MANAGEMENT OF COOL-SEASON GRASSES FOR HAY PRODUCTION AND QUALITY

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ABSTRACT

Western irrigated growers are fortunate to choose from several adapted grass species and many productive varieties of cool-season grasses for high quality and valuable grass hay. Prices are reported annually of grass hay selling for $200, $250, and $300 per ton! It appears anyone should be able to produce grass hay and reap large bank accounts from these prices. Unfortunately, many folks have tired and given up. Those growers who make a living from grass hay know many but not all of the steps of success. For those who have not made a living from grass hay, or those who would like to improve their grass hay management, this paper is dedicated to you. We have summarized the basics of grass hay growth, development, quality and management. In addition we introduce the newest concepts of tracking root dynamics and their impact on current and the following years' harvestable yields. Fall management is as critical for cool-season, perennial grass as it is for alfalfa, but the steps and reasons are different than for alfalfa.

Key Words: forage grasses, hay, root growth, seasonal growth, species selection, stubble

Perennial cool-season grasses are widely cultured for irrigated forage production in the western USA, and hay from them is in strong demand for certain livestock classes. These unique crops contribute to agricultural sustainability through retention of soil and water against erosion and runoff, and provision of wildlife habitat, lower input requirements and costs than for annual crops, flexibility of end-uses, and high value if managed and marketed correctly. Perennial grasses are intensely managed in pure stands for specialty domestic and export grass hay markets, as a forage alternative in rotations with alfalfa, and in cases where environmental conditions are unsuitable for other crops including alfalfa. Grasses are often mixed with perennial legumes at planting, or are interseeded into thinning alfalfa canopies to extend stand life. Our paper reviews impacts of species selection, forage management, and root behavior on hay production, quality, stand persistence, and contributions to environmental conservation.

Grass characteristics and behavior:

Perennial cool-season grasses that are commonly grown under irrigation or on naturally wet sites throughout the West include orchardgrass, smooth and meadow bromegrasses, tall fescue, intermediate and tall wheatgrasses, and the wet-meadowland species timothy, reed canarygrass, and creeping and meadow foxtails. Most of these species are of Eurasian origin. On non-irrigated soils with good production potential, these species generally require at least 14-16 inches of

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annual precipitation for survival and moderate production. Optimum daytime temperatures for growth of cool-season grasses are in the range of approximately 68-77° F, whereas those for growth of alfalfa and warm-season annual and perennial grasses are approximately 86-95° F. Cool-season grasses have relatively shallow root systems, in contrast with alfalfa. For most of these grasses, effective rooting depth ranges among species from approximately 6 inches for timothy to perhaps as much as 30 inches for tall fescue. This rooting pattern typically requires more frequent but lighter applications of irrigation water than alfalfa for replacement of evapotranspiration losses without water movement past the root zone. As will be pointed out later, forage production potential fluctuates in relation to management impacts on the depth to which roots explore soil profiles for water and nutrients.

Another major difference among grass species is date, and range in dates, at which heading occurs. Most perennial cool-season grasses require the signals of decreasing daylength and/or temperature in fall (vernalization) in order to initiate flowering in spring in response to increasing daylength and/or temperature. Timothy, an exception, has little or no vernalization requirement for flowering and therefore exhibits heads at each cutting. Most of the other cool-season grasses display reproductive growth stages only in the first cutting followed by vegetative stages in regrowth cuttings. Early to late maturing varieties of orchardgrass, tall fescue and timothy may vary by 3 weeks in maturity. Varieties of other cool-season hay grasses display a lesser range in heading dates among varieties. On a species level, timothy is often as much as 4 weeks later in maturing compared to orchardgrass. Depending on market requirements, late-heading species and varieties can offer opportunities to shift hay-making to parts of the season that have better hay-drying conditions.

Forage harvesting involves inevitable trade-offs between increasing dry-matter production and decreasing nutritional value and intake potential with advancing plant maturity. The fundamental changes that occur with maturation are leaf senescence, increasing stem mass and fiber level, and decreasing fiber digestibility. Maturity stage or plant tissue age at cutting also has relationships with cycles of utilization and restoration of plant energy reserves for regrowth and winter survival. Plant developmental stage or tissue age at harvest therefore has dramatic impacts on forage production, quality, regrowth rate, and stand persistence. For defoliation-sensitive grasses such as smooth brome, timothy, and intermediate wheatgrass, regrowth will be more rapid if first cutting is delayed until nearly bloom stage, when basal buds in the crown region are nearly ready to form new tillers. Similarly, recovery of these grasses from later cuttings is often slow because of their tendency to elongate internodes and elevate growing points into the defoliation zone when plants are in vegetative phases of growth. By contrast, orchardgrass, meadow brome, and tall fescue first harvested at the higher-quality stage of boot to early head will regrow from basal buds very quickly, because these basal buds form replacement tillers at much earlier growth stages than in smooth brome, timothy, and intermediate wheatgrass. Recovery of these species from regrowth cuttings is also typically very rapid because their growing points remain protected from removal due to lack of internode elongation in vegetative growth phases.

Levels of reserve carbohydrates in basal stubble also tend to be low at boot and early heading stages in smooth brome and timothy, increasing to higher levels that support more rapid regrowth following cutting at late heading and flowering stages of growth. Because smooth bromegrass, timothy, and intermediate wheatgrass exhibit slower regrowth from crown buds and

are susceptible to growing point removal at vegetative growth stages, these grasses are less tolerant of poorly managed grazing or frequent haying than orchardgrass, meadow brome, and tall fescue. For applications that combine haying and grazing, orchardgrass, meadow brome, and tall fescue are more suitable dual-purpose species.

For high-digestibility hay, grasses should be harvested at boot stage of development in the first cutting. Harvesting at late heading and later stages of first growth will provide forage digestibility levels more appropriate for livestock maintenance purposes, but with high dry matter production. Anti-quality compounds in cool-season grasses include alkaloids in older and common varieties of tall fescue infected with endophytic fungi and older varieties of reed canarygrass, and the possibility of toxic levels of nitrates. Newer endophyte-free tall fescue and low-alkaloid reed canarygrass varieties are available. Nitrate accumulation is usually related to excessive levels of available soil N and plant stress factors that retard topgrowth to a greater extent than root uptake of nutrients. Forage nitrate testing is inexpensive and readily available from forage testing laboratories.

To summarize, factors to consider in the selection of appropriate species include 1) adaptation of the species to site characteristics of climate and soil; 2) establishment ease and anticipated stand life; 3) intended management intensity and practices; 4) responsiveness to irrigation and fertilizer inputs; 5) maturation rate and seasonal growth distribution; and 6) end-use applications including possible use as pasture as well as hay.

Species performance data including dry matter production, quality, and suitability to limiting environmental conditions such as temperature, pH, salinity, drought, and excessively wet soils, are available from land-grant university Cooperative Extension and Agricultural Experiment Station bulletins and reports. Performance of a grass crop established from common seed may not equal that of a named variety reported in university variety testing literature. If the characteristics of a particular variety are important to the site and application, specify certified seed for assurances of varietal purity and low weed-seed contamination.

Irrigated cool-season grass species for hay:

Timothy has a deep-rooted history in the West, making it the most widely recognized grass hay crop. From the racetrack to the backyard, every horse owner seems to demand timothy hay. Although this grass does not require winter vernalization for reproductive tiller development, yield from first cutting hay is the largest of the season followed by a smaller second cutting. Timothy is winterhardy throughout the Pacific Northwest (PNW) and into western MT, WY, UT and northern CA, even though its corm and roots are shallow in the soil. Timothy should be seeded at less than 8 pounds per acre for hay in a firm to hard seedbed with careful long-term irrigation and fertility management. The market place demands a weed-free crop that exhibits long cylindrical seedheads with a bright green color and little to no brown leaf in the bales. Orchardgrass has gained in popularity because irrigated hay growers receive at least one more cutting per season compared to timothy. Orchardgrass is vernalized over winter resulting in a first cutting yield dominated by reproductive tillers with seedheads. Regrowth cuttings will have very few seedheads, and represent a more uniform distribution of total season production than in timothy and smooth brome. Orchardgrass should be seeded at about 20 pounds per acre in a firm

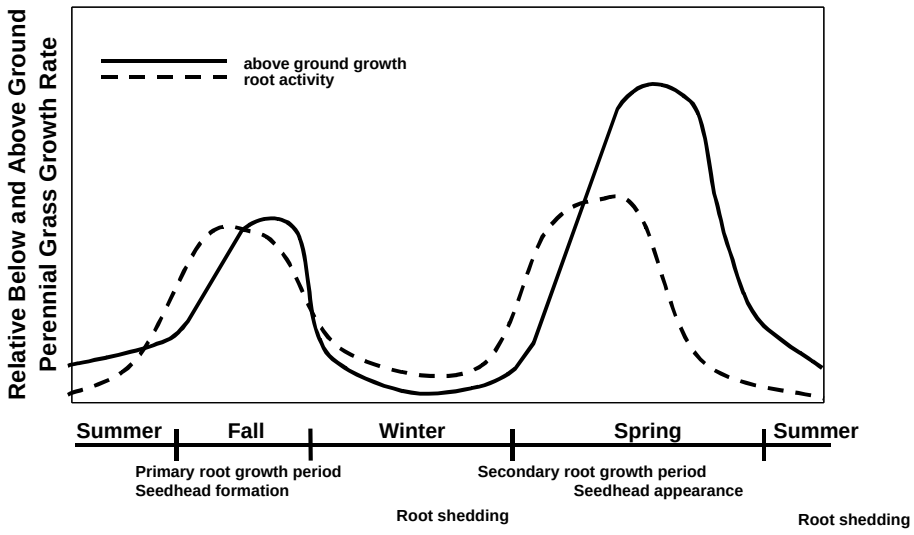
seedbed with adequate soil fertility for several crop years. Orchardgrass is often chosen to overseed a thinning alfalfa stand that will demand partial weed control and good irrigation management during the establishment period. Tall fescue continues to gain acceptance with endophyte-free varieties that reduce livestock owner worries about animal health. The seedhead life cycle and regrowth patterns of tall fescue are similar to orchardgrass. Tall fescue is more widely adapted to the West than orchardgrass by withstanding harsher winters and hotter summers and a broader range in soil pH. Successful stand establishment of tall fescue includes seeding at about 20 pounds per acre of fresh seed as germination rates may drop after a year or more in storage, and in a firm seedbed with adequate soil fertility and time for establishment. Smooth bromegrass is grown in every state in the West. This plant has an extensive rhizome system and is easily induced into summer dormancy with drought or hot temperatures. First cutting yields can be excellent but regrowth is slow since all new tillers emerge less quickly from crown buds than in orchardgrass or tall fescue. Normally smooth bromegrass will be planted with alfalfa at 10 pounds per acre for hay rather than in pure stands at 20 pounds per acre. In the West it may take 2 or 3 years, far longer than for timothy, orchardgrass, or tall fescue, before a smooth bromegrass stand has matured to a sustained yield. Meadow bromegrass is grown for hay and pasture on dryland and under irrigation in the West. Meadow bromegrass will contribute more to season-long yields in mixtures or pure stands than smooth bromegrass because it behaves much like orchardgrass in regrowing rapidly after first cutting. Intermediate wheatgrass, another sod-forming, rhizomatous species normally matures later than smooth bromegrass, but exhibits similar first cutting growth habit but regrows much better than smooth bromegrass. Intermediate wheatgrass mixes well with alfalfa for hay grown with limited or no irrigation. The pubescent (hairy) types are better adapted to the southwest while the newer varieties with increased persistence should be selected for the PNW and intermountain states. Tall wheatgrass is used on saline sites. This grass is more widely adapted to extremes in soil limitation and will tolerate over-irrigation better than intermediate wheatgrass. Tall wheatgrass is better grown in pure stands than mixtures because forage quality and palatability appear to decrease rapidly as tall wheatgrass matures. Livestock will selectively reject mature tall wheatgrass pasture or hay.

A different approach to grass hay management:

Most grass hay growers have taken the approach that the grass is always going to be there. Hey, it's just grass, no big deal. Stands are replanted with hopes of greater production, but low yields return. Growers may perceive that this is a cycle within grasses that cannot be broken. Through intensive research of harvesting and root sampling various cool-season grasses a different approach is proposed to reverse inherently low grass hay yields. It all starts with understanding what occurs below ground as much as what we harvest. Unlike alfalfa that stores its carbohydrates in the crown and taproots, cool-season grasses store most of their carbohydrates in the bottom 3 to 4 inches of stubble. Actually very few carbohydrates are stored in the fibrous root system. Figure 1, adapted from Fransen et. al. (2003), depicts dynamics of above and below ground growth cycles for about a dozen cool-season grasses grown in WA State. This is the basis of their forage calendar, which starts in September, the real beginning of the cool-season grass growth cycle. During September and October the following years' seedhead meristems are established. Additionally, this is also marks the first generation of new grass roots. The previous few months of summer the grass roots were dying and being shed by the plants that even enjoyed adequate fertility and irrigation. These grasses will again shed roots during winter when the top

is either dormant or covered in snow. In the spring the roots will start growing 1 to 3 weeks before you can actually see new green growth. Spring root production will be delayed and reduced if livestock are allowed to graze hay fields in late winter or early spring when spring root production begins. The spring rooting period extends longer than in the fall but most cool-season hay-type grasses will not produce new seedhead tillers at this time. Following the summer solstice these plants will again shed their roots until fall. It is easy to follow the pattern described here by simply digging the grasses, washing the soil from the roots, and observing if the roots are white (alive and healthy) or tan-brown-black (dying to dead). Most grass hay growers permit livestock to graze the fields down to nearly soil level in the fall. This only eliminates the major carbohydrate storage tissue -- the bottom 3 to 4 inches of stubble -- that is needed to continually feed the newly established fall seedheads. By removing this stubble the grass must draw from its already meager root reserves for winter survival. This always delays spring green up from several weeks to a month. If you must graze the hay field in the fall, you can increase cool-season grass hay production by not allowing animals to graze lower than 3 or 4 inches from the soil surface. In addition, maintain excellent soil fertility - especially phosphorus and potassium - as the grass enters the critical fall regrowth period. In the spring allow the new root system to become well established if the goal is to produce heavy, first cutting yields. Regrowth cuttings are also dependent upon maintaining proper stubble height when the grass is undergoing great stress during summer root shedding. Never cut cool-season grass hay fields lower than 3 inches! To maintain healthy, productive, and dense grass stands requires careful attention to increasing grass roots and maintaining stubble. Decreasing grass rooting dynamics will delay spring green up, decrease first cutting and total yield, reduce nutrient and water uptake, increase weed invasion, increase environmental stress on the plants, and support the same excuses for low yields and poor quality used for years. Alfalfa hay growers learned fall management is critical to plant survival and generous yields, and this is also very true for cool-season grasses.

Figure 1. Cool-Season Grass Root and Top Growth Forage Dynamics



Overseeding a thin alfalfa stand:

Alfalfa stands thin after several years of intensive hay harvesting. Overseeding with a compatible cool-season grass can extend productive life of the stand. Through careful management and species selection, certain grasses can help accomplish this goal. Attempting to control the major weed problems in the existing alfalfa stand via harrowing or with selective herbicides will provide greater success for the overseeded grasses. To increase overseeding success, soil nutrients should be tested and corrected for N, P, K, and S. Orchardgrass, tall fescue, smooth bromegrass, and meadow bromegrass are all excellent grasses for overseeding into thinning alfalfa. Seeding rates should be increased about 50% over the standard seeding rate in your area, followed by repeated irrigation applications. Do not allow the soil to dehydrate, as this will ensure grass seedling death. An excellent time to overseed is in the very early fall when temperatures start to cool and humidity increases. The combination of prior weed management, greater soil-seed contact with adequate nutrients and moisture will result in a thicker cool-season grass stand with the alfalfa.

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