Performance of Switchgrass 'Alamo' Population and Selections for Sustainable Production on Marginal Soils under Low-Input Management

Malay Saha[1] (mcsaha@noble.org), Josh Barbour[1], Melissa McMahon[1], Yuan Wang[1], Na Ding[1], Erin Nuccio[2], Colin Bates[3], Lauren Hale[3], **Jennifer Pett-Ridge[2], Kelly Craven[1], Wolf Scheible[1], Michael Udvardi[1], Jizhong Zhou[3], Mary Firestone[4*]**

[1]Noble Research Institute, Ardmore, Oklahoma; [2]California Lawrence Livermore National Laboratory, Livermore, California; [3]University of Oklahoma, Norman, Oklahoma; [4]University of California, Berkeley, California.

Project Goals: Switchgrass (SG; *Panicum virgatum* L.) is a perennial C_4 grass native to the tallgrass prairies and a most promising feedstock in the U.S. for bioenergy production. Capable of abundant biomass yield with minimal fertilizer or water, SG can survive on marginal soils, and even thrive once established. We hypothesize that successful establishment and sustainable cultivation of SG in marginal soils is in part enabled by beneficial plant-microbial interactions. We are investigating the succession of rhizosphere microbial communities, and ecosystem-scale effects of high- and low-performing SG plants grown in nutrient-limited soils in southern Oklahoma. The outcome of this research will provide a better genomic basis for SG cultivation in marginal soils, expand our knowledge of the interactions between soil microbiomes, plants and ecosystems, and ultimately guide efforts for translation into agronomic row crops.

To study plant-soil microbiome characteristics of switchgrass growing in 'marginal' nutrient or water-limited soils, we established field plots at two research farms, both remnants of the Dust Bowl Era in Oklahoma. Seeds of the 'Alamo' switchgrass cultivar were germinated in petri dishes and seedlings were transferred into 25-cm tall cones. 500 randomly selected 58-day old seedlings were then transplanted into a well-prepared field plot at the Red River farm of the Noble Research Institute (NRI) on May 13, 2016. Plants were arranged in a Honey-comb design with 1 m spacing between plants. Another 500 seedlings were planted into the NRI 3rd Street farm on June 23, 2016 following the same protocol. No chemical fertilizer or pesticides were applied in either location, and only hand weeding was used to keep the plots weed free. Data on different morphological characteristics were collected throughout 2016, 2017 and 2018. Biomass was harvested after senescence each year.

Spring green-up started as early as Feb. 17 and continued up to March 3, 2017, which is quite early compared to other years. In 2018, plants start regrowing between March 7 and April 3. All the plants flowered between June 28 and July 23, 2017. In 2018, flowering started a week early (June 21) but continued until July 29. Plants started regrowing and flowered almost at the same time in the two locations. Continuous height increment was observed throughout the growing season. Wide variation was observed among the plants for plant height. In 2016, the plants were as short as 45 cm, but grew up to 182 cm. A significant increase in plant height was observed in the second year of growth (2017). The height of the plants ranged between 48-301 cm with an average of 244 cm. Average plant height in 2018 was 249 cm. While plants were taller at the Red River than the 3rd Street farm in the first two years, plants were 12 cm shorter in the Red River farm compare to those in 3rd Street farm in 2018. Significant variation was observed for biomass production among the Alamo genotypes at both the locations. In 2016, the establishment year, biomass weight of the plants varied from 0.03-1.08 kg $plant^{-1}$ with an average of 0.46 kg $plant^{-1}$. However, in 2017, plant

biomass yield varied from 0.18-4.07 kg plant^{-1} with an average of 1.42 kg plant^{-1}. Compared to the establishment year (2016), a threefold increase in biomass yield was recorded in the following year. It has not yet been possible to harvest the plants after the 2018 growing season due to excessive wet conditions.

On the basis of biomass yield in 2016, high (n = 12) and low (n = 8) performing genotypes were selected from both locations. Clonal ramets from each selected high- and low-performing genotype were prepared at the NRI greenhouse. Four replicates of each of the 40 genotypes were established in field experiments at both the 3rd Street and Red River locations in May, 2017 following the same experimental design. Morphological characteristics of the selections were collected throughout the 2017 and 2018 growing seasons. Average plant height of high- and low-selections were 179 vs. 161 cm in June 27, 192 vs. 174 cm in July 27, and 217 vs. 205 cm in October 17, 2018. Some of the low-performing genotypes selected on the basis of establishment year performance did not continue to be low performing in the replicated trial. Biomass was harvested after a killing frost in December, 2017. Biomass yield of low selections varied between 0.21-0.76 kg plant^{-1}, whereas those of high selections varied between 0.38 to 1.12 kg plant^{-1}.

Biomass yield from the establishment year was used to identify high- and low-performing genotypes at both locations. To measure total belowground biomass, three high and three low performing individuals from Red River and two from each group at 3rd Street were excavated to ~1.5 meter depth. Physio-morphological characteristics were measured from each plant. Significant variations between high- and low-performing genotypes for root, shoot, and crown weight were observed across locations. Better shoot and crown growth were recorded in 3rd Street but root growth was higher in the Red River site. Variation for morphological traits between the high and low biomass genotypes was much more pronounced in 3rd Street genotypes compared to those from the Red River farm.

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