The pros and cons of Miscanthus -- uses more water, leaches less nitrogen

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Miscanthus at maximum biomass tops 11 feet, shown with Emily Doherty for scale. Credit: Photo courtesy S. Long Lab, University of Illinois

In the search for the perfect crop for biofuel production, *Miscanthus* has become the darling to many. But in an effort to not be charmed by its enormous potential for biomass production, researchers at the University of Illinois are taking a careful look at the pros and cons of its behavior in the field.

A recent study analyzed water quantity and quality in plots of *Miscanthus*, switchgrass, corn, and soybeans and found that *Miscanthus* used substantially more water, but reduced the potential for nitrogen pollution to water bodies.

"We found that *Miscanthus* tends to dry out the soil much more than

corn, soybeans, or switchgrass later in the growing season," said Greg McIsaac, environmental scientist in the College of Agricultural, Consumer and Environmental Sciences. "This would likely reduce runoff, stream flow and surface water supplies later in the summer and in early fall, when streams are typically at their lowest. It could reduce the amount of water available to those who are downstream in late summer and early fall."

Switchgrass behaves like *Miscanthus* early in the growing season, drying out the soil. It then goes into a reproductive mode and uses very little water in the late summer and fall.

McIsaac said that *Miscanthus*'s impact on water supply may be small if it is planted on only a few acres in a watershed. "The severity of the impacts will likely vary depending on the nature of the soils and climatic conditions. In areas where water is in short supply, switchgrass may be preferable, understanding that switchgrass creates much less biomass than *Miscanthus*," he said.

"It will likely be in the farmer's economic interest to plant the most productive crop, which may also use more water than their current crops. When and where this occurs over significant areas, downstream water users should consider how it is going to influence their water supply. They may need to develop plans to address more frequent water shortages, or perhaps attempt to influence the planting decisions through incentives or policy. It is something to be aware of and plan for if *Miscanthus* or a similar water-demanding crop becomes economically attractive to farmers," he added.

The fact that both *Miscanthus* and switchgrass use more water early in the growing season than corn and soybeans could be seen as a benefit because flooding is often a problem that time of year. Drying out the soil earlier in the spring would reduce runoff from spring rains, he said, and

thus reduce flood flows.

The study also looked at how nitrogen moves or "leaches" into the ground water beneath the four crops. With corn and soybeans where the field has tile drainage, the fertilizer and soil organic nitrogen gets converted to nitrate which is highly soluble and moves with the water to the tile drains. From there it moves out to the ditches and streams, causing problems for drinking water supplies and contributing to the hypoxia in the Gulf of Mexico.

The *Miscanthus* and switchgrass plots in the study received no added fertilizer and grew vigorously without it. Consequently, it wasn't surprising that the unfertilized *Miscanthus* and switchgrass had much lower leaching than soybeans or fertilized corn.

McIsaac explained that there are several factors at work, not just the absence of applied fertilizers. "The roots in perennial grasses go deeper into the soil. They're more extensive and they are active earlier in the growing season - so if we had perennial corn, it might behave more like these grasses. But even with soybeans, where we also didn't apply fertilizer, the amount of leaching was almost as high as with corn. So it's not just the absence of fertilizer, it's also the perennial roots that retain more soil nitrogen."

"We did not apply fertilizer to *Miscanthus* or switchgrass because the study was designed to look at a low-input biofuel," McIsaac said. "The results showed that you can get high productivity without fertilizing *Miscanthus*, at least for the first three to four years. It is likely that if you apply fertilizer to *Miscanthus* and switchgrass, there would be more leaching than what we saw in our study, with no application. But because of the root activity, I would expect fertilized *Miscanthus* and switchgrass to leach less than fertilized corn. To be certain, this needs further study."

More information: Miscanthus and Switchgrass Production in Central Illinois: Impacts on Hydrology and Inorganic Nitrogen Leaching appears in the September-October edition of the *Journal of Environmental Quality*.

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