

## Fertilizer requirements of the bioenergy crop miscanthus

Dennis Pennington, [Michigan State University Extension](#) - May 29, 2012

**Miscanthus giganteus is a high yielding bioenergy crop that is efficient in nutrient utilization.**

*Miscanthus giganteus* is a warm season perennial grass that is a contender as a cellulosic ethanol crop due to its high yield potential. A number of studies have been conducted to determine the nutrient requirements of miscanthus. The “perfect” bioenergy crop would be one where high yields could be achieved with little or no application of fertilizer.

### Nutrient removal rate

Nutrient removal could be defined as the amount of each nutrient per pound of biomass times the harvested yield. Soil type, temperature, rainfall, timing of harvest and previous cropping history are some of the factors that impact biomass yield. Miscanthus is a C4 grass, which means it is a very efficient user of water and grows better in warmer temperatures. Most studies show the largest accumulation of biomass and nutrients is in August. Typically, miscanthus contains 4.9, 0.45 and 7.0 grams/kilogram of N, P and K respectively in harvested tissue. In Michigan, mature stands of miscanthus will likely yield 9 tons per acre or 18,000 lbs per acre. Based on this, one acre of miscanthus would remove 88, 8 and 126 lbs of N, P and K respectively. This should be the maximum amount of nutrients to be supplied each year. Miscanthus has a very low nutrient removal rate compared to other bioenergy contender crops. The plant has a remarkable ability to turn only modest amounts of nutrients into large amounts of biomass.

Reasons for low nutrient removal rate:

- Miscanthus has a very deep and extensive root system that is very efficient at taking up nutrients.

- Nutrient use efficiency is very high for miscanthus (uses small amounts of nutrients for large gains in biomass yield).
- Translocation of nutrients from above ground plant parts to the root system in the fall of the year cycle nutrients for next year's crop.
- The crop has the ability to remobilize nutrients from the rhizomes to growing plant parts.

## **Effect of harvest timing on nutrient removal**

As plants grow, nutrients are absorbed through roots from soil and water. The rate of uptake increases in parallel with crop growth rate. Miscanthus is a warm season grass. These type of grasses will translocate nutrients expressed in stems and leaves back to the roots after senescence. This is why timing of harvest is so important. Waiting for at least two weeks after a killing frost will allow the plant time to move a significant portion of nutrients back to the roots for next year. Waiting until after killing frost presents some harvest challenges, but from a nutrient perspective is the best option. Typically, biomass is handled dry – usually baled. Good drying conditions are hard to get with late fall weather. Sometimes a tradeoff will need to occur between finding the best weather for harvest operation and translocation of nutrients back to the roots.

## **Fertilization studies**

As miscanthus gains popularity as a bioenergy crop in the United States, many public and private companies are conducting research on the long-term impacts of various fertilization schemes on yield. Some studies show a significant response to nitrogen application, while others have achieved high yields with no additional nutrients. Nitrogen fertilizer should not be applied during the establishment year, as it will provide more benefits to weeds than the crop. As a relatively new crop, it will take time to determine how it will react to fertilization on different soil types, management schemes and climate conditions. Developers of biomass crops are seeking low or no input crops with high yield. The jury is still out on defining the optimum fertilizer rate for miscanthus.

## **Bottom line**

The amount of fertilizer needed to maintain miscanthus long term is dependent upon soil, climate and management conditions. It is recommended to harvest not earlier than two weeks after a killing frost. Keep track of biomass yields and apply fertilizer accordingly. In current research plots, mature stands of miscanthus (3 years old) are producing about 9 tons dry matter per acre on productive soils with adequate rainfall. In

these conditions, the crop will remove 88, 8 and 126 lbs of N, P and K per acre respectively. There may be some soil buffering effects or the ability of plants to withstand reduced input rates, but the long-term impact remains to be determined.

It is hard to imagine a crop that removes nutrients at harvest without needing supplementation at some point. Also, in Michigan, we are at the northern edge of the miscanthus growing area and winter kill can be an issue, particularly over the first winter.

For more information, contact [Dennis Pennington](mailto:dennis.pennington@msu.edu) at 269-838-8265.

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