Phenology and Productivity of Pearl Millet in the Wisconsin Central Sands

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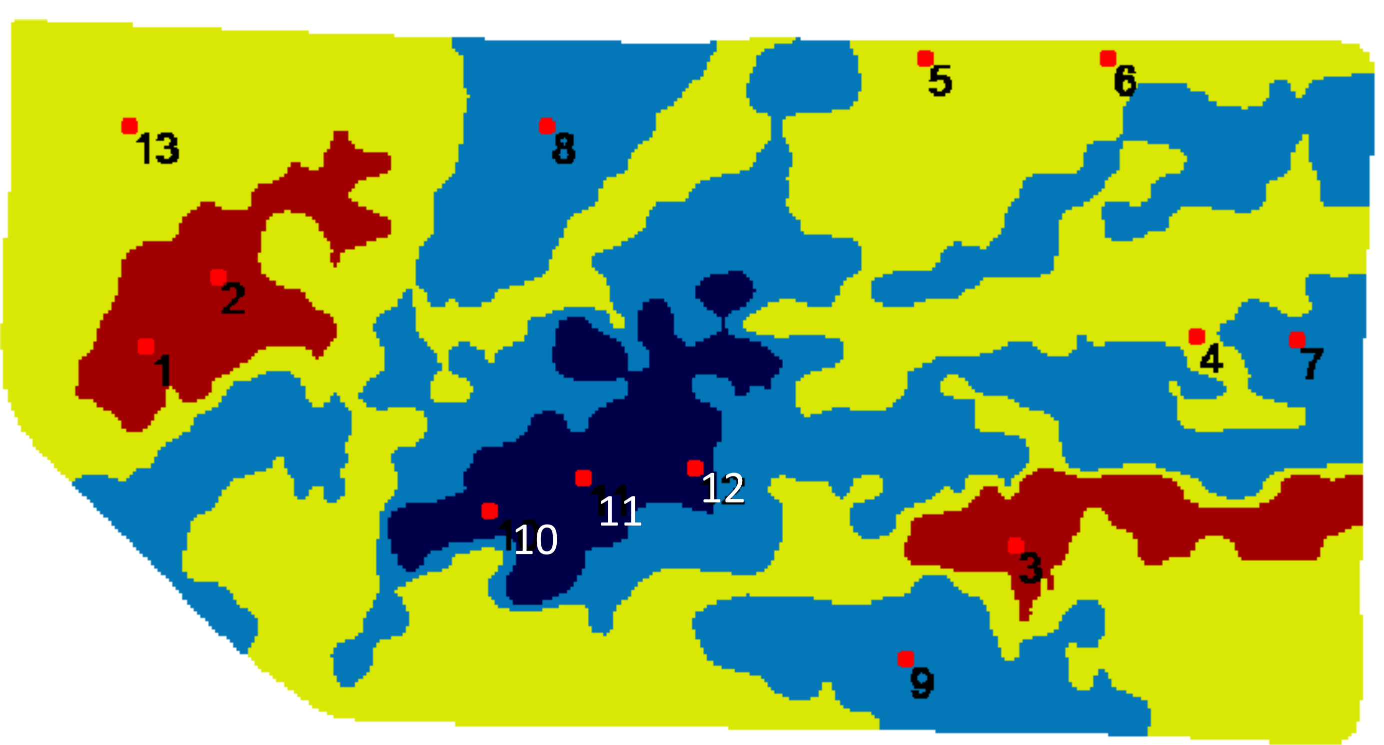
Introduction

- Wisconsin is a top producer of canning vegetables and potatoes, many of them grown in the Wisconsin Central Sands (CS), a region dominated by well-drained sandy soils that require extensive irrigation (Kraft et al 2012).
- Cover crops are often utilized during the shoulder seasons for erosion control in the CS, but can also help increase soil organic carbon, improve soil structure, add nutrients to the soil, and increase soil water holding capacity.
- Though not commonly grown in the CS, Pearl Millet (PM) is of particular interest because of its drought resistance, high productivity, and potential ability to repress a common root-lesion nematode (*Pratylenchus penetrans*) found in potato and therefore reduce fumigation needs (Ball-Coelho et al. 2003).
- Relatively little is known about PM's ecological and biophysical properties in the CS. We have collected data on phenology, photosynthesis, and productivity in PM in order to determine how pearl millet provides for environmental and ecological needs of the region.
- We also hope to determine whether differences in soil texture impact productivity and water use in PM using data from EC maps and soil particle size analysis.



Soil electrical conductivity mapping was performed to a depth of 0-1 m in Spring 2015 when the soil was approximately field capacity (Precision 2012). Zones were created based on both EC and elevation, 13 management zones were created over the field.

Methods

- Study was performed on a 28 ha commercial vegetable production field in Plover, WI
- Thirteen zones were created within the field based on soil electrical conductivity and topography, using the same methods suggested for precision irrigation applications (Corwin and Lesch, 2005; Farahani et al. 2005)
- Measured leaf area index in each zone using a LI-COR 2200 Plant Canopy Analyzer (Lincoln, NE)
- Assessed leaf photosynthetic response to light, temperature, and vapor pressure deficit using a LI-COR 6400 (Lincoln, NE)
- Measured above ground net primary productivity (NPP) in each zone using above ground biomass sampling
- Measured belowground net primary productivity (NPP) in each zone using the ingrowth root core method (Vogt et al. 1998) (von Haden and Dornbush, 2014).
- Cores were installed to a depth of 40cm 3-5 days after planting and removed on 9/24 with above ground biomass samples

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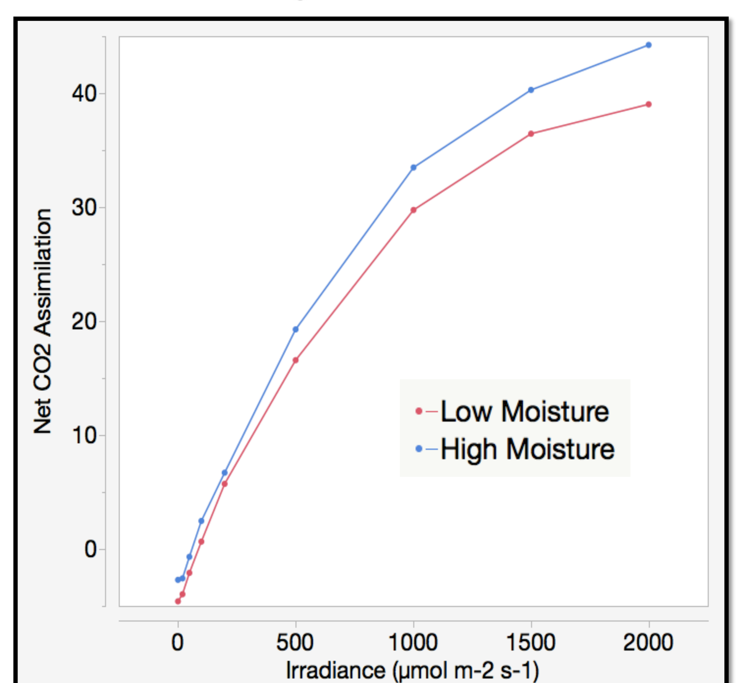
Management

- PM preceded by sweet peas in rotation
- Peas harvested 7/23/15
- PM planted using a Brillion Drill with bed packer on July 24/25
- Seeding rate was ~10lbs per acre
- Germination began 7/27
- Herbicide and fertilizer were not applied
- Crop was irrigated after planting to swell seed and establish a good stand (for approximately half of it's growing season)

Results

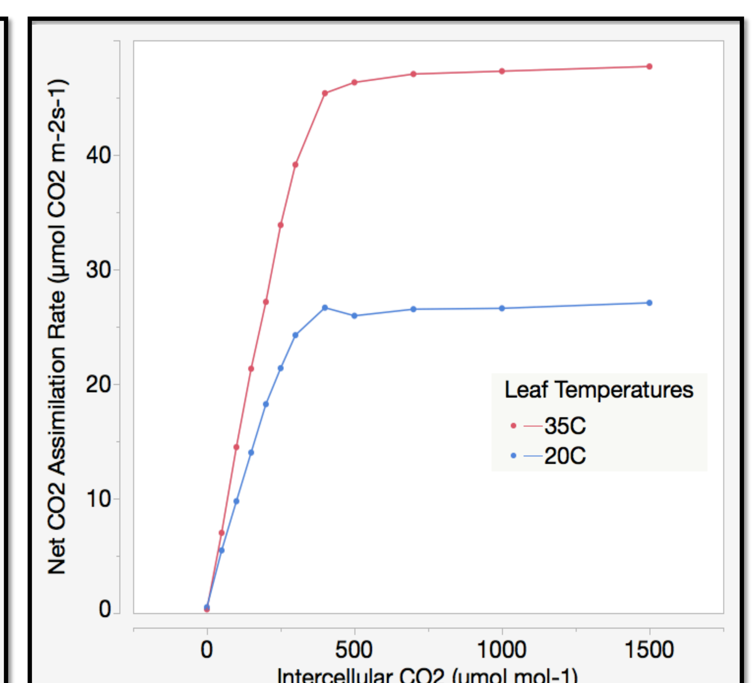
- PM is capable of generating large amounts of biomass in a relatively short time frame.
- LAI appeared to be higher in zones with high EC and low elevation.
- Higher leaf temperatures and soil moisture generally lead to higher photosynthetic rates in PM.
- Considerable variability was observed between zones in both above and below ground biomass, possibly because of nitrogen fixation by peas. Further analysis is needed to determine whether these differences are statistically significant.

Low vs. High Soil Moisture Light Curves



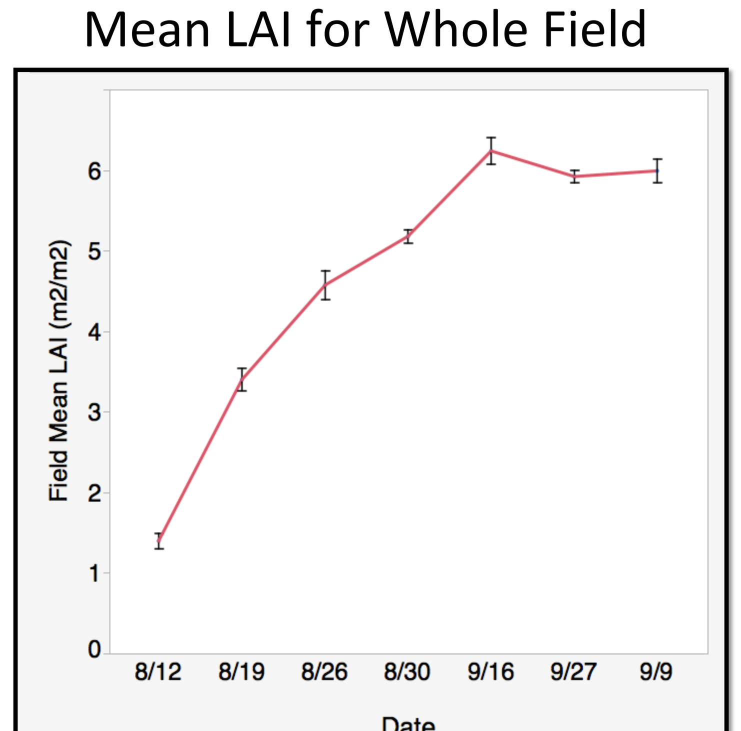
Light curves taken at 35°C with variable soil moisture levels. Soil moisture was 0.0661m^{3}m^{-3} (low) on 9/16 and 0.1406m^{3}m^{-3} (high) on 9/1.

35°C vs. 20°C Leaf Temperature A-Ci Curves



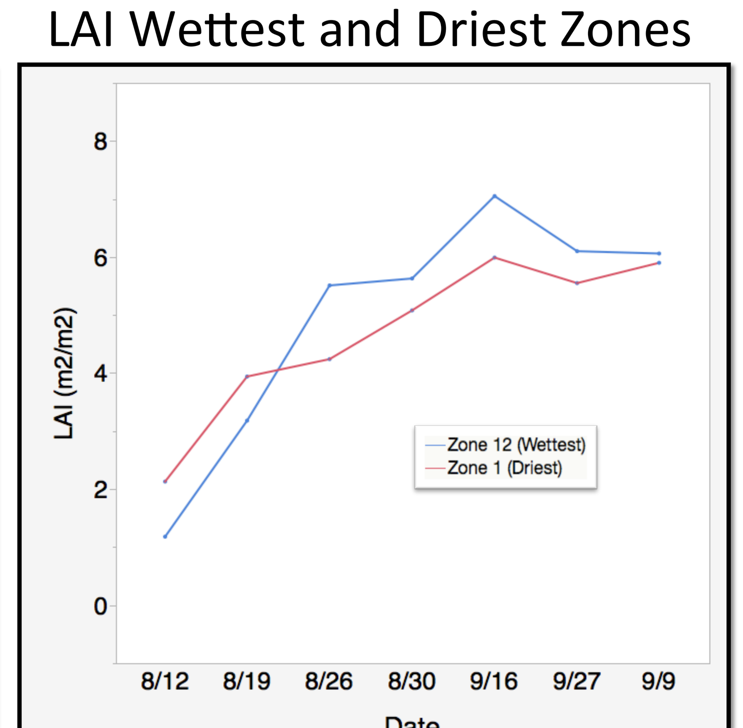
A-Ci curves at leaf temperatures of 35°C and 20°C measured on 9/1 and 9/18 at soil moisture levels of 0.1406m^{3}m^{-3} and 0.1836m^{3}m^{-3} respectively.

Mean LAI for Whole Field



LAI measurements were taken in each zone approximately every 7-10 days. The values for each zone were then averaged by date.

LAI Wettest and Driest Zones



Wet zones were generally those with high EC and low elevation. Dry zones had low EC and high elevation.

References

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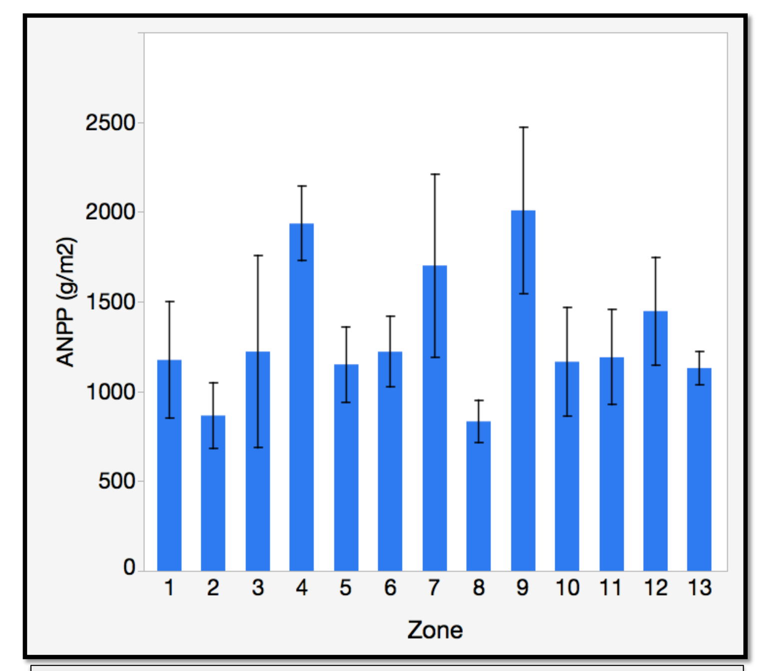
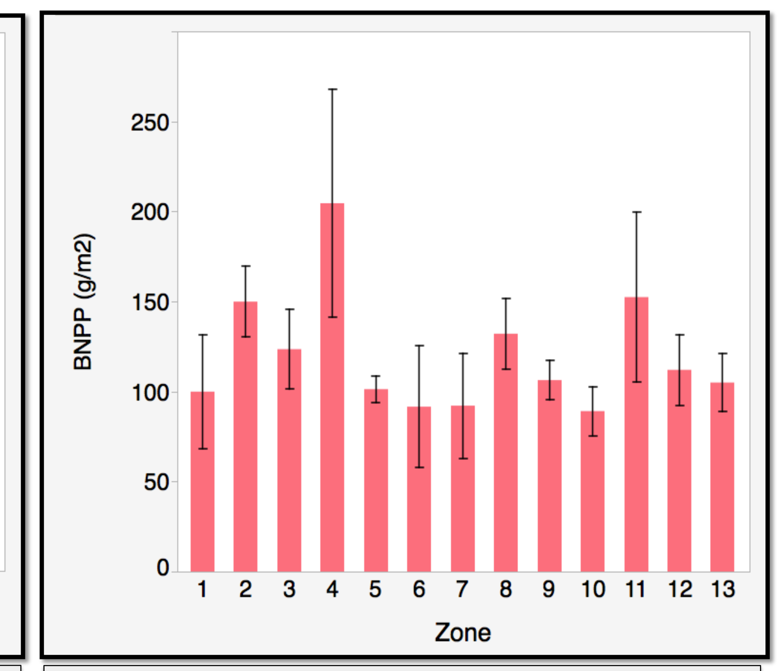
Left: Pearl millet at sunset in late September Right: Measuring photosynthesis with a LICOR 6400

Above Ground NPP by Zone



Above ground biomass was sampled in 3 locations in each zone. Samples were 0.5m x 0.5m and taken at peak biomass on 9/24.

Below Ground NPP by Zone



BNPP was measured by placing 3 cores in each zone. We assumed root mass below 40cm was equal to 14% total root mass (Gregory and Reddy 1982).

Top: 3 Cores were installed in each zone after planting and removed after approximately 8 weeks.
Bottom: After removal, cores were stored at 5°C until roots could be removed, washed, dried, and weighed.
Left: A 6ft Field assistant next to PM on day of above ground biomass sampling.

Future Directions

- Particle size analysis data from soil samples from each zone will be used to look for relationships between soil texture, productivity, and phenology.
- Data from passive capillary lysimeters and soil moisture probes will also be used to create a water budget for PM which will be compared to common crops in the region.
- Plant tissue analysis will be used to determine %C and %N.
- Overall our research is helping to fill the current data void on PM's biological and biophysical properties in the Central Sands. We will continue to investigate Pearl Millet's potential as a viable cover crop option in the Central Sands.