Long-Term Assessment of Miscanthus Productivity and Sustainability (LAMPS)

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Research has consistently shown that Miscanthus × giganteus (hereafter, Miscanthus) is among the most productive biomass crop options for the Midwestern US. Although Miscanthus has been shown to be highly productive in its first few growing seasons, some reports have suggested yields may decline over time. Confirming yield decline in a perennial crop such as Miscanthus is challenging, because in most studies, stand-age is confounded with growing season making it impossible to determine if it is age, or the growing season conditions causing yield decline. As Miscanthus adoption and use continues to increase for fuel, fiber, and bioproducts, it is critical to determine stand longevity, as well as whether yield declines may be overcome through management e.g., additional nitrogen fertilizer.

To address this challenge, the biomass team at Iowa State University established the Long-Term Assessment of Miscanthus Productivity and Sustainability (LAMPS) project. This project aims to answer the questions that industry and producers are asking regarding best management practices for Miscanthus.

Materials and Methods

Statistical design. The statistical design of LAMPS is a randomized block design with a split-plot. The whole-plot treatment is planting year, and the sub-plot treatment is N application rate. Whole-plots are 24 m × 61 m and each sub-plot is 12 m × 24 m. Nitrogen application rates (0, 112, 224, 336 and 448 kg ha-1) are repeated once per planting-year and block combination. LAMPS is a chronosequence study with each planting year (2015, 2016, and 2017) repeated four times.

Field sites. The LAMPS project is replicated across three research farms: Allee Demonstration Farm in northwest Iowa, Sorenson farm in central Iowa, and the Southeast Research and Demonstration Farm in southeast Iowa.

Land preparation and herbicide program. Miscanthus was planted each spring following conventional tillage appropriate to each farm. Harness®, Harness® XTRA, or Prowl® pre-emerge herbicides were applied as close to planting as possible. Approximately one month later, a second application of pre-emerge herbicide, with a differing mode of action than the planting application, was made. If necessary, a broadleaf herbicide labeled for corn (2,4-D or Laudis®) was tank mixed with this pre-emerge application. Additional applications of broadleaf herbicides were made as necessary to ensure a weed-free establishment during the first two growing seasons. All herbicide applications were made at the rate suggested for corn growing on the soil type found at each respective location. No herbicide was required in the third growing season or beyond.

N application. A liquid solution of urea ammonium nitrate (UAN - 28% or 32% depending on the farm) was applied prior to planting using a side-dressing applicator (Figure 1) or was applied over the top using spray equipment. Nitrogen was applied at the appropriate rate each spring prior to or as close to emergence as possible.

Plant material and planting. 'Freedom®' Miscanthus rhizomes were sourced from AGgrow Tech, LLC, and a proprietary rhizome planter (Figure 2) was used to plant each site.

Data collection. Yield has been continuously measured at all locations since the commencement of LAMPS. Yield is measured by hand-harvesting 1-2 m^2 of Miscanthus from each plot. Material was cut at a height of 6 in. using a hedge trimmer. Biomass was weighed in the field, then dried to determine a bone-dry yield.

Preliminary Results and Discussion

Yields. Averaged over all sites, there was a significant effect of nitrogen fertilizer ($p < 0.05$), however, there also was a significant interaction between N rate and Site ($p < 0.05$). The overall N rate effect was driven by one site: Sorenson (Figure 3).

As in previous years, Miscanthus grown at Sorenson showed a significant yield and striking morphological response to nitrogen fertilizer (Figures 4, 5).

Planting year also was a significant factor ($p < 0.05$). Averaged over sites and N rate, yields were 24.7, 25.5, and 29.9 Mg ha-1 for 2015, 2016 and 2017 planted Miscanthus, respectively (7th, 6th, and 5th growing season, respectively). Although the youngest stand had the highest yield, it is unclear whether yields are declining in the LAMPS Miscanthus, as all yields in general were higher than previous years (Figure 4).

Based on results from the past seven years, Miscanthus yield response to N rate and aging has been inconsistent. When there has been a response to nitrogen, it has occurred at the lowest N rate, and Miscanthus did not benefit from additional nitrogen. Currently, the recommendation is to annually apply between 50-100 kg ha-1 of nitrogen fertilizer. Researchers will continue to monitor stand longevity at LAMPS.

Figure 1. Side-dresser used for applying liquid UAN to Miscanthus plots prior to planting.

Figure 2. Proprietary Miscanthus rhizome planter.

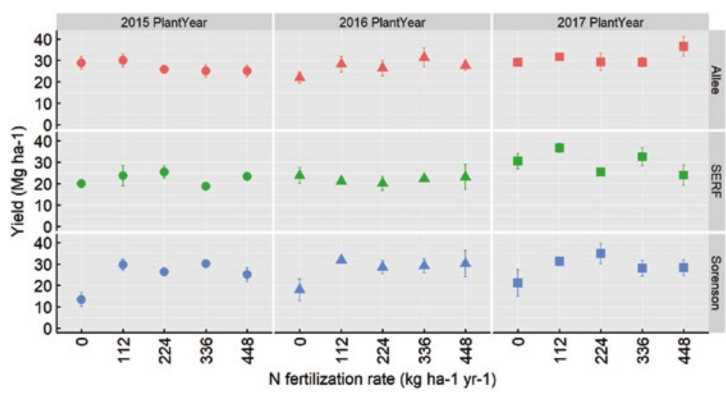

Figure 3. 2021 LAMPS Miscanthus yields.

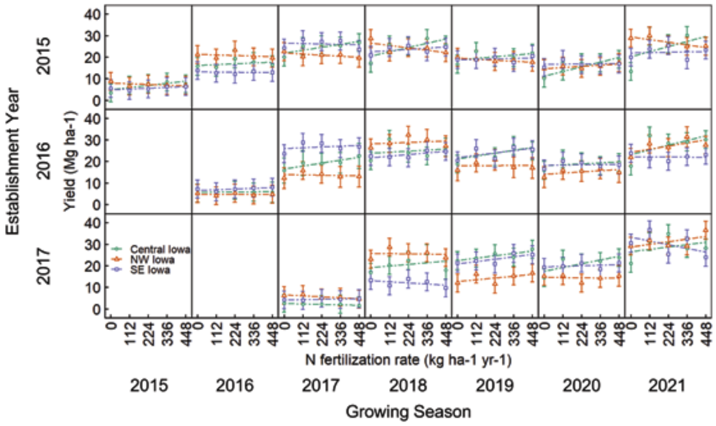

Figure 4. LAMPS Yields 2015-2021.

Figure 5. Miscanthus morphological response to N fertilizer at the Sorenson research farm. N rates pictured left to right: 224, 0, 448 kg N ha-1.

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