

FORAGE PHYSIOLOGY
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Forage physiology refers to the processes and activities that occur with the functions of a grass or legume forage plant. Having some knowledge of this can be useful in understanding how forage grasses or legumes grow in order to manage them for optimum productivity and stand persistence. This can be helpful to a livestock producer in managing pastures and hay for improved animal performance.

You are a grassland farmer

It is important to remember that grassland is the crop and animals are the harvesting equipment and commodity that is sold. Thus, the major emphasis should be on how to manage the grass crop and not simply the animal as is often the case. **Leaves** are the desirable part of the plant desired by animals. The leaves are the harvested product but they are also essential for capturing solar energy. Unlike other crops, forages must tolerate frequent loss of leaves while being able to capture adequate amounts of solar energy. Thus, good pasture management is a critical balance between maintaining adequate leaf numbers to capture sunlight for growth while supplying forage high in protein and digestible energy.

How do leaves grow?

Leaves arise from **tillers** growing from the base of the grass plant. Tillers remain alive for only a limited time, ranging from a few weeks to several months. This means that it is essential to have a large number of new tillers developing throughout the growing season to provide leaves. New grass tiller development is affected by a number of factors:

- Temperature. Tiller development in cool season grasses such as tall fescue is optimum at 60 to 70F, declining sharply in hot summer weather. In warm season grasses such as bahiagrass and bermudagrass it is most abundant at 80 to 85F.
- Light is essential for tiller development. Thus, large accumulations of ungrazed grass in a pasture or hayfield causes severe shading of the plant basal areas so new tiller development is minimal and few new leaves are produced.
- Nitrogen and potassium fertilization increases new tiller development.
- Adequate soil moisture favors tiller development.

Light

Although soil nutrients and water are essential for forage plant growth, the most important input is solar energy. This energy is used, together with carbon dioxide from the air in the process of photosynthesis to produce sugars and starch. Leaves are like photoelectric cells that produce energy from the sun for a fence charger. A pasture or a hayfield is like a massive solar panel collecting energy from the sun. Grassland farming is managing a pasture or a hayfield to collect as much of the incoming sunlight as possible and converting it into usable forage for livestock.

Several factors affect the amount of solar energy captured by forage plants during photosynthesis:

- Warm season grasses such as bermudagrass have a different photosynthetic pathway and can capture about twice the total energy of cool season grasses such as tall fescue during their main growing season. However, cool season grasses such as tall fescue can utilize sunlight over a much wider range of temperature than warm season grasses which have little photosynthesis below 60F but have much more growth at high temperatures.
- Young leaves actively capture sunlight, peaking at about three weeks and cease after four to six weeks in summer. Leaf aging occurs more slowly during cool weather. Thus, old leaves are unproductive and should be removed from a pasture by grazing to be replaced by young leaves.
- As leaves accumulate in a pasture, shading of lower leaves reduces the amount of sunlight reaching them so less photosynthesis occurs. Forage species differ in their ability to allow sunlight penetration into the leaf canopy. Warm season grasses such as bermudagrass have leaves at a more acute angle which allows sunlight to penetrate through more leaf layers than cool season grasses such as tall fescue. This, together with greater ability of individual leaves to utilize much more of the sunlight than cool season grasses, results in the very high forage yield of bermudagrass during a shorter growing season. In contrast, clovers have their leaves in a more horizontal position which causes a great deal of self-shading of lower leaves. This means that clover should be grazed frequently to supply adequate light to leaves. In general, accumulating large amounts of old grass in a pasture will increase the percentage of dead leaves while reducing the amount of leafy green forage desired by grazing livestock.
- Overgrazing of a pasture, in addition to not providing adequate forage for grazing animals, results in few leaves to capture sunlight. Thus, most of the light reaching an overgrazed pasture falls on bare areas of soil or dead leaves and is wasted. Too few solar collectors are available to utilize sunlight and produce sugars for plant growth.
- Undergrazing of pastures provide plenty of forage for animals but much of it is dead leaves and stems so nutritive quality declines. These pastures also have massive numbers of aging leaves that are unable to utilize sunlight and thus contribute nothing to growth. A dense thick leaf canopy also prevents light from reaching lower leaves and reduces development of new buds for new tiller production.

Forage plant carbohydrate reserves

Storage carbohydrates (sugars and starch) serve as the plant bank savings account to:

- Support plant respiration needs of living cells during winter or summer dormancy.
- Supply food for regrowth of new leaves after close grazing, hay cutting, or dormancy.
- Aid cold and heat resistance of forage plants.

Excess energy from photosynthesis is moved from leaves and stored as starch or sugars in:

- Roots (alfalfa, red clover, sericea lespedeza, kudzu).
- Base of stems (tall fescue, orchardgrass, dallisgrass, big bluestem, switchgrass).
- Rhizomes (bahiagrass, bermudagrass, johnsongrass, perennial peanut).
- Stolons (white clover).

Forage species differ in their carbohydrate storage reserves and is an important factor that can affect their tolerance to grazing:

- Tall fescue and orchardgrass - tolerate fairly close grazing during cool season but close grazing during summer depletes carbohydrates and weakens stand, especially of endophyte-free tall fescue and orchardgrass.
- Bermudagrass and bahiagrass - they have abundant rhizomes for carbohydrate storage and many leaves close to the ground so can be closely grazed.
- Switchgrass, big bluestem, eastern gamagrass, and johnsongrass - have few leaves close to the ground and limited rhizomes so must be rotationally grazed or stands weaken.
- Alfalfa, red clover, and sericea lespedeza - erect-growing legumes with few basal leaves that require rotational grazing to maintain adequate carbohydrate storage in roots for stand survival and productivity. Grazing-tolerant alfalfa varieties are much more tolerant of close continuous grazing but will benefit from rotational grazing.
- White clover - has many stolons for carbohydrate storage so can tolerate close grazing. The new Durana and Patriot white clover varieties are much more tolerant of close, continuous grazing than commercial ladino varieties because they have more leaves close to the ground and far more stolons for carbohydrate storage, resulting in much longer stand life in grass sods.

Practical grazing and hay management

Although forage species differ in their tolerance to grazing, there are some general principals that should be considered in practical grassland management.

- Grazing should be frequent enough to remove leafy green forage but maintain abundant new tillers and enough leaves for photosynthesis to stimulate new growth.
- Avoid continuous overgrazing as insufficient leaf tissue is available to utilize incoming sunlight.
- If rotational grazing is used, avoid too long a rest time between grazing periods.

As time between hay cuttings is extended, hay yield increases somewhat but regrowth is delayed due to fewer tillers, allowing weed seed to germinate and contaminate the crop. Cutting hay more frequently costs more but it results in high quality leafy hay which may reduce or eliminate the need for protein or energy supplements during winter hay feeding.

Good grassland farming involves managing a pasture or hayfield to collect as much of the incoming sunlight as possible and convert it into high quality forage.