Evaluating cover crop planting date effects on the ecological sustainability of energy sorghum

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Energy sorghum is an emerging bioenergy feedstock due to its high biomass production, but grown as an annual crop requiring fertilizer inputs, it exhibits high soil nitrous oxide emissions and nitrate leaching that detract from its ecological sustainability. Cover cropping, a process in which non-cash crops are planted after cash crop harvest, can reduce non-growing nitrogen losses from agricultural fields, in addition to many other ecosystem services such as improving soil health, reducing erosion, controlling pests and disease, and increasing biodiversity. Poor establishment of the cover crop before winter can lead to smaller ecosystem benefits, but the planting date is typically constrained by the cash crop harvest date. Since energy sorghum is harvested green, this allows for flexibility in harvest date. We hypothesized that earlier sorghum harvest and cover crop planting dates would lead to lower soil nitrogen losses due to greater cover crop biomass enabling more plant nitrogen uptake over the non-growing season. In 2021, we initiated a two-year field experiment at the University of Illinois Energy Farm, with three different sorghum harvest and cereal rye cover crop planting dates: August, September, and October (the typical sorghum harvest date). In the first year of our study, we found that cover crop biomass was greatest with September planting ($P = 0.003$), with aboveground biomass from sorghum re-growth shading out the cover crop planted in August. Given that the root systems of sorghum remain intact at harvest, the sorghum harvested in August had produced an additional 8.1 Mg ha^{-1} dry biomass by re-growth harvest in November. Total sorghum biomass harvested increased with later harvest dates ($P = <0.001$), with 21.0 Mg ha^{-1} for the September harvest date and 27.0 Mg ha^{-1} for the October harvest date compared to a total of 16.8 Mg ha^{-1} for the August harvest date. Analysis of soil nitrous oxide emissions, nitrate leaching rates, and net nitrogen cycling rates are ongoing, but based on our hypothesis, we expect the lowest nitrogen losses for the sorghum plots harvested in September. Our study suggests that sacrificing some energy sorghum yield by harvesting one month earlier does generate the benefit of increasing the potential for cover crops to reduce agroecosystem nitrogen losses.

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