

## **ROOTS ARE GONE IN THE SUMMER: WHERE AND WHY?**

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As temperature increases during summer months, turf quality of cool-season turfgrasses often declines. The symptoms of summer quality decline include slow shoot growth, decline in shoot density, algae encroachment, disease infection, and eventually died turf. Accompanying with or even prior to turf quality decline are thinning and shortening of roots. Where do roots go and why do roots become fewer and shorter in summer?

The most active growing periods for shoot and root growth of cool-season grasses are spring and fall when temperature is within the optimum range. However, new root production declines while roots that have been produced in fall and spring start to die when summer approaches. That is why we see roots are fewer and shorter.

Many factors influence root growth, including environmental factors such as high temperature, poor soil aeration, drought, flooding, and nutrient deficiency. Cultural practices such as mowing, irrigation, and fertilization also affect root growth.

The most significant environmental factor influencing root growth is soil temperature. The optimum temperature for root growth of cool-season grasses is 10 to 18 C. However, soil temperature often exceeds the optimum temperature requirement for root growth in summer. Research in K-State suggests that high soil temperature is more detrimental than high air temperature for root and shoot growth in creeping bentgrass. High soil temperature inhibits carbohydrate supply from shoots to roots while carbohydrate consumption by roots increases due to increases in root maintenance respiration with increasing temperatures. The imbalance between carbohydrate supply and carbohydrate consumption can cause carbohydrate starvation and limit root growth, which, in turn, reduces nutrient and water uptake capacity.

High temperature combined with poor soil aeration has been found to be more detrimental than high temperature stress alone. Poor soil aeration or low oxygen supply can occur because of improper soil management, such as that caused by over-irrigation and compaction; poor soil quality, such as fine-textured soils or layered soils with poor drainage; or layering in high-sand-content putting greens that can result in perched water table. These factors limit oxygen diffusion in the soil and oxygen supply to roots. Roots require sufficient oxygen in order to produce energy in the respiration process to support plant growth. Oxygen demand increases with increasing temperatures. Therefore, poor soil aeration combined with high temperature inhibits root respiration, and can cause death of roots. Generally, well-aerated sand greens produce better root growth than poorly aerated native soils.

Improper management such as close mowing and over-irrigation or deficit irrigation in the summer can also have significant impact on root growth. For example, close mowing has been found to cause shallow rooting and reduces root viability. We found that creeping bentgrass mowed at 1/8 inch restricted deep rooting, compared grasses mowed at 5/23 inch. In addition, low mowed grasses had more severe root dieback in the summer than high mowed grasses. What is the problem with low mowing? Low mowing removes large amount of leaf area that otherwise would be available for photosynthesis. As temperature increases, photosynthesis or carbohydrate production process is inhibited, while respiration, the carbohydrate consumption process, continues to increase with increasing temperatures. Therefore, under high temperature conditions, when grasses are mowed closely, food consumption can exceed production, which limits carbohydrate supply to roots. Therefore, close mowing can result in carbohydrate starvation in roots and therefore, can cause death of roots.

In summary, vigorous and healthy roots are essential for healthy turf. Root dieback of cool-season grasses in summer is a natural process. However, abiotic and biotic factors and cultural practices can accelerate this process. Maintaining lower soil temperature in the summer by any means possible, improving soil aeration, and raising mowing height as high as it is allowed can all contribute to active, extensive root growth.