WATER USE EFFICIENCIES OF GRAIN SORGHUM GROWN IN THREE USA SOUTHERN GREAT PLAINS SOILS

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ABSTRACT

The ratios of economic yield:evapotranspiration (ET), or water use efficiency (WUE), and economic yield:irrigation water application, or irrigation WUE (IWUE), help evaluate the productivity of irrigation in agricultural systems. Water stress at critical growth stages, excessive soil water evaporation, soil water storage, runoff, and drainage are among the many factors which result in declines in either or both of these ratios. The objective of this research was to evaluate the effect of soil type, soil water use characteristics, and seasonal climatic differences on the WUE and IWUE of grain sorghum grown in the semi-arid climate of the southern Great Plains of the USA. In 1998 and 1999, grain sorghum [*Sorghum bicolor* (L.) Moench 'PIO-8699'] was grown in 0.75-m rows with 16 plants m^{-2} at Bushland, TX in lysimeters containing monolithic soil cores of either the Amarillo, Pullman, or Ulysses soil series. Irrigation treatments in both years were 100%, 50%, 25%, and 0% replacement of ET, simulating deficit irrigation that results from limited water availability such as reduced well capacities. The WUE was significantly higher and ET lower in the milder climatic conditions of 1999 compared with 1998, which had a higher evaporative demand. Once normalized for climatic differences, yield response to ET was similar for both years. Crops grown in the Amarillo soil had significantly higher WUE compared with crops in the other soils, primarily due to reduced ET rather than increased yield. Grain sorghum grown in the Ulysses soil was able to produce higher yields at lower plant available water compared with the other two soils, but the crops in all soils reduced yield when experiencing water stress at a critical growth stage of pollination. At comparable final soil water contents, grain yields of the crop in the Pullman soil were higher in 1999 (lower evaporative demand) compared with yields produced in 1998 (higher evaporative demand), while the crops in the other two soils produced similar yields in both environments. The relationship between irrigation application and yield was more curvilinear in 1998 possibly due to increased soil water evaporation at the higher irrigation applications, while the relationship was more linear in 1999. In general, IWUE declined with increasing irrigation application within each year, but was variable in some irrigation treatments, due to water stress at critical growth stages. No differences among soil types occurred in IWUE in either year, primarily due to variability among replicates.