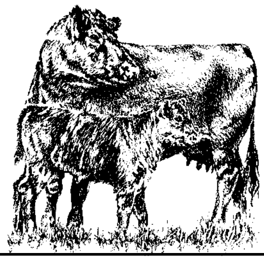

Grass Growth and Development Considerations for Grazing Management

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In the livestock business, as in many businesses, producers rely on conversion of raw materials into a saleable product, or in this case, using vegetation to produce meat. With this in mind, it is important for cattle producers to approach grazing management as a business that strives to maximize the efficiency of that raw material conversion. Producers must have a complete understanding of the source of raw material and how to sustain it for maximum profitability in both short and long terms.

For grazing management, this means understanding plant growth, survival, and production and how these factors interact with livestock grazing for different forages on a rancher's rangeland. This fact sheet reviews the basics of plant morphology (structure) and identification, plant growth and development, plant response to grazing, and how these tools can be used in a grazing system.

Plant Morphology and Identification

Identification of range plants common to a producer's area is important to help recognize conditions and trends on rangeland. Start by identifying the differences between plants in a species group (e.g., grass, grasslike, forb, shrub, and half-shrub).

see 1-2

Grasses are characterized by hollow jointed stems. Leaves occur in two rows on opposite sides of the stem and have parallel veins.

Grasslike plants include sedges and rushes, commonly known as wiregrass and tulees. They look like grasses, and may be misidentified as grass, but there are some distinct differences. Grasslike plants (with only a few exceptions) have solid stems that are either triangular or round in cross section and have no joints. Like grasses, veins of leaves are parallel but occur in three rows on the stem.

see 3-4

Forbs are non-grass plants with annual stems (tops). The leaves are usually broad with netlike veins. Examples of forbs are "herbs" and "wildflowers," such as yarrow, phlox, larkspur, and Indian paintbrush.

Shrubs are woody plants with buds and stems that live over the winter above the ground and branch from near the base. Examples are big sagebrush, rabbitbrush, and bitterbrush.

Half-shrubs are perennial plants that die back each winter, not to the ground line, but to a perennial woody base or a bare ground stem. An example of a half-shrub is winterfat.

Lifespan and Root System

Plants can also be classified based on their lifespan and type of root system. The lifespan of plants can be categorized as annual, biennial, or perennial.

Annual plants live only one season, and reproduce only by seeds.

Biennial plants live 2 years and reproduce by seed the second year. Normally biennial plants form a low growing rosette the first year, then "bolt," or put up a seedhead or flower the second year. There are few biennial grasses.

Perennial plants live over from year to year, producing leaves and stems for multiple years from the same crown. They reproduce by seeds, stems, bulbs, underground rootstocks, and rhizomes. Perennials can be both short-lived (3 to 5 years) and long-lived (6+ years).

Growth characteristics of plants are also related to the type of root system and above-ground stem and leaf structure they possess. Often times, biennial plants are characterized by taproots *(primary root growing directly downward and giving rise to smaller lateral branches)*. Perennial grasses, on the other hand, are

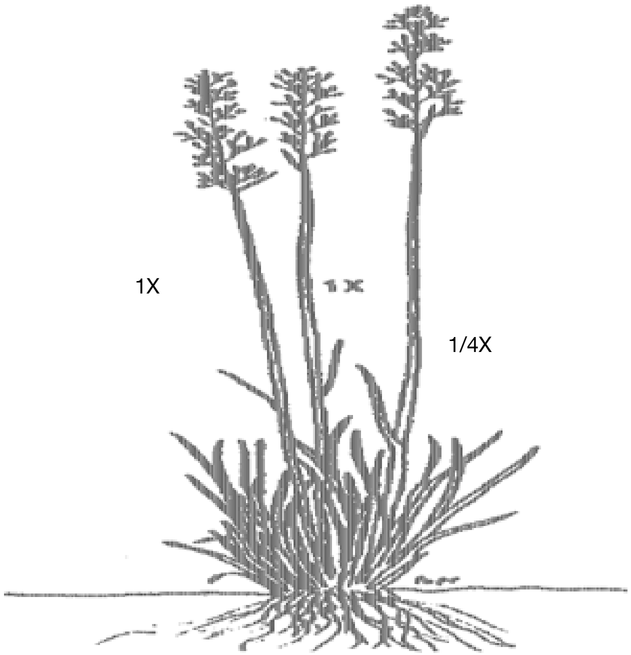

Fig. 1. Examples of stemless grass, Kentucky bluegrass (left), and a stemmed grass, bluebunch wheatgrass (right).

normally categorized as either rhizomatous (sod forming) or bunchgrasses. Examples of bunchgrasses include bluebunch wheatgrass, orchardgrass, and Idaho fescue. Examples of rhizomatous grasses include quackgrass, Kentucky bluegrass, and intermediate wheatgrass.

Leaf and Stem Structure

see 6-7

The leaf and stem structure of the plant is important because it determines whether the growing point (apical meristem) spends most of its time high on the plant (susceptible to grazing), or more protected in the lower leaves of the plant. Grasses may be referred to as stemmed or stemless, or as having culmed or culmless vegetative shoots (Fig. 1).

Stemmed grasses, such as bluebunch wheatgrass, have a more elevated growing point (apical meristem) at an earlier stage of production, while the tiller is still vegetative (meaning the apical meristem is still producing leaves), and therefore, are more susceptible to removal by grazing or mowing. Stemless plants, such as Kentucky bluegrass, have a low growing point until it sends up a reproductive tiller right before maturity.

Grass Plant Identification

Species identification could be an entire book in itself. However, since grass is the main component of the cattle grazing resource, the following explanation of plant parts used for identification and management purposes will focus on grasses. However, many of the same guidelines apply for other species groups, and these should not be overlooked.

Each grass plant consists of roots, crowns, and tillers. Some grass species are also characterized by the presence of stolons or runners, and rhizomes. Following is an explanation of each plant part and their main functions.

Roots: The main functions of roots are to extract and carry water and minerals from the soil to the stems, store food over winter for spring growth, and to anchor the plant in the soil. Roots grow from a growing point at the tip.

Rhizomes: Rhizomes are creeping underground stems with joints and leaflike scales. Rhizomes store food and produce new plants.

Stolons: Stolons are creeping, lateral stems that grow above ground and root at nodes along the runners. Their functions are the same as those of rhizomes.

Crown: The crown is the base of the plant from which the roots and the tillers originate. see 8-9

Tiller (Shoot): The grass tiller is series of units including a leaf blade and sheath, collar, ligule, node and axillary bud, and internode. Seedheads form at the top of each reproductive tiller. A characteristic of different grass species is the number of vegetative vs. reproductive tillers. Reproductive tillers are those that put up a seedhead at maturity, while the vegetative tillers remain leafy.

The proportion is somewhat dependent on that season's growing conditions, but to some extent is characteristic of the species. Thus, within a particular species, more favorable conditions usually result in more reproductive tillers, whereas conditions such as drought limit production of reproductive tillers. see 10-11

Apical Meristem: This is the growing point of the tiller or shoot. Tissues that become seedheads, stems, leaves, roots, nodes, or dormant buds arise here.

Buds: Buds are located at the nodes, which are at the base of the tiller with unelongated internodes, or on stems, stolons, and rhizomes with elongated internodes. Dormant or inactive buds have potential to produce a new tiller with a new growing point. The supply of buds accounts for new tillers when the growing point is removed via grazing or mowing, and is the basis for perennial plants to live from year to year.

Nodes: Nodes are the joints between internodes on the stem where there is a bud that may produce a branch, or remain dormant. The leaf also arises from a node on the stem. The space between the nodes is called the internodes.

Leaf Sheath, Blade, Collar, Ligule, Auricles: These are all part of the leaf that possess individual characteristics often needed in grass identification. Figs. 2 and 3 show specific locations of each of these parts.

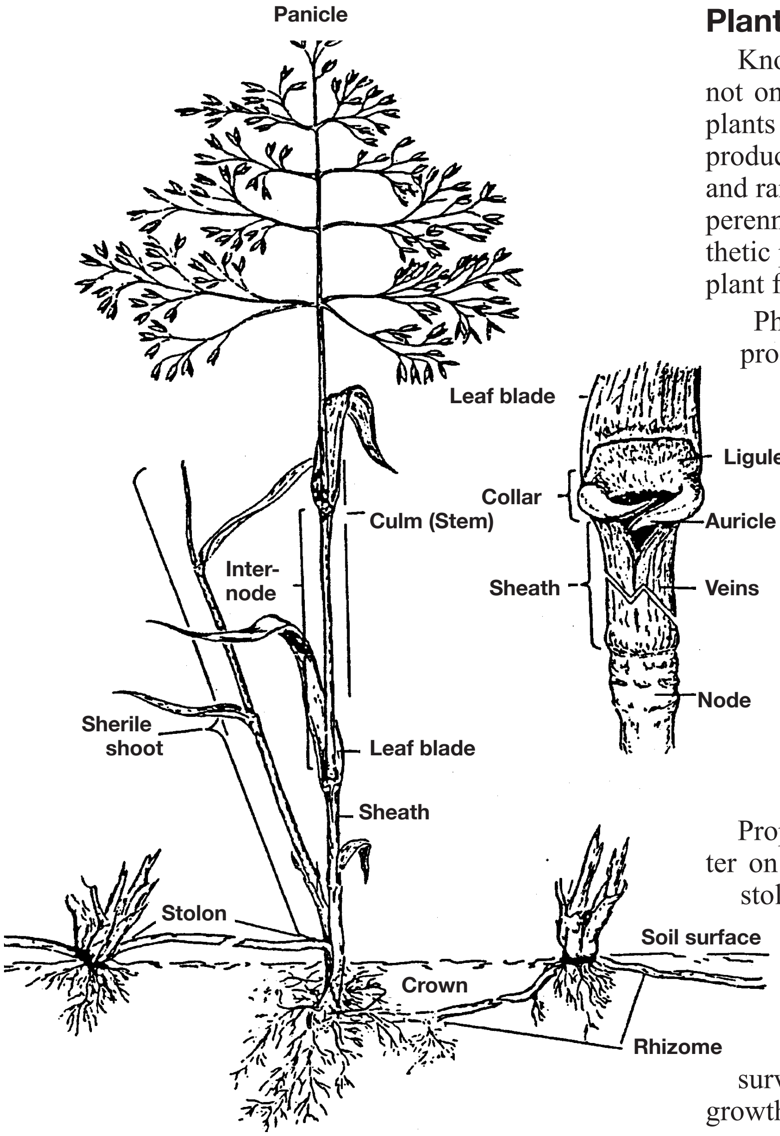

Fig. 2. The grass plant and its parts.

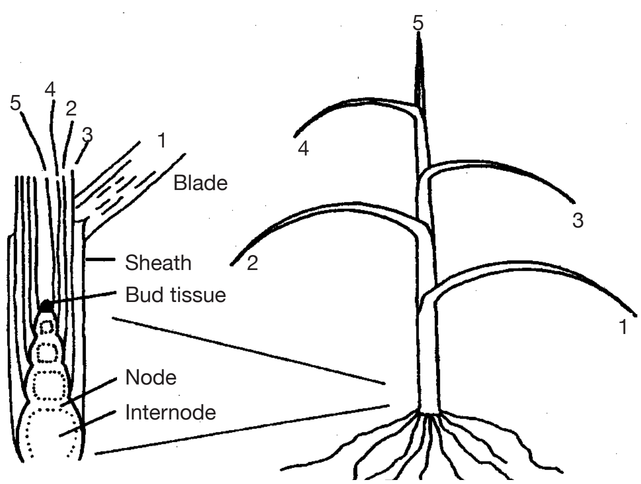

Fig. 3. Anatomy of a grass tiller. Leaves are in decreasing order of age from 1 to 5. Apical meristem is near the base of the tiller on top of a series of unelongated internodes in the case of a stemless grass or grass with culmless vegetative shoots.

Plant Growth and Development

Knowing the parts of the grass plant is important not only for identification, but in understanding how plants grow. Perhaps the most important concept cattle producers need to know when managing their pastures and rangeland, whether dryland or irrigated, is that for perennial grasses to remain productive, the photosynthetic process must maintain the energy balance of the plant for survival and growth.

Photosynthesis is the process by which the plant produces its own energy or food from the sun's energy by combining with water and carbon dioxide, in the presence of chlorophyll contained in the green leaf. Photosynthesis provides the carbohydrates that are needed for active plant growth during the growing season, for winter survival, and for regrowth after defoliation or after winter dormancy.

Perhaps the best way to explain the role of various plant parts in forage production, as well as crucial times for grass plant survival, is to examine the life cycle of a growing plant.

Dormancy (Winter)

Properly managed perennial plants survive the winter on energy stored in the roots, crowns, rhizomes, stolons, and stem bases. Plants remain alive during the dormant periods by using some of their stored energy.

Growth Initiation (Early Spring)

Stored energy is not only used to help the plant survive dormancy, but is also used for initial spring growth after dormancy periods. The amount and rate of new spring growth of perennials depends on the level of energy stored during the previous growing season.

Initiation of spring growth begins when new tillers arise in the axillary buds of older tillers. This depletes the total amount of available energy within the plant, so the energy reserves must be restored for the plant to maintain health and productivity for the next year.

Active Growth (Late Spring/Summer)

Because the initiation of spring growth depletes the energy store in the plant, it is crucial that the plant gets the opportunity to continue growth past these early stages in order to replenish the used root reserves. Because growth has priority over storage for energy use, the most demanding time for a plant is during the growing season when the plant must maintain itself and continue growth after defoliation.

As a general rule, energy storage increases when the growth rate slows and the leaf area is large. On the contrary, energy storage decreases when leaf area is small and the growth rate is fast. New growth in grasses occurs in one of three ways:

1. Leaves and stems continue to grow from intercalary meristems, secondary zones of growth at the base of the internode, sheath, and blade (fastest form);
2. New leaves grow from apical meristems inside the stems (intermediate); and
3. New tillers grow from axillary buds at the base of the plant (slowest form).

As discussed previously, new growth in the spring results from new tillers growing from the axillary buds at the base of the plant. Once the new tillers begin growth, each new leaf unit develops from the apical meristem inside the stem. This becomes the growing point of that plant.

Apical meristems may remain at the bottom of the tiller, near the ground, or become elevated when the internodes elongate. The location of the apical meristem during elongation, and the timing of elongation, is specie specific.

This knowledge is crucial to grass management, because vegetative (leaf and stem) growth continues as long as growing conditions are favorable, but when the apical meristem becomes reproductive (starts generating seedhead components rather than leaves) or is removed through grazing, growth of that tiller stops. Once the apical meristem is removed or has shifted to reproductive status, new leaves can only be generated from another basal bud producing a new shoot or tiller.

If the apical meristem is not removed during grazing (in the case of a low growing point) then growth of that tiller can continue. This results in the use of less stored energy and a faster recovery time for the plant.

Kentucky bluegrass and tall fescue are examples of grass species that maintain low growing points until about the time the tiller enters the reproductive stage. Hence, because the growing point is low throughout most of the season, the plant is more resistant to close continuous grazing. Smooth brome and timothy, on the other hand, elevate their growing point early in development, even while still vegetative, due to internode elongation, making these plants susceptible to damage during close continuous grazing and require longer recovery times between grazing periods.

Regrowth and Dormancy Preparation (Fall)

Fall is a critical time in terms of survival, because the plant must have sufficient energy reserves to develop buds that are vigorous enough to survive the winter and begin growing the next spring. The site of these energy reserves in grasses is the base (lower 3 to 4 inches) of the above-ground portion of the plant, hence maintenance of adequate stubble is essential to maintaining effective energy reserves in the plant. Also, close defoliation late in the season removes nearly all of the protection that the crown buds and newly developed tillers need in order to be insulated from cold winter temperatures.

Implications for Management of Rangeland Grasses

While all the previous discussion applies to management of both irrigated and rangeland grasses, added stresses caused by arid conditions makes rangeland grass management even more crucial. Managed spring grazing and grazing after plant maturity do not greatly affect energy storage and seem not to be injurious to plants. This is dependent, however, on how much soil water is still available to allow ample regrowth after grazing. Regardless of season of use, grazing should not resume until leaves have made good regrowth.

When growing season soil water is limited and plants are grazed severely, the amount of leaf area and corresponding root mass present will not be sufficient for the plant to adequately restore its energy supplies. The size of the root system will be reduced, which will affect the ability of the plant to make normal growth the next year. Also, the low energy reserves will weaken the plant's ability to tolerate cold winter temperature.

All of these factors begin to create a vicious cycle that will lower the productivity and sustainability of the grass community over the long term. The amount of time it takes for the plant to make good regrowth is dependent on such factors as the elevation of the growing point and the tillering rate of the plant, which was explained previously.

This information will help a cattle producer keep better track of what is present on rangeland, and how the relative amounts of those species and species groups vary over time. For instance, the proportions of the previously listed species groups in a pasture can be representative of the type of grazing pressure being received. To understand these relationships, producers need to recognize that cattle are "grazers," meaning that their foraging behavior consists of taking large bites, or grazing for quantity rather than quality of forage.

Grazers tend to focus their foraging pattern on grasses. Sheep, goats, and deer, on the other hand, are "browsers." This behavior is accommodated by their small mouth parts, allowing them to be more selective foragers. They focus on consuming high quality rather than quantity with each bite. Browsers are more likely to consume leafy shrub parts and forbs.

Putting a Management Plan in Place

Producers may wonder how this information is related to the species group make-up of specific pastures. Based on the descriptions, grass is the "raw material" that cattle producers rely on most. Thus, trends may be used in pasture species group make-up to determine the effects that grazing has on the grass component of an individual vegetation community.

For instance, if a producer's management objective is for long term, maximum grass production and sev-

Table 1. Summary of the growth characteristics of six rangeland grasses common in the West.

Species	Growing point height[1]	Timing of maturity[2]	Proportion of reproductive to vegetative tillers[3]	Recovery period (short or long)[4]	Additional management considerations
Squirreltail	High	Early	High	Short	Low palatability at later maturity Tillers rapidly
Kentucky bluegrass	Low	Early	Low	Short	Low overall production
Crested wheatgrass	Low-medium	Early	High	Short	Loses palatability early Tillers rapidly
Bluebunch wheatgrass	High	Mid	High	Long	Doesn't tiller well after heavy grazing Defoliation at greater than 30 percent during seedhead emergence is detrimental
Idaho fescue	Low	Mid	Moderate	Short	Most grazing tolerant native bunchgrass Highly palatable Can tolerate up to 50 percent defoliation during active growth Responds well to one-time severe defoliation, not repeated
Thurber's needlegrass	High	Mid	Moderate	Long	High palatability

[1]The "Growing point height" refers to the height of the growing point throughout most of the growth of the plant. Stemmed grasses tend to elevate their growing point much earlier in growth than stemless grasses.

[2]The timing of maturity influences the ideal season of grass usage. Using a grass at its stage of most active growth (boot stage) results in slower recovery and depletion of more energy reserves.

[3]The proportion of reproductive to vegetative tillers influences the grazing susceptibility of a grass because in plants with a low number of reproductive tillers the growing point remains protected longer than in plants with a high proportion of reproductive tillers. Remember that (1) seedhead formation and (2) removal of the growing point cause plants to restart growth from the dormant buds, using additional energy reserves.

[4]The recovery period is the relative amount of time it takes for the plant to put up new tillers once growth on existing tillers ceases. It is related to the number of axillary buds in the crown of the plant.

eral years of monitoring reveals a decline in the grass component of pasture land, the producer is probably not meeting management objectives in that pasture. The producer can then use this information to adjust management strategies to improve the grass component.

Because of the variation in plant morphology and growth characteristics among the many species of range plants, it is important for cattle producers to become familiar with what plants are dominant in individual grazing programs. Furthermore, knowing some of the growth characteristics of these plants will help producers to alter management to meet the objective of providing for the animal's nutrient requirements while maintaining a sustainable, productive forage base. Table 1 lists some of the important growth characteristics of range grasses common in the West.

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Editor's Note: Refer to the Digital Edition version of this paper for color photographs of grass plants.

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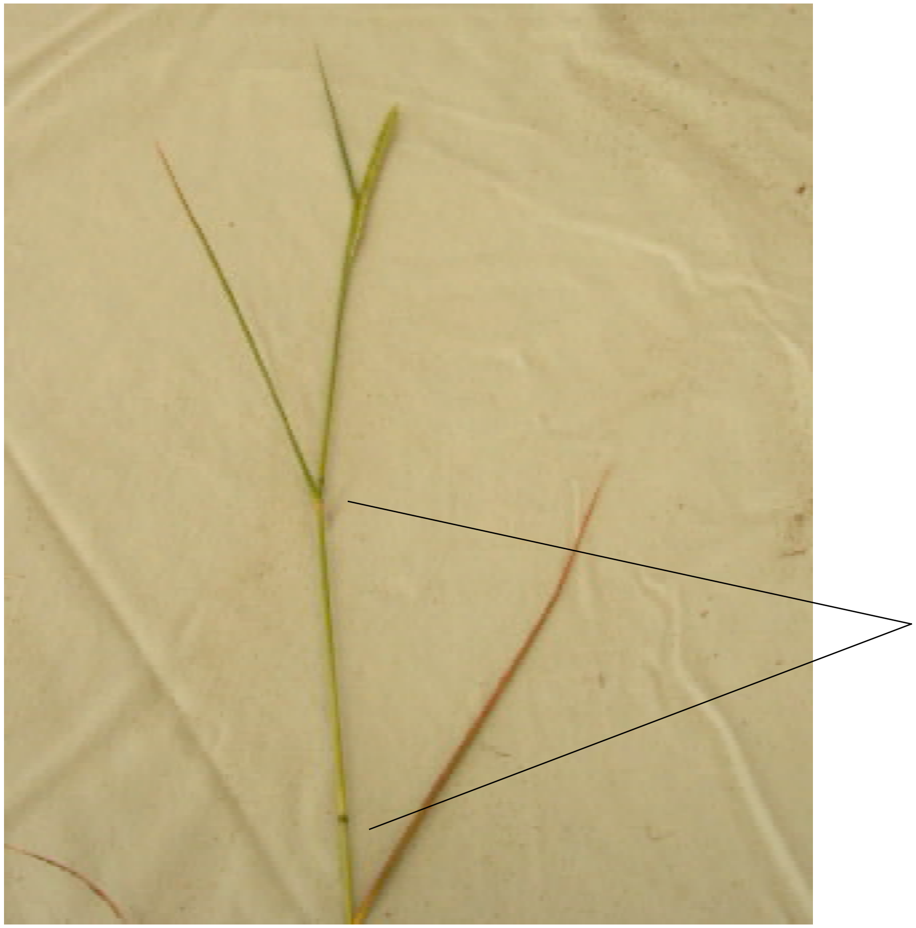

Stem nodes: The space between the nodes is known as the internode. As the stem elongates this space increases.

Digital 1. Crested wheatgrass tiller. Notice that leaves are in two rows on the stem with parallel veins on the leaves. Stems are also jointed as is indicated by the nodes found on the stem.

Digital 2. Parallel veins characteristic of grass leaves.

Digital Figures 1 and 2

Back

Digitals 3 and 4. Forbs are characterized by leaves with "netlike" veins and typically showy flowers.

Digital Figures 3 and 4

Back

Digital Figure 5

Digital 5. The shrub is characterized by a woody stem that branches near the base.

Back

Digitals 6 and 7. Notice the differences in growth form between the bunchgrass (left) and the rhizomatous grass (right). The bunchgrass, as expected, forms a clump, while the shoots of the rhizomatous grasses are more dispersed.

Digital Figures 6 and 7

Back

Digital 8. Notice the extensive branching that connects each shoot.

The rhizomes of quackgrass.

Digital 9. New plants can start from less than 1 inch of rhizome in some species.

Digital Figures 8 and 9

Back

Digital 10. Crested wheatgrass tiller. Notice the series of units including the leaf blade and sheath. Not visible in this photo are the collar, ligule, and axillary bud.

Reproductive tillers are characterized by seedheads. Some plants produce more seedheads in a normal year than others.

The leaf is the primary area of photosynthesis. It is also the most nutritious part of the plant in terms of forage.

The leaf sheath is the area where the bottom of the leaf joins the stem. It appears to wrap itself around the stem.

Digital 11. The reproductive seedhead of a crested wheatgrass plant.

Digital Figures 10 and 11

Back