

Grass Growth and Response to Grazing

Fact Sheet No. 6.108

Natural Resources Series | Range

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Grasses are the dominant plants in most forage-based enterprises throughout the world. Whether livestock graze native rangeland or tame pastures, grasses usually are the basis of the energy and nutrients for animal growth and maintenance. Grazing livestock should harvest only part of the perennial forage crop to maintain the health and vigor of grasses.

Energy and nutrients from forage-based diets produce approximately 80 percent of the red meat products consumed in the United States. Animal gains from forage-based programs usually are less expensive than from any other current program. Animal products come from lands that usually are not suited for production of other food or fiber for human consumption. These lands include rangelands that usually are not capable of being cropped and pasturelands that are not suited for long-term intensive crop production because of low productivity, high erosion risk or other problems. Manage these lands to sustain perennial grass production.

Growth and Development

A grass plant is a collection of plant parts, like a tree or shrub, made up of growth units called tillers. Each tiller produces roots and leaves. Vegetative tillers consist primarily of leaves (Figure 1), whereas reproductive tillers produce a stem, seedhead, roots and leaves (Figure 2). The basal area of the stem, where roots often arise, is the crown.

The crown usually has a number of buds (growing points) that produce new tillers and roots. New tillers are anatomically and physiologically connected to older tillers. Therefore, several connected tillers may all live and share water, carbohydrates and nutrients. If one tiller dies, an adjacent tiller with established roots and leaves usually lives.

Some tillers stay vegetative, while others become reproductive and produce seedheads. Whether a tiller becomes reproductive depends on environment and hormones produced in the plant.

For example, a reproductive tiller may remain vegetative if the growing point (terminal meristem) is removed by grazing. Vegetative growth, therefore, is favored by some grazing, which reduces the number of seedheads produced and may stimulate the formation of new tillers. Vegetative tillers usually are less stemmy and more nutritious than reproductive tillers.

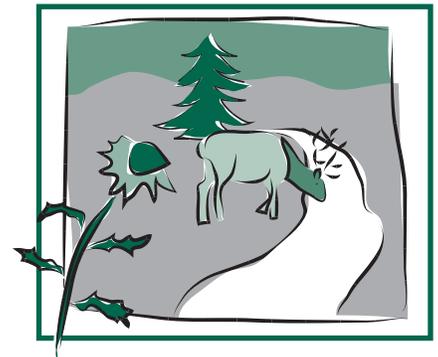
Seed production may be valuable, however, if the operator wishes to harvest a seed crop or if there is a need for seed to produce new seedlings in the stand. Seed production is not always essential for stand maintenance, as many grasses reproduce by vegetative means such as tillering or production of new stems from underground rhizomes.

Vegetative Growth

An apical meristem (expanded portion of Figure 1) is responsible for leaf formation. The intercalary meristems at the base of leaf blades and sheaths are responsible for leaf expansion (insert in Figure 2). Each leaf is rolled into a tube-like form in its lower portion and unfurls as the blade extends. Subsequent leaves follow the same pattern.

As new leaves push up from the center of the rolled tube portion of the first leaf, the growth is similar to extension of a telescope. In Figure 1, leaf 1 is the oldest; leaf 8, the youngest, is emerging. In this example, the growing point (apical meristem) is at or near the soil surface and is protected from large grazing animals. Grazing, therefore, removes leaf tissue but, in most cases, will not harm the growing point that produces the leaves.

Grass growth, for either cool- or warm-season species, begins in spring when the soil warms. As the first grass leaf is exerted, it extends in length or height through



Quick Facts

- Leaves are more palatable than stems, and new growth or regrowth is more nutritious than older tissue.
- Grasses are most negatively affected when grazed during their reproductive period and least affected during dormancy.
- Spring growth can be grazed if plants are given an opportunity to regrow without being used again.
- Sufficient photosynthetic tissue must remain on plants for production of carbohydrates to meet growth and respiration demands of the plant.

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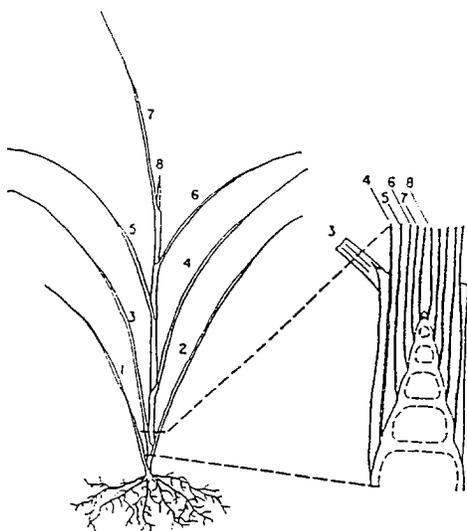


Figure 1: A vegetative grass tiller. Leaf 1 is oldest and leaf 8 is just being exerted. The enlarged area of the crown shows the apical meristem that produces the leaves.

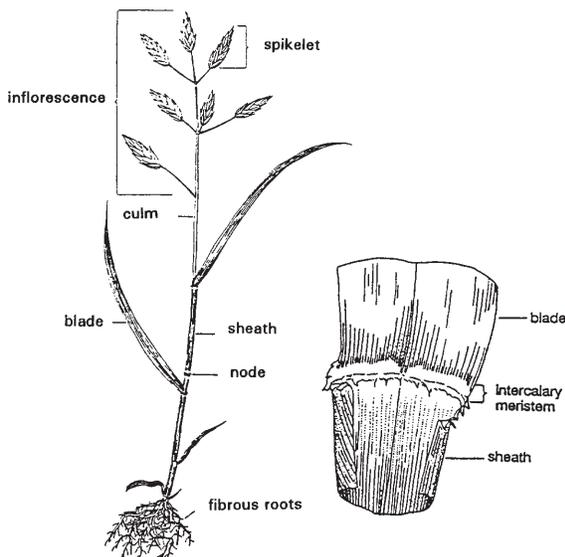


Figure 2: A reproductive grass tiller. This tiller has a stem (or culm) and seedhead that differs from the tiller in Figure 1. Intercalary meristematic tissue at the base of the leaf blade, near the ligule (insert), allows for leaf expansion.

formation and growth of new cells at the base of each leaf blade. This growth area (intercalary meristem) is at the base of the leaf blade adjacent to the sheath (insert in Figure 2).

Chlorophyll, which develops rapidly in young leaves, gives plants the ability to carry on photosynthesis. Photosynthesis uses energy from sunlight and carbon dioxide from the air to produce carbohydrates. However, photosynthesis may not meet the energy demands of the rapidly growing new leaf. Production of the first one to three leaves requires a substantial amount of energy in the form of carbohydrates stored in the crown of the plant. However, as these first leaves fully extend, rapid rates of photosynthesis supply sufficient carbohydrates for growth of other leaves and roots. When severe defoliation occurs, carbohydrates stored in the roots and crowns may be needed to initiate new growth.

Leaves have a definite life span, as do tillers. The first spring leaf normally dies in the summer. Leaves are most photo-synthetically active when they reach full expansion. As they age, their capacity for photosynthesis declines. The excess carbohydrate produced through photosynthesis helps produce additional leaves, reproductive organs or roots. Thus, photosynthate produced by the plant is used efficiently in growth and maintenance. Once a leaf can no longer produce enough carbohydrates through photosynthesis for its own needs, it dies.

Reproductive Growth

Grasses often begin a transition from vegetative to reproductive growth when most of the vegetative growth is produced for that year. Plant hormones and physiology control the transition from the vegetative to the reproductive state.

Reproductive meristems are stimulated to begin growth, which results in development of stems, a few leaves, and reproductive structures. These reproductive structures often grow rapidly, with little production of leaf area, but rapid expansion of the flower stalk (culm) and seedhead (inflorescence) (Figure 2).

In grasses, most of the reproductive structure contains chlorophyll and is capable of photosynthesis. Thus, little, if any, carbohydrate reserve in crowns or roots is used for production of grass seed.

The apical meristem elevates during growth of reproductive structures (Figure 2). This is different from the vegetative meristem, where leaves form at the base of the plant and the apical meristem remains at or near the soil surface (Figure 1). Grazing can remove the reproductive apical meristem and halt seedhead production. For seed production, avoid grazing during this period. However, you can manage grazing to reduce the seed crop and stimulate future tiller production.

Carbohydrate Reserves

Grasses commonly store carbohydrates when most leaf growth is complete. Even though leaves still have a high photosynthetic capacity and sufficient leaf area for photosynthesis, there are few demands for new growth. Therefore, carbohydrates accumulate in roots and crowns and serve as storage organs for growth the next spring. These carbohydrate reserves also are necessary for plant respiration during winter dormancy when photosynthesis is not possible but crowns and roots remain alive.

Cool- and Warm-Season Colorado Grasses

Some grass species grow during cooler times of the year (various wheatgrass, needlegrass, brome grass, bluegrass). These grasses are commonly called cool-season or C₃ species and grow when temperatures are 40 to 75 degrees F. These grasses begin

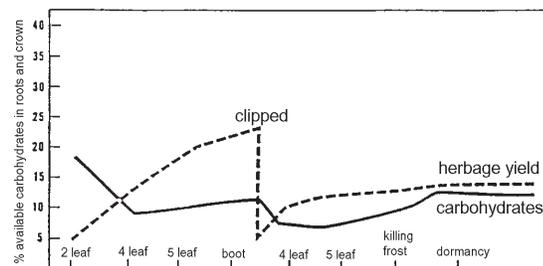


Figure 3: Growth and carbohydrate reserve level of a grass as affected by defoliation.

growth in early spring as soon as the soil is above freezing and daytime temperatures are conducive to growth. These cool-season grasses produce high-quality forage early in the growing season. However, they do not grow during the hot periods in midsummer, and often become semi-dormant. They may grow again in the fall as temperatures cool and late summer precipitation replenishes soil moisture. Thus, there may be two growing periods for these grasses: early spring and late summer or fall.

Warm-season or C₄ species (blue grama, buffalograss, bluestems) grow during warmer periods when temperatures are 70 to 95 degrees F. Warm-season grasses use soil moisture more efficiently than cool-season species and often can withstand drought conditions. The C₄ grasses have different leaf cellular structure that cause them to be more fibrous, contain more lignin, and be less digestible. Therefore, livestock normally prefer C₃ grasses if they are at the same growth stage as C₄ species.

However, because C₃ grasses often enter the reproductive period at about the time that C₄ grasses begin growth, livestock normally seek out this new growth from warm-season species. New foliage is always more digestible than more mature foliage, whether it be from a C₃ or C₄ species. Protein content declines throughout the growing season in both C₃ and C₄ grasses, but more so in C₄ species. Grasses, even when dormant, are fair to good sources of energy for ruminant animals, but other nutrients, especially crude protein and carotene, are likely deficient when plants are dormant.

A rangeland or pasture that has warm- and cool-season species has a longer season of green vegetation than if only one of these classes is present. High-quality, nutritious forage is available throughout the growing season with a mixture of cool- and warm-season species. If only cool-season species are present, these species are the most nutritious during spring and possibly again during late summer or fall if regrowth occurs. There usually is a period during midsummer when cool-season grasses are less palatable because of stemmy reproductive structures and older leaf material. On the other hand, a pasture that contains primarily warm-season grasses does not provide very

nutritious forage in early spring, because these grasses grow better during late spring through midsummer.

Different growth habits and requirements of cool- and warm-season species can be used to your advantage in a grazing program. For example, you may want to establish cool-season grasses in tame pastures to use in early spring or fall when these species are most nutritious. Livestock can rotate to pastures with warm-season species during late spring and summer.

Warm season grasses (blue grama, buffalograss) dominate many ranges in eastern Colorado. If you use crested wheatgrass, Russian wildrye, bromegrass, or winter wheat for early-season pastures, move animals to native rangelands during late spring and summer. Cool-season species dominate Colorado's mountainous rangelands, with only a small component of warm-season species. Because of cooler temperatures in the mountains and shorter growing seasons, cool-season species adapt best to these conditions.

Management Implications

There are three important factors that affect how grasses respond to grazing: 1) **frequency**, 2) **intensity** and 3) **season**. Range ecologists and physiologists have found that as grazing increases, grass productivity typically declines. Frequency can be more important than intensity. A plant that is harvested often has more photosynthetic tissue removed and little opportunity for regrowth. These plants may enter a period when soil moisture, temperature and growth stage limit regrowth and little leaf area remains for photosynthesis. Thus, their ability to replenish reserves or produce additional new tillers is restricted.

Figure 3 shows what can happen to carbohydrate reserves and growth if a plant is defoliated once. If a plant experiences several defoliations, reserve levels and forage production might decline further. A plant that is grazed intensely during early spring and given a deferment during the remainder of the growing season may produce additional growth and be more vigorous than a plant that receives less intense defoliations throughout the growing season.

Seasonal Impacts

Grasses can produce large amounts of nutritious leaf growth during spring months. Leaves continue to age and die; therefore, a portion of the leaves can be harvested through livestock grazing with little effect on the plant. However, enough photosynthetic material must remain for production of carbohydrates to meet growth and respiration demands of the plant. If grazing removes too much leaf material, growth rate is slowed materially, and additional reserves may be required for regrowth (Figure 3). Root growth usually is affected by heavy defoliation, which makes the plant less competitive and more vulnerable to drought, because roots may not penetrate to depths where adequate moisture exists.

Livestock grazing during the growing season can affect regrowth of grasses. When moisture no longer is available and temperatures are too high or too low for rapid growth, regrowth is reduced considerably by grazing. Therefore, grazing in this pasture should be discontinued or reduced. If defoliations continue, little leaf area may remain throughout the growing season, and plants could enter dormancy with less vigor and lower reserves. This could significantly reduce growth the following year.

Grasses can withstand greater defoliation during early and rapid growth stages than they can later in the growing season, after most growing is complete and little opportunity for regrowth exists (Figure 3). Plants produce more leaves than stemmy tissue in the spring. These leaves contain abundant supplies of energy, protein and other nutrients necessary to meet most grazing-animal requirements. Grasses can be used heavily during this period, but discontinue or reduce grazing in time to allow for regrowth of leaves for photosynthesis and carbohydrate production.

If grasses are grazed in the reproductive phase, use them less intensely than during spring growth. Little opportunity for regrowth exists during midsummer, so sufficient leafy material should remain after grazing to maintain carbohydrate levels within the plant.

Grazing during the fall and winter periods, after plant growth is complete and plants are dormant, can be much heavier

than at other periods of the year. This old material is of little value to the plant, as photosynthetic capability will be low, at best. This older and dead material is low in some essential nutrients, particularly protein. Energy content, however, remains moderate to high. Removal of dead leaf material and stems during dormancy has little direct effect on the plant.

However, mechanical injury to crowns can occur through trampling. Removal of mulch and litter may cause greater temperature extremes near the soil surface. This may adversely affect growth the following year. Although fall and winter grazing has the least detrimental effect on grasses, there may still be some negative impact if grazing is heavy.

Grazing Strategies

Develop flexible grazing management strategies that allow plants a rest or deferment after grazing. This is necessary for regrowth and to maintain sufficient leaf area for growth and maintenance.

Heavy grazing throughout the growing season usually is the least desirable grazing strategy. A management strategy that incorporates rest periods and movement

of animals through different pastures usually is more desirable for grass growth than season-long grazing. If you know the amounts, kinds and locations of available plants (cool- and warm-season grasses), and what grasses grazing animals prefer, you can develop a strategy that meets the needs of plants and animals.

Management plans should use the forage resource and maintain it through time. Grazing plans, however, must be flexible. Consider differences in growing conditions across years as a result of drought or wet cycles, depletion of forage supply by wildlife or insects, and other rapidly changing environmental conditions. Consider these along with the impacts of grazing livestock to determine what effects the combined impacts will have on plants.

Try to avoid rigid plans that require moving animals from one pasture to another on given dates. Other environmental factors certainly will influence grass growth and use at any point in time. Base your decision to move stock on how much the grasses are used and how much green leaf material remains, not on a predetermined date.