RFQ to 116. Later cuttings produce higher quality forage. Trials using 8 cultivars conducted near Royal City, Washington in 2004 exhibited crude protein averages of 16%, 19%, 22%, and 19% for the 1st through 4th cuttings, respectively (1).

Figure 7.
Seedling orchardgrass killed by scald in areas under windrow due to high temperatures and moisture.

Figure 8.
Orchardgrass is swathed and left in windrows for drying.

Figure 9.
Tedders spread the hay out of the windrows for faster drying.

FACTORS AFFECTING MARKETABILITY

Factors such as dustiness, excess soil, molds, weeds, and color affect the marketability of orchardgrass. Dust and mold in hay can cause respiratory maladies in horses. Hay with mold can cause abortions in cattle. Weeds often lower the palatability and nutritional quality of hay. Some weeds common to the Columbia Basin such as common groundsel ***(Senecio vulgaris L.)*** and fiddleneck ***(Amsinckia intermedia Fisch. & Mey)*** are poisonous to livestock. Other grass weeds such as green and yellow foxtail ***(Setaria sp.)*** and cheatgrass can cause sores in the mouths of livestock.

Pacific Rim importers will reject containers of compressed hay that show signs of excess soil (Fig. 10). Export lots of compressed hay often consist of 5 to 10 containers. If port inspectors find contamination in 1 container, the whole lot may be rejected and shipped back to the US at the expense of the exporter. This can cost up to $10,000 for that export lot.

Some growers report that fluffing hay after a heavy dew or light rain will mix the bleached with the unbleached hay and leave a greener-looking bale (Fig. 11); however, there is no evidence that the blue-green color often preferred by purchasers of hay has any nutritional advantage.

Aaron Hull

Figure 10.
Japanese import officials are inspecting for excess dirt, foreign material, and insects.

Figure 11.
Fluffing orchardgrass after a heavy dew or light rain mixes bleached and unbleached hay, resulting in a greener bale.

STORAGE

Hay left exposed to the weather can suffer considerable spoilage. A ¾ in rain can soak into and ruin the top 3–4 tiers of bales in a stack as well as bottom bales amounting to greater than 40% loss. Hay should be protected by tarps or barns.

Export hay is wrapped. Commercial tarp systems that protect the top, sides, and bottom of stacks cost from $4–$10/tn depending on the width and height of the stack (Fig. 12). Hay barns cost more initially, but amortized over 15–20 yr, average about $8–$10/tn (Fig. 13). A well-maintained stackyard is free of weeds and trash and elevated so that water will drain away from the stack.

Glen Knopp

Figure 12.
Commercial tarp systems protect the top and sides of stacks. A rock base prevents the hay from absorbing moisture from the soil.

Glen Knopp

Figure 13.
Hay sheds are competitive with tarp systems when amortized over 15–20 yr.

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For Further Information

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Use pesticides with care. Apply them only to plants, animals, or sites 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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