

Leaves of Grass

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"Leaves of Grass" was the title of a book written by the famous American poet, Walt Whitman, which is not concerned with pasture grasses but is a good title for an article on how grass leaves grow. After all, cattle producers are actually "grass farmers" who market the product through their livestock. Understanding a bit about the functioning of leaves may be useful in managing a pasture to maintain productivity, nutritive quality, and stand persistence.

Harvesting solar energy

There is much discussion these days about non-renewable sources of energy from petroleum, natural gas, and coal versus renewable sources such as wind, water, and sun. Obviously, all these sources of energy are of solar origin. Solar panels with photoelectric cells are increasingly being used to collect solar energy and operate small calculators, electric fences, and even for illumination via storage batteries. However, this is puny compared to the massive biological solar collectors livestock producers have in their pastures! In reality, each leaf in a pasture or hayfield is a potential biological solar collector, operating day after day with minimal maintenance.

Operation of leaf solar collectors

Cells in the spongy tissue of leaves are the site of photosynthesis, a chemical process by which water and carbon dioxide (CO₂) react to form sugars. This process takes place in the presence of chlorophyll, the green pigment in plant leaves, and requires light energy to drive the reaction. In addition to light, photosynthesis requires large amounts of water and when this is not available the rate of photosynthesis declines. The sugar produced in this process is then translocated from the leaf chloroplasts to cells throughout the plant and provides both energy and carbon for all other reactions within the plant. Most of this energy is utilized for plant growth but a considerable amount is lost in respiration, similar to what happens in humans and animals.

There are two basic types of leaf solar

collectors which have different photosynthetic pathways. Cool season grasses such as tall fescue, orchardgrass, annual ryegrass, rye, and wheat have one process with an optimum temperature for photosynthesis of about 60 to 80 F. Legumes such as clovers and alfalfa are similar in this respect. At higher temperatures, photosynthesis and growth of these grasses and legumes decline even when soil moisture is adequate. Warm season grasses such as bermudagrass, bahiagrass, pearl millet, and sorghumsudangrass have a more efficient photosynthetic pathway with optimum temperatures for photosynthesis of 80 to over 90 F. However, warm season grasses have a much narrower temperature range for photosynthesis than cool season grasses or legumes. For instance, cool season grasses can maintain some photosynthesis and produce sugars at temperatures near freezing while warm season grasses have little photosynthesis below 50 F. Warm season grasses can

utilize approximately twice as much solar energy as cool season grasses and are more efficient in production of energy. They also are more efficient in utilization of water and nitrogen in the photosynthetic process for dry matter production.

Obviously, the amount of incoming solar radiation will affect productivity of leaf solar collectors. In summer, with maximum solar radiation and cloudless skies, light energy is adequate for optimum photosynthesis of individual grass leaves. However, cloudy skies can reduce the amount of available light energy desirable for warm season grasses but it will be more than adequate for cool season grasses. In autumn, solar radiation declines greatly and may be inadequate for optimum photosynthesis even when temperatures are favorable. Compounding the problem in winter is the short daylength and cloudiness which can result in very low light levels, resulting in poor pasture growth.



Longevity of leaves and photosynthesis

As leaves emerge and grow, they increase in ability to capture sunlight, peaking at about 15 to 20 days and then decline slowly until after six weeks or more photosynthesis is minimal. Leaf aging is affected by temperature, with senility occurring more rapidly at higher temperatures. Generally, old leaves in a pasture are contributing little as solar collectors. In addition, these nonproductive leaves continue to respire and utilize sugars. Thus, it is desirable to maintain a high percentage of young leaves in a pasture and avoid accumulation of old non-functioning solar leaf collectors.

Functioning of leaf solar collectors in a pasture

The potential of an active grass leaf to utilize light energy depends on an adequate supply of water and soil nutrients such as nitrogen, phosphorus, and potassium. In addition, the performance of an individual leaf is greatly affected by shading of other leaves in a pasture or hayfield. Leaf angle affects light penetration into the grass sward or mass of leaves. Grasses and legumes that have horizontal leaves will shade other leaves more than if they are at an acute angle which allows sunlight to penetrate deeper into the sward. Clover leaves tend to be displayed in a horizontal position and only a few leaf layers result in complete shade for lower leaves. Forage plants with leaves set at a more acute angle on a taller stem such as pearl millet, bermudagrass, and alfalfa allow light to penetrate deeper into the canopy and result in greater productivity. Another factor is the total leaf area per unit of land. When too many leaf layers have accumulated, then leaves lower in the canopy will receive little or no sunlight and be nonfunctional.

When large amounts of leaves remain in a pasture the efficiency of leaf solar collectors will decline in efficiency. In addition, shading reduces development of new leaf tillers from buds at the base of the grass plants. Other effects of this accumulation are a decline in forage nutritive quality and losses in dry matter as leaves die and decompose. Skillful grass farmers can reduce these problems by pasture management that centers on maintaining productive leaf solar collectors in good condition for as much of the grazing season as possible.

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