Eleven years ago, in a review article, Clothier and Green (1997) assessed the hydrologic budget at the land surface and pronounced that plant roots are “the big movers of water and chemical” in the vadose zone. This seems fair considering that all transpiration begins with the extraction of water from soil by roots. Evaporation sends approximately 40% of global terrestrial precipitation back to the atmosphere (Gerten et al., 2005). Clothier and Green (1997) went on to note that considerable understanding of roots had been gained from research begun in the 1960s, but they also indicated that much of roots were at best only partially understood. Subsequent review articles (e.g., Hopmans and Bristow, 2002; Wang and Smith, 2004; Darrah et al., 2006; Skaggs et al., 2006) have struck similar themes.

A number of current issues related to climate change, water management, and ecohydrology are giving impetus to new research aimed at understanding roots and their functioning. The research is producing new methods, data acquisition, and theoretical understanding. Several recent symposia have featuring sessions at the 2006 Soil Science Society of America Annual Meeting (SSSA 2006, Indianapolis, IN) and the 2007 European Geosciences Union General Assembly (EGU 2007, Vienna, Austria). For this special section of the *Vadose Zone Journal*, we invited authors from these symposia as well as other leading researchers to contribute to this special section focusing on plant roots and their functioning. The resulting 13 papers contain a snapshot of current worldwide research on roots and root function.

A major obstacle to studying roots is that they cannot be readily observed in the soil environment. Several papers in the current issue take aim at this “out-of-sight” problem, using advanced imaging techniques to image roots and their functioning at the scale of a single plant or root. Because the technologies were developed for medical imaging and industrial applications, their application to root imaging may require new protocols. Pohlmeier et al. (2008) used a magnetic resonance imaging (MRI) technique called SPRITE MRI to obtain small-scale water content maps in a soil and root system and observe water uptake patterns in plants. They observed that uptake occurs predominantly in the finer root system. Segal et al. (2008a) developed an MRI procedure to obtain three-dimensional images of a seedling root system in a phytosimulator, as well as the soil water content; they were also able to observe dynamic water uptake by a single root. Segal et al. (2008b) then used a related procedure to observe the functioning of root hairs in the water uptake process. Oswald et al. (2008), on the other hand, used a different imaging technology, minirhizotron, to follow spatial and temporal patterns in dry soil. Meanwhile, Vargas and Allen (2008) demonstrate the combined use of minirhizotron with an array of soil sensors to understand root and rhizomorph dynamics. These authors observed the functioning of fine roots and rhizomorphs over short time intervals and conclude that continuous minirhizotron measurements are needed to understand the biophysical factors that regulate belowground carbon flows.

While imaging holds great potential for future root investigations, this method is not always feasible or appropriate; thus, other techniques and instrumentation are needed. For example, root investigations of in situ soil water potentials over a wide range of pressure, particularly in arid areas where dry soil conditions may persist. In conjunction with the MRI investigations noted above, van der Ploeg et al. (2008) tested a recently developed polymer tensiometer designed to measure matric potentials down to −1.6 MPa. With this new tensiometer, van der Ploeg et al. (2008) could closely follow spatial and temporal patterns in dry soil. Meanwhile, Vargas and Allen (2008) demonstrate the combined use of minirhizotron and neutron radiography. These authors observe the functioning of fine roots and rhizomorphs over short time intervals and conclude that continuous minirhizotron measurements are needed to understand the biophysical factors that regulate belowground carbon flows.

The new experimental techniques and instrumentation will undoubtedly provide data in areas critical to the functioning of the vadose zone and the fate of water. These advances will redouble the conclusions of Clothier and Green (1997) that roots and their functioning at the scale of a single plant are crucial to our understanding of the vadose zone.