Plant Physiology 101 for Profitable Pastures

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Without really knowing it, grazing-based dairy producers are often faced with the following questions:

Is pasture management based on what is best for the animal or what is best for the plant? It is important to manage for the plant because it is the basis of feeding. A grazing-based producer benefits most from having a uniform and predictable seasonal distribution of grass.

How does one achieve uniform and predictable seasonal distribution of grass? First, a quick lesson in plant physiology. Photosynthesis utilizes energy from the sun to produce carbohydrates in the plant. Fructose, a sugar, is the primary carbohydrate produced. Carbohydrates are important in this process since they:

- are produced by photosynthesis,
- enable the plant to grow more leaves and tillers,
- are stored in stem bases, roots, and rhizomes,
- are consumed by grazing animals,
- keep the plant alive during stress (winter, drought).

How does grazing affect the plant? In order for regrowth and the production of the necessary leaves, the plant uses two sources of energy including:

- existing leaves, which make new carbohydrates through the process of photosynthesis,
- stored carbohydrates.

What is the importance of residual height? When an adequate residual height remains after grazing, photosynthesis in the remaining leaves produces most of the carbohydrates for new leaves. Put another way, a greater proportion of new leaves are being produced from carbohydrates in existing leaves rather than from stored carbohydrates.

When there is an inadequate residual height remaining after grazing, the plant must move stored carbohydrates up from the stem base to produce new leaves. Thus, a smaller proportion of new leaves is being produced from carbohydrates in existing leaves, with a greater proportion coming from stored carbohydrates. It is easier and more efficient for plants to grow new leaves by producing carbohydrates with old leaves than by moving stored carbohydrates.
An inadequate residual height:

- will increase the length of rest periods between rotations,
- may change pasture composition because some grasses can tolerate over-grazing better than others,
- may encourage weed growth.

Figure 1 illustrates the rate at which grass grows depending on the residual height. The rate increases as residual height increases until the grass is long enough to start shading the underside of the plant and slow down the growth. An adequate residual height, which promotes quicker regrowth, also shortens the length of time before cattle can graze in the same pasture again (see Figure 2).

How do grasses differ from one variety to the next? Grass varieties differ in their response to defoliation, or their ability to grow back after being grazed. As an example, orchardgrass and meadow fescue can be compared. With orchardgrass, the stem bases (where carbohydrates are stored) are higher in the canopy and therefore more likely to be eaten by grazing cattle. However, stored carbohydrates are less likely to be eaten with meadow fescue because their stem bases are closer to the ground. In addition, meadow fescue maintains more leaf area below grazing height than orchardgrass, which also encourages regrowth due to the additional leaf area which captures more sunlight for photosynthesis.

This difference in plant response may bring to mind the rule of thumb, “graze at three leaves,” or let the cows into a paddock after the plants have produced three new leaves since the last grazing. This rule applies primarily to perennial ryegrass and is not always appropriate or applicable for orchardgrass and other tall grasses. With these grasses, grazing between the third and fifth leaf stage stimulates growth of secondary tillers and allows for the development of axillary buds.

What are the important considerations to be taken into account for managing the pasture plant? Consider the three following critical elements for managing the pasture plant efficiently: nitrogen application, water availability, and the timing of late-season grazing. The results in Figure 3 are from a study conducted on a pasture in Dane County, WI. Results in the figure illustrate a notable increase in tiller growth when nitrogen was applied in June.

When should nitrogen be applied? Spring nitrogen application is the most advantageous time for the individual plant, however, forage is already abundant at this time. Applying nitrogen in lateMay or early June helps to stimulate summer tiller growth.

In addition to nitrogen, water is an essential element for plant growth. Figure 3 illustrates how tiller growth decreased during a July drought. During moisture stress, plants are more dependent on stored carbohydrates for growth. It is important to recognize the beginning of moisture stress and consequently increase the residual height of grazed plants and lengthen the rest periods between rotations. By doing this, there are more leaves present to help supply the plant with necessary carbohydrates.

If drought conditions persist, consider using a sacrifice pasture. Remove the animals from all paddocks, except the sacrifice pasture, and feed them hay. The plants in the sacrifice paddock may die from overgrazing, but the rest will be saved in the process.

Just as a plant needs water and nitrogen to grow, it also needs a rest period in the fall, before the first frost. The plant has a 'switch' that tells it when to start preparing itself for winter and the next year's growth; this is referred to as fall axillary tiller growth. Figure 3 illustrates how plant growth increases again in the fall. Therefore, it is beneficial to treat pastures well late in the growing season. Secondary tillers produced in late summer and fall are the basis for the next year's growth. Let grasses grow (uninterrupted) three to four leaves before a killing frost to store sufficient carbohydrates, and leave a 3- to 4-inch residual height.

Finally, lest it be thought that rotational grazing is a fairly new phenomenon, the following is an interesting quote from an early researcher.

"Animals delight most to feed on fresh plants. Cattle supplied with this kind of food would be quickly fatted. If a farmer divided his land into 15 to 20 equal divisions, stopped his beasts from roaming indiscriminately, put the whole number of his beasts into one of these divisions. Have the numbers of beasts so great as to consume the best part of the grass in one day. Give them a fresh park every morning to repeat the same repast. Have so many parks as days required to advance the grass to the proper length after being eaten fare down, so the first field would be ready to receive them after going over all the others, so they might be carried round in a constant rotation."

James Anderson,
Scottish Agriculturist,
1777

Figure 1.

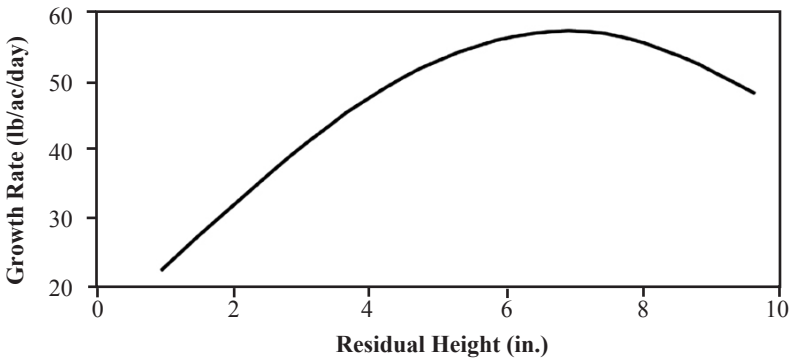

Figure 2.

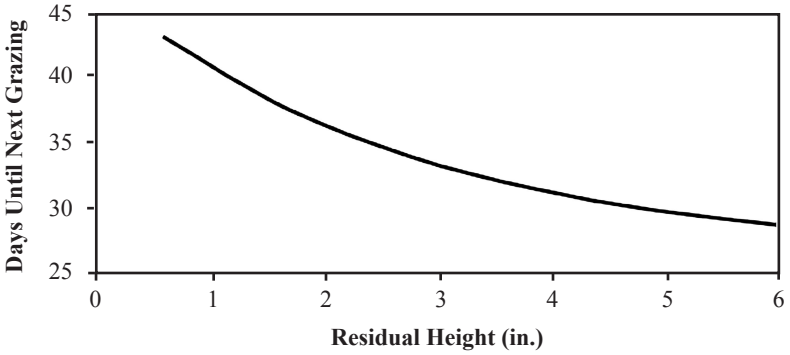

Figure 3.