Seasonal Accumulation and Partitioning of Carbon- and Nitrogen-Containing Compounds in Perennial Bioenergy Crops

Jennifer Burks*, Jeffrey Volenec, Sylvie Brouder
*jlburks@purdue.edu
Purdue University, Agronomy Department, 915 W State St. West Lafayette, IN, USA

Rationale:

Little is understood about the growth constraints, potential yield, and composition of popular second-generation bioenergy crop candidates *Miscanthus* x *giganteus* and switchgrass.

Objective:

To quantify and compare seasonal dry matter production, partitioning of organic reserves among organs, and potential ethanol yields of *Miscanthus*, switchgrass , and an unmanaged prairie (control).

Methods:

We sampled plants monthly (April-Oct) and in December to measure above-and below-ground yield and accumulation/partitioning of total nonstructural carbohydrates (TNC), protein, and amino acids as components of organic reserve pools. Potential ethanol yields were calculated based on biomass fiber composition (Badger 2002).

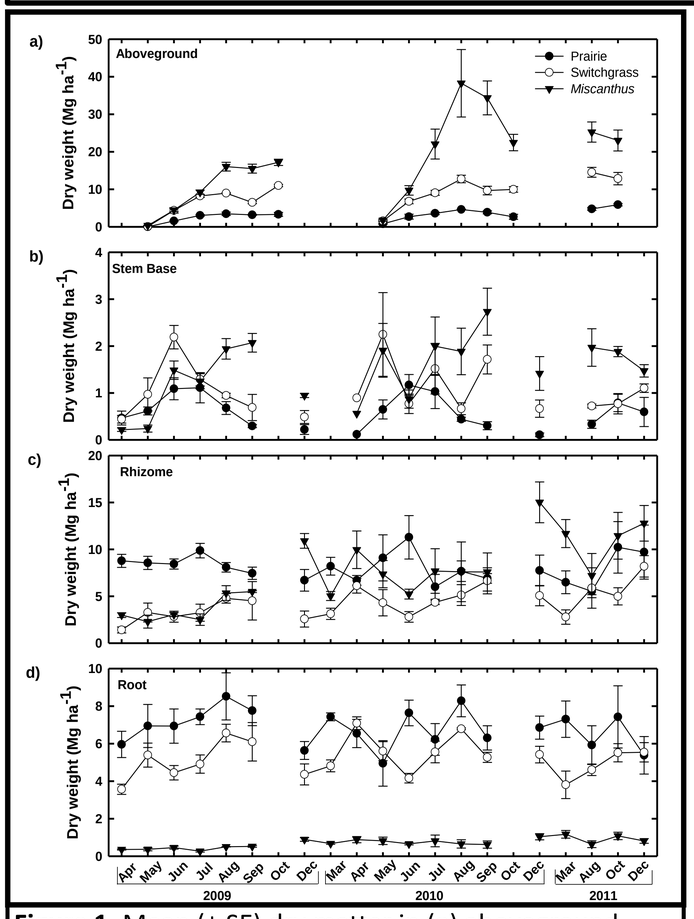

Figure 1. Mean (± SE) dry matter in (**a**) aboveground biomass, (**b**) stem base, (c) rhizome, and (**d**) root in an unmanaged prairie (control), switchgrass, and *Miscanthus*.

Acknowledgements:
-Financial Support: USDA-NIFA, NRI Managed Ecosystem Program Grant/CRIS (Contract/Grant/Agreement # 2008-35101-19152 CRIS project # IND010826G)
-US DOE "Development of Methodologies for Determining Preferred Landscape Designs for Sustainable Bioenergy Feedstock Production Systems at a Watershed Scale" (Contract # DE-EE0004396/001)
-US DOE 2009 North Central Sun Grant Competitive Grant Program on Sustainable Biomass Production Systems "Optimization of biomass productivity and environmental sustainability for cellulosic feedstocks: Land capability and life cycle analysis"
-Purdue Ecological Sciences and Engineering (ESE) Program, the Volenec Lab, and the Brouder lab

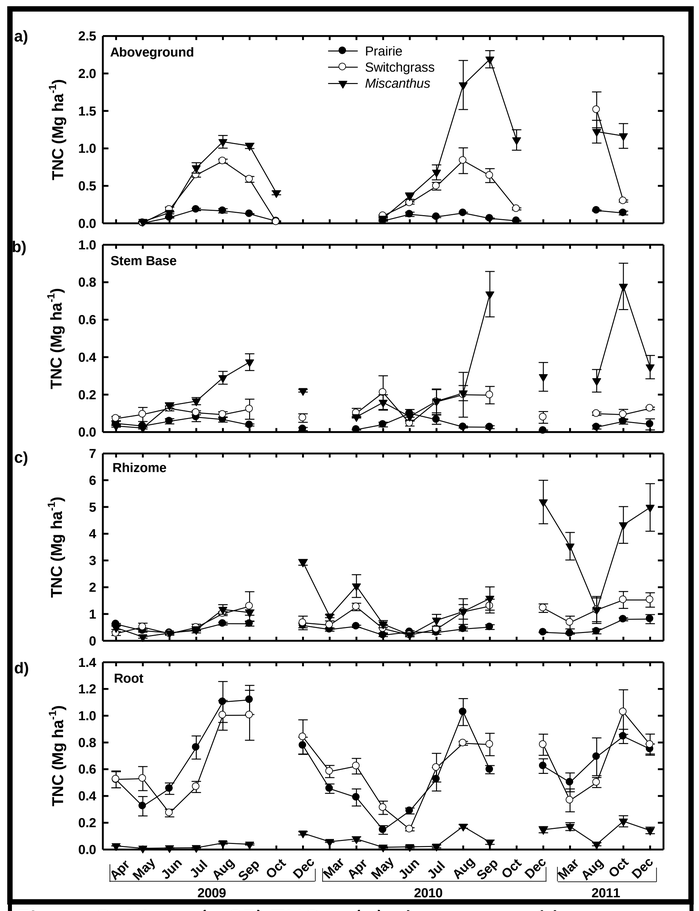

Figure 2. Mean (± SE) TNC in (**a**) aboveground biomass, (**b**) stem base, (**c**) rhizome, and (**d**) root in an unmanaged prairie (control), switchgrass, and *Miscanthus.*

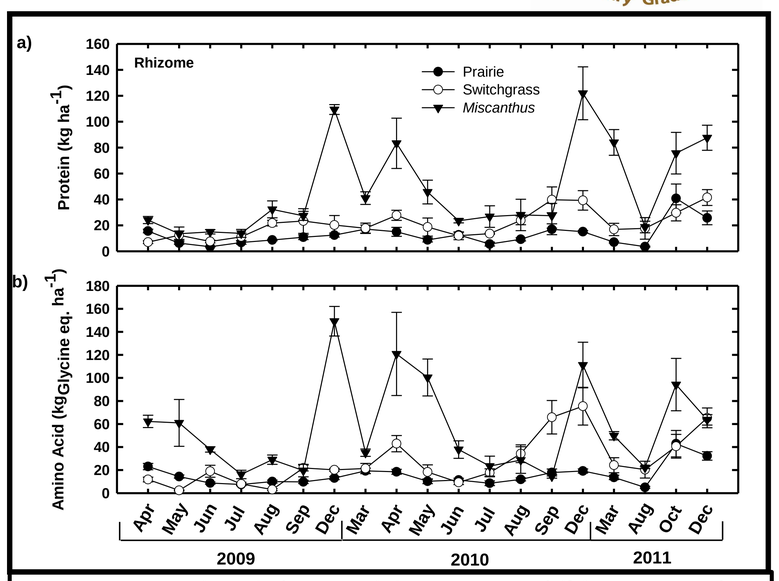

Figure 3. Mean (± SE) rhizome (**a**) protein and (**b**) amino acid content in an unmanaged prairie (control), switchgrass, and *Miscanthus*.

Table 1 Fiber composition (mean ± SE) of *Miscanthus,* switchgrass, and unmanaged prairie biomass sampled in October

	Prairie	Switchgrass	*Miscanthus*
Acid Detergent Lignin (g kg^{-1})	39 ± 3	59 ± 3	85 ± 3
Hemicellulose (g kg^{-1})	296 ± 19	305 ± 9	256 ± 10
Cellulose (g kg^{-1})	369 ± 11	341 ± 4	431 ± 4
Total Ash (g kg^{-1})	67 ± 2	56 ± 1	36 ± 2
Total Ethanol (L ha^{-1})*	1031 ± 170	2430 ± 176	5006 ± 344

*calculated using conversions from Badger (2002)

Reference:

Badger PC 2002 Ethanol from cellulose: A general review. p. 17–21. In: J. Janick and A. Whipkey (eds.), Trends in new crops and new uses. ASHS Press, Alexandria, VA.

Conclusions:

1. *Miscanthus* produced the most aboveground biomass and the least root biomass of the three species, and increased rhizome mass by 300% during establishment (Fig. 1).
2. Prairie and switchgrass stored TNC equally in roots and rhizomes while *Miscanthus* TNC storage was primarily in rhizomes. Seasonal TNC cycling was evident in both roots and rhizomes, where masses were high in December, declined during the growing season, and increased during autumn (Fig. 2).
3. Seasonal fluctuations of protein and amino acid content of *Miscanthus* rhizomes were greater than in switchgrass or prairie rhizomes. This suggests rhizomes are significant sites of N storage during winter in *Miscanthus* (Fig. 3).
4. Acid detergent lignin and cellulose were highest for *Miscanthus*, while hemicellulose and total ash were lowest in *Miscanthus* (Table 1).
5. Predicted ethanol yields were significantly higher in *Miscanthus* than switchgrass and the unmanaged prairie (Table 1).