Water

Carl S. Hoveland, Crop & Soil Sciences Dept., Univ. of Georgia, Athens, GA

Water is important! A cow can lose 40% of its body weight in protein and fats and still survive but loss of about 10% of its water is lethal. Water is likewise the most critical nutrient for pasture and hay production, even more important than nitrogen, phosphorus, or potassium. It is absolutely essential for life to exist. Cells, the building blocks of plants, are about 1/1000 of an inch in size and contain the fluid protoplasm that is the living matter of the cell. When water is insufficient and the protoplasm dehydrates, the cell dies. No other nutrient is as critical for plant survival as water.

Water use by plants

Huge amounts of water are utilized by growing grasses and legumes as they convert sunlight along with carbon dioxide into starch and sugar. Although water is a major raw material in photosynthesis, less than one percent of the water taken up by the roots is used to produce food. The vast majority of plant water is lost from the leaf stomata (tiny pores) which operate as an evaporative cooler or air conditioning system to cool the plant. In addition, as water moves upward it carries minerals, sugars, and amino acids.

Depending on plant species and temperatures, about 300 to 1,000 pounds of water are required to produce one pound of dry forage. Thus, pasture plants with a deep root system have an advantage in securing water at greater depths provided that plow pans or very acid subsoils do not prevent deep root penetration. Perennial plants such as bermudagrass and bahiagrass have much deeper root systems than tall fescue or orchardgrass. White clover has shallow rooting, resulting in wilting and often death of leaves during hot dry weather while many of the grasses remain green and productive.

Water availability to plants

Good pasture growth over the growing season depends on plants obtaining adequate amounts of water at all times. Availability of water to plants depends on a number of things:

(1) Distribution of rainfall over the growing season. In a cool moist climate such as Ireland, total annual rainfall is only 27 inches but it comes in gentle frequent showers, and only small losses from plants and soil makes it even more effective. In contrast, the southeastern USA generally gets 50 inches or more annually, much of which comes during winter when plant water needs are low. Summer rainfall comes erratically from high intensity thunderstorms. High summer temperatures increase the water losses from plants and soil. In the southeastern states of Alabama, Georgia, and South Carolina, autumn droughts are common and make it difficult to establish winter annual forages.

(2) Water losses from runoff. During winter, soils become saturated with water from prolonged rains so surplus water runs off the land into streams and lakes. Heavy thunderstorms in summer may produce substantial runoff because the infiltration rate is low, especially on hard clay soils.

Measurements of water runoff over two years on tall fescue-bermudagrass pastures at the Central Georgia Branch Station, Eatonton, show that at least 15% of the total annual rainfall or about 8 inches is lost this way. This loss will be higher on steep pasture land.

(3) Soil texture affects the amount of rainfall that can be stored. A clay soil may hold 4.5 inches of water per foot at field capacity of which about 1.5 inch is available to the plant. In contrast, a sandy soil may hold only one inch of water of which only 0.5 inch is available to the plant.

(4) Depth of root development affects the amount of water available to the plant. This is affected by forage species, compacted soil layers or "pans", subsoil acidity, and nematodes. In many of our soils, subsoils have a pH below 5.0 which increases release of toxic aluminum and stops root growth of many forage species. A few grasses and legumes such as bahiagrass, bermudagrass, pearl millet, rye, sericea lespedeza, and annual lespedeza can grow roots and extract water from acid subsoils.

What can be done?

(1) Irrigation certainly will improve forage production during drought but it is usually not cost effective except for silage corn or production of high-quality horse hay. If irrigation equipment is available from row crop production, it may pay to irrigate rye or wheat during autumn to secure rapid establishment and early grazing for stocker steers.

(2) Selection of drought-tolerant grasses and legumes. Warm season grasses such as bermudagrass, bahiagrass, switchgrass, and pearl millet are much more efficient than cool season grasses such as tall fescue, orchardgrasses, and Kentucky bluegrass in dry forage production per unit of water used. This is especially impressive since the major production of the warm season grasses occurs during summer under high temperature when water losses from plants and soil are high. However, the cool season grasses have advantages over the warm season grasses in their higher nutritive quality and productivity during cooler months of the year. Coastal bermudagrass is deeper rooted and more drought-tolerant than common bermudagrass or bahiagrass. Where very acid subsoils are a problem, pearl millet roots will grow well and extract water from greater depths than sorghumsudangrass.

Endophyte-infected tall fescue is more drought-tolerant than endophyte-free varieties. However, the new non-toxic endophyte-infected tall fescue varieties (seed of which will be available in quantity to farmers by autumn 2000) have drought tolerance similar to toxic endophyte-infected Kentucky 31 tall fescue. Alfalfa, on soils where it is adapted, is more drought-tolerant and productive than any of the clovers. Sericea lespedeza and kudzu, with taproots capable of deep rooting in acid subsoils, are extremely drought tolerant. Puna chicory is also able to develop roots in acid subsoils and make considerable growth during dry weather.

(3) Fertilize to maintain good plant root development. Productivity of well-fertilized grasses and legumes is greater because of better water use efficiency.

Under-fertilized pastures suffer more during drought periods.

(4) Grazing management. Grasses like bahia and bermuda with dense leaf cover near the ground and underground food storage in rhizomes can be grazed closely without harming the plants. However, more erect growing forage plants such as tall fescue, orchardgrass, johnsongrass, switchgrass, alfalfa, red clover, and sericea lespedeza with less leaves near the ground are more dependent on food reserves in the basal plant parts, roots, or rhizomes. When these plants are grazed closely and continuously over time, water efficiency declines along with forage production. Heavy grazing pressure, as compared to leaving a 3-inch stubble, of tall fescue during summer drought periods furnishes only small amounts of forage but will reduce autumn production by 75% or more, according to Georgia research. Moving cattle to bermudagrass during hot summer periods and resting tall fescue pastures is a good way to obtain better water efficiency on tall fescue pastures in autumn.

Conclusions

Annual rainfall in the southeastern USA is high but not well distributed and soil water storage is limited. Row crops often suffer severe losses because they are so dependent on obtaining sufficient water during critical flower and fruiting periods. In contrast, pasture and hay plants have more flexibility and cope better with periods of inadequate water since they can make compensatory growth during adequate rainfall periods if soil fertility is satisfactory. Selection of grasses and legumes best adapted to local conditions, adequate fertilization to maintain good root systems, and favorable grazing management can assist in obtaining the most forage from available water.