THE ROOT ISSUE OF DROUGHT TOLERANCE

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One of the most important aspects of forage production is rarely ever seen. In fact, it is literally the root of the issue. Roots are not given much thought until drought or other stresses strike. With proper management, root growth and development can be optimized and the impact of these stresses will be minimized.

Nearly every producer can list out "the drought years." For example, the drought of 2011 will be permanently seared in the minds of many southern forage growers. In most areas, however, some amount of drought stress occurs each year. A crucial forage management principle is to insulate one's production system from drought risk.

During a drought, forage crops can exhibit stress tolerance by being more efficient with the available water, that is, producing relatively high amounts of dry matter (DM) for every acre-inch of rainfall received. In fact, our most common perennial forages are typically very efficient at using water (Table 1). This is critical when the region is frequently subjected to drought stress or is dependent upon irrigation.

Table 1. The water use efficiency and rooting depth (when unlimited) of selected forage species.

Species	Water Use Efficiency	Rooting Depth
	lbs of DM /ac•in	inches
Tall Fescue	1064	48
Common Bermudagrass	1019	50
Hybrid Bermudagrass	1646	78
Pensacola Bahiagrass	1194	79
Ladino Clover	480	38
Red Clover	436	45
Alfalfa	682	120+

A crop's rooting depth is also a major factor influencing its water use efficiency. The rooting depths reported in Table 1 are impressive. But, it must be pointed out that these values come from plots that had deep soils, excellent fertility, and were rarely cut or grazed. With the exception of sites with shallow bedrock or impenetrable layers, rooting depths can still be optimized in less than ideal situations using proper management.

Maintaining soil pH within recommended ranges is the first key to fostering a well-developed root system. This ensures that plant nutrients are readily available and that other elements do not become toxic. For example, maintaining a rather neutral soil pH prevents aluminum (Al) from becoming dissolved in the soil moisture. Soluble Al is toxic to the plant and is a common cause of poor root development. Neutralizing the soil pH causes the Al to return to a solid form. In some cases, like when subsoil pH because extremely acidic, it may be necessary to add gypsum ($CaSO_4$). Although gypsum does not alter the soil pH, it can infiltrate the soil profile and reduce the solubility of Al.

Cutting and grazing management is also a major factor that affects the root system of a forage crop. When a forage plant is cut or grazed, root growth stops and some of the roots even begin dying back. This allows the plant to redirect those carbohydrates and protein reserves toward the regrowth of the foliage. If the plant is quickly cut or grazed again, the roots will die back even more. Eventually, this

repeated defoliation will result in a root system that essentially mirrors the top growth. Consequently, when drought stress becomes severe, these areas are the first to stop growing, turn brown, and go dormant or die.

In pastures that are continuously stocked (i.e., no rotation or rest period), areas become preferentially grazed and individual plants may be grazed several times in the same week. At a recent field day in Northern Florida, University of Florida extension soil scientist, Dr. Cheryl Mackoviak, demonstrated what effects such frequent defoliation can have on forage crops (Figure 1). She had grown bahiagrass in 3-ft lengths of PVC pipe and clipped them every 2, 7, or 21 days for a couple months leading up to the field day. Note how well-developed the root system was when it was harvested relatively infrequently.

Allowing for adequate rest ensures that the root system becomes deep and well-developed. Many similar field and grazing experiments have established how much rest is required by the plants to regenerate their root systems. However, it is important to note that it is not an exact matter of days. Growing conditions vary and the rate of top-growth influences the rate at which roots redevelop. Most university extension services and conservation districts provide recommended rest periods for forage species in their region.

As plans are made for the upcoming growing season, take a minute to consider how current management is affecting root system development. If there is a chronic problem, get at the root of it.

Figure 1. Frequent defoliation results in an under-developed root system.