2019 LTER Standard Sampling Report

Main Cropping System Experiment (MCSE)

Soil

Soil was regularly sampled on the LTER to a depth of 25 cm at each of 5 stations in all replicates (R) of all treatments (T) 1-8, CF, DF, and SF. Samples were taken once or twice each month, for a total of thirteen times between March 27 and November 18. Soil was sampled using a ¾" diameter push corer. Two cores were taken from each station with all 10 cores composited for each plot. However, on July 29, the soil was too dry to use a push corer in T1-8. A bucket auger, with 2¾" diameter, was used instead and fewer cores were taken per plot. In addition, T3 and T4 individual station and prairie strip soil was sampled three times in 2019 (May, July, September). Inorganic nitrogen extractions and soil moisture determinations were done on subsamples from all soil sampled. Analysis of the extracts for nitrate and ammonium will be completed by Cathy McMinn during winter 2019-2020.

The April 9 soil samples were air-dried and archived. A subsample from each of the July 29 samples (including the T3, T4 prairie strip soil) was incubated in the field for 21 days and then inorganic nitrogen extracted to evaluate mineralization potential.

A post-harvest extensive grid soil sampling was done in all replicates of T1-6 and T8NT on October 23. This soil was air-dried and sent to the MSU Soil and Plant Nutrient Lab for standard analysis which includes pH, lime requirement, P, K, Ca, and Mg. Additional samples were included in the fall soil lab analysis this year. Soil from the routine sampling on October 16 in T7, 8, CF, DF and SF was air-dried and sent to the soil lab. Also, see MCSE Microplot and Nitrogen Deposition Study below.

Deep soil cores were sampled twice on the MCSE in 2019 using a Geoprobe 540MT pulled behind a Gator. In T3 and T4 cores were taken prior to prairie strip establishment (see MCSE Microplot section) and in T6 prior to planting of switchgrass. Three four foot deep soil cores were taken from each T3 and T4 main plot and paired with three samples taken from the prairie strips between April 26 and May 14. A total of 72 cores were sampled. Between June 12 and 18, ten four foot deep soil cores were taken from each T6 plot, two near each station, for a total of 60. All cores were (or will be, some from T6 are still refrigerated for processing) sectioned (0-10, 10-25, 25-50 and 50-122cm) and length, mass and moisture measurements taken for bulk density calculations. The soil was/will be air-dried and archived for later analysis and comparison with future cores.

Gas

Gas was sampled throughout the LTER using round static chambers between April 11 and November 6. MCSE plots that were sampled include T1-7 R1-4, as well as the fertilized, untilled microplots in T7 R1-4 and prairie strips in T3, T4 (see MCSE Microplot section). Static chambers were also sampled in T8 R1-4 and all replicates of successional and forested sites, CF, DF, and SF. Sampling in the forest sites included the Nitrogen Deposition Study microplots. With a sample frequency of once or twice each month, gas samples were taken eleven times during the 2019 field season. The MCSE (including T8) was sampled in the morning and forest sites sampled in the afternoon of the same day. Winter sampling began on December 19 and should continue monthly

through March 2020. This sampling includes only T1-7 and DF. All of these chamber samples were put into Labco exetainers and transported back to the lab for analysis. They were analyzed for nitrous oxide, carbon dioxide and methane by Kevin Kahmark and Cathy McMinn using the Agilent/Gerstel automated GC in Academic 330.

Soil temperature and soil samples to determine moisture content were taken near each chamber when gas was sampled during the field season. Air temperature was logged both inside and outside, while light was measured outside, of some chambers using HOBO dataloggers.

Sampling began this year on the MCSE static chambers with the Mobile Integrated Cavity Offset Spectroscopy (MICOS) system. The MICOS was used to sample MCSE chambers four times in 2019, once in early summer and then monthly in August, September and October. This sampling was paired with the hand sampling into exetainers detailed above and the data from each will be compared.

Water

Soil water samplers, or lysimeters, were used to collect water from the soil at about a 1m depth in T1-7 R2-4 and all replicates of CF, DF, and SF. Samplers were evacuated and leachate collected once or twice a month. Twelve collections were made between March 19 and November 26. The volume of leachate collected was recorded. When 20mL or more of leachate was collected, the sample was filtered and frozen for analysis and archive. Analysis for nitrate and ammonium of all leachate samples taken should be completed by Cathy McMinn during winter 2019-2020.

In the spring of 2019, archived water samples collected from LTER T1 and T2 prior to 2007 were subsampled and analyzed for total dissolved phosphorus (TDP). This project yielded more than 150 points of data. Subsampling and analysis was completed by Dave Weed, Hamilton lab.

Plants

Plant biomass samples were taken from plots prior to tillage, harvest, weed-control measures and at peak biomass. Plant species separations were completed for most but not all samplings. On April 23, re-sprouted poplar biomass from 2018 was measured in all T5 plots. Plants were sampled ahead of herbicide applications in T5 and T6 on June 6 and 7. Herbicide applications were made to prepare plots for planting of poplars and switchgrass, respectively. Poplar trees were planted in T5 June 24-26. Switchgrass was planted in T6 on June 28. Wheat was sampled ahead of harvest in T1-4 on July 15-22. Plant samples were taken before mowing to control weeds in the prairie strips in T3 and T4 (see MCSE Microplot section) on July 22-23 and September 12, in T6 on August 16-20 and in the main part of T4 August 29-30. At peak biomass, early August through late-September, plant samples were taken from T5, T7, T8, and SF. Leaf litter was collected in traps on the ground in CF, DF, and SF between September 10 and December 20. Poplar leaf litter was collected in ground traps September 26-December 10. Leaf litter traps were checked and leaves collected bi-weekly. In addition in T5, since the trees were very small and ground traps may not have collected representative samples, leaf litter was collected directly from the ground on December 6 to compare to trap biomass. T5 poplar tree damage from caterpillars, deer and other was assessed on October 10 and 11. On November 26 and 27, post-frost biomass samples were taken from T7 plots. All plant material from all samplings was dried at 60ºC for at least 48 hours. All dried biomass will be

weighed, ground and archived. Subsamples will be analyzed for carbon and nitrogen by Stacey VanderWulp.

In all replicates of CF and DF, all trees with a dbh (diameter at breast height) greater than or equal to 5cm are marked with a unique numbered tag. The dbh of all tagged trees was measured in January and February 2019. The diameter of ten randomly chosen poplar trees in each T5 plot were measured at 15cm above the ground on November 21.

All replicates of T7 were burned on March 26 to help control woody growth.

Yield data was collected from all of the mechanically harvested plots.

Drone flights were only completed over portions of the MCSE, as requested researchers. Drone flying was done by Kevin Kahmark.

Insects

The Landis lab continued to monitor generalist insect predators for spatial and temporal dynamics following the updated version of the Insect Abundance protocol. Coordination of that research was handled by Elizabeth D'Auria. Monitoring was conducted by attaching one yellow sticky card (Great Lakes IPM, IPM-CRW-100) to a T-post about 1.2m above the ground at each of the five stations within each replicate of T1-T7 and the nine forest plots. T-posts and sticky cards were installed on May 16 and weekly sampling started on May 23. Sampling concluded on August 29. The target taxa consisted of 14 common to rare ladybug species (Order: Coleoptera, Family: Coccinellidae); soldier beetles (Cantharidae); fireflies (Lampyridae); scorpionflies (Order: Mecoptera); and other non-target generalist predators (e.g. 20 spotted ladybug). New in 2019, was the addition of insect sampling (same taxa as above) within the prairie strips in T3 and T4. A T-post and sticky card was installed at the center of the prairie strip in three locations in all replicates of these two treatments. Weekly sampling began on July 9 and concluded on August 29.

A 22 foot tall aphid suction tower onsite is part of a network of towers used to monitor regional aphid migration patterns in the Midwest. The fan on the tower was turned on and the first collection cup deployed on May 10. The collection cups were collected and replaced every Friday through October 18 at which time the tower was turned off. The samples were mailed to the University of Illinois at Urbana-Champaign for analysis.

MCSE Microplot Experiments

Herbicide-free Microplots (T1 R1-6, T2 R1-6): On October 28 soil samples were taken from each microplot, air-dried, and sent to the MSU Soil and Plant Nutrient Lab for standard analysis.

OLD Rainfall Manipulation Experiment (T1 R1-4, T2 R1-4): Shelters were not installed in 2019 and no samples were taken. This experiment was maintained from 2014-2018.

NEW Rainfall Manipulation Experiment (T1 R1-4, T2 R1, 3, 4 and 6, T7 R1-6): Shelters will be installed in this experiment in summer 2020 near the south end of the plots. The footprints for that installation were determined in September and October 2019. Phoebe Zarnetske's work will occupy two of the seven footprints in each T7 plot. Preliminary sampling of plants and soil in all T7

footprints was completed in fall 2019. On October 14 and 15, plant samples were clipped from the center of each core LTER footprint and sorted to functional group plus a few easily identified species in the field lab. The Zarnetske footprints were divided into quadrants and sampled similarly the following week. Soil was sampled on November 20 in all T7 footprints. Samples were taken to 10cm depth, 2cm diameter from the center of each core LTER footprint and 1cm diameter from three corners in each Zarnetske footprint. Soils were archived at -80F for future work. Open top chambers (passive warming) were installed in the Zarnetske footprints on December 12.

Prairie strips (T3 R1-6, T4 R1-6): On April 25, 2019 a twenty two species prairie mix was planted in a 15 foot strip down the center of each T3 and T4 plot. Pre-establishment deep soil cores were sampled here in April and May and surface soil sampled three times through the 2019 season (see MCSE soil section). Non-destructive species composition data was collected by the Haddad lab in July. Also in July, three plant samples were collected from each strip. One sample from each strip was sorted to species. On October 28 soil samples were taken from each prairie strip, air-dried, and sent to the MSU Soil and Plant Nutrient Lab for standard analysis.

Poplar Fertilization Gradient (T5 R1-6): No sampling was done in 2019. These microplots were stopped with the harvest of poplars in 2018.

Brome grass (T6 R1-6): When the main T6 plots were planted to switchgrass in June 2019, a 50 foot wide by 30 foot long area in the northwest corner of each plot was left unplanted. Brome grass will be planted there in 2020. In the meantime, a rye cover crop was planted there in November 2019. On October 28 soil samples were taken from each microplot, air-dried, and sent to the MSU Soil and Plant Nutrient Lab for standard analysis. No other sampling was here done in 2019.

Disturbance/Fertilization Microplots (T7 R1-6): Started in 1989, these microplots are in the northwest corner of each T7 plot. There are four microplots in each plot; each microplot measures 5x5m. They combine disturbance/tillage and nitrogen fertilization in a full factorial design. Greenhouse gases were sampled eleven times in the untilled, fertilized microplots of T7 R1-4, as detailed in MCSE Gas section above. Soil was sampled on November 4 from all T7 microplots. The soil was air-dried and sent to the MSU Soil and Plant Nutrient Lab for standard analysis.

Fertilizing and plant sampling was led by the lab of Jen Lau. The fertilized microplots received urea the week of June 16. The T7 microplot plant biomass was sampled near its peak on September 11 for untilled and September 16 for tilled. All samples were dried and weighed. Species were not separated. Discussions with Jen Lau about the uncertain future of continuing the tilled microplots, lead to the decision to harvest fruits from Giant Foxtail (*Setaria faberi*) in October. Fruits were harvested twice during the month to capture full fruit maturation. Harvest was from at least 30 individual plants per microplot. These seeds will be used by Jen Lau in the future to investigate plant traits, adaptation, and response to continued nitrogen fertilization.

Nitrogen Deposition Study

Nitrogen is applied to subplots at each of the three replicated sites of CF, DF, and SF. Fertilizer solutions were applied to the 1F, 3F and 10F subplots in this study on three dates. Urea (46% N) was applied on April 2, July 10 and October 17-18. Rates of fertilization are 1gN/m^2/year for the 1F subplots, 3gN/m^2/year for the 3F subplots, and 10gN/m^2/year for the 10F subplots. Gas was sampled

on a routine basis in this study; see the Gas section under MCSE. Soil samples were taken from each of these areas on October 15. The soil was air-dried and a subsample sent to the MSU Soil and Plant Nutrient Lab for standard analysis.

Resource Gradient Experiment

From April through October 2019, 125 water leachate samples were collected from the LTER Resource Gradient soil water samplers. These samples were analyzed for anions, cations, non-purgeable organic carbon (NPOC), total dissolved nitrogen (TDN), alkalinity, and NH4-N (via IC). Silicate and total dissolved phosphorus (TDP) will also be analyzed on these samples. Dave Weed was responsible for sampling and analysis.

Soil samples were taken on November 4. Four cores (0-25cm) were pooled from each plot, two in the crop row and two between rows. The soil was air-dried and sent to the MSU Soil and Plant Nutrient Lab for standard analysis.

The LTER Resource Gradient experiment automated trace gas system was dormant in 2018.

Yield data was collected when plots were harvested mechanically.

Interaction Experiment

Rainout shelters were installed in all four no-tillage, no-fertilizer plots to manipulate soil wetting/drying regimes to examine the relationship between ANF and switchgrass phenology, diazotroph communities and nitrogenase iron protein (nifH) expression. This work is led by Sarah Roley and Carmella Vizza.

Yield data was collected from all plots when harvested mechanically. A subsample of the harvested biomass was dried and will be ground and analyzed for carbon and nitrogen by Stacey VanderWulp.

Biodiversity Study

Yield data was collected from all of the annual crop treatments when harvested mechanically.

Cellulosic Biofuel Experiment

Yield data was collected from all of the treatments when harvested mechanically.

Written by Stacey VanderWulp (with contributions from Elizabeth D'Auria, Mark Hammond, Kevin Kahmark and Dave Weed)

Archived Material

Experiment	sample type	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
LTER MCSE	leachate											
LTER MCSE	plants											
LTER MCSE	T7 microplot plants											
LTER MCSE	surface soil											
LTER MCSE	T7 microplot surface soil											

Experiment	sample type	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
LTER MCSE	leachate											
LTER MCSE	plants											
LTER MCSE	T7 microplot plants											
LTER MCSE	surface soil											
LTER MCSE	T7 microplot surface soil											
LTER MCSE	deep core soil											
LTER Biodiversity Study	surface soil											
LTER Resource Gradient	surface soil											

Experiment	sample type	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LTER MCSE	leachate										
LTER MCSE	plants										
LTER MCSE	T7 microplot plants										
LTER MCSE	surface soil										
LTER MCSE	T7 microplot surface soil										
LTER MCSE	deep core soil										
LTER Biodiversity Study	surface soil										
LTER Resource Gradient	surface soil										

Agronomic Soil Analysis

Experiment	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
LTER MCSE												
LTER Resource Gradient												
GLBRC BCSE main												G1-3
GLBRC BCSE micro												G1-3
GLBRC BCSE deep core												
GLBRC Scale-up												L1, M1
GLBRC MLE												
GLBRC Switchgrass Gradient												