Soil Respiration of Three Bioenergy Crops: How Energy Sorghum Compares to Maize and Miscanthus

Haley K. Ware, Jack Goldman, Adam C. von Haden, Janith M. Chandrasoma, Wendy H. Yang, Evan H. Delucia

Energy sorghum is an emerging annual bioenergy crop that can be integrated into existing annual crop rotations as opposed to perennial bioenergy crops. However, the ecosystem benefits of energy sorghum are not yet well-characterized so its potential to support an ecologically sustainable bioeconomy is uncertain. In this study, we aimed to compare soil carbon loss to the atmosphere for sorghum against maize, an annual crop, and miscanthus, a perennial bioenergy crop, by quantifying soil respiration (RS), a major component of the carbon cycle, and partitioning RS into heterotrophic respiration (RH) and autotrophic respiration (RA). Since 2018, we have been measuring growing season soil CO_2 efflux in replicated 1 ha plots of maize, energy sorghum, and miscanthus (established in 2008) at the University of Illinois Energy Farm in Urbana, IL. In 2021, sorghum differed significantly in RS from miscanthus ($P = .008$) and maize ($P = .004$) and all three crops differed significantly in the proportion of RS attributed to RH vs. RA using root exclusion collars ($P < .001$). Energy sorghum had the lowest cumulative RS (772 ± 51 g C m^{-2} d^{-1}), with RH comprising 63% and RA comprising 37% of its RS. Miscanthus had the highest cumulative RS (983 ± 24 g C m^{-2} d^{-1}) and the highest contribution of RA to RS (44%). The cumulative RS of maize was comparable to miscanthus (920 ± 72 g C m^{-2} d^{-1}), but the contribution of RA to RS was lowest for maize (25%). The magnitude of energy sorghum RH was comparable to miscanthus and ~40% lower than for maize. Our results suggest that, while energy sorghum is grown as an annual crop, its lower loss of soil carbon to atmosphere compared to maize could contribute to lower carbon intensity of energy sorghum production.

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