A Novel Estimation of the Nitrogen Demand of *Miscanthus x Giganteus*

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Introduction and Objective

Estimating the nitrogen (N) demand of *Miscanthus x giganteus* (miscanthus) is important to calculate N uptake, N storage, and N losses in biomass production systems. We propose an approach to estimate the N demand of miscanthus via the N *dilution curve*.

Our objective is to estimate the parameters of this curve using a biophysical growth equation and theoretical leaf and stem N concentrations.

Definitions and Model

Critical N Concentration (N_c, kg N kg^{-1} biomass): minimum plant N concentration corresponding to maximum crop mass (Greenwood *et al*, 1990). The N_c decreases as the biomass (W, Mg ha^{-1}) increases due to the dilution of leaf mass.

Modeling N_c: the dilution curve as a function of biomass using the allometric equation:

$$N_c = aW^{-b}$$

a = N_c concentration at W = 1 Mg ha^{-1}

b = coefficient of dilution

a, and b are the constants to be determined

Biomass Partitioning Equation:

Leaf Biomass (L, kg m^{-2}): $L = \frac{W}{1+4W}$

Stem Biomass (S, kg m^{-2}): $S = W - L$

http://lovegrassfarm.blogspot.com/2011/04/miscanthus-giganteus-ornamental-grass.html

Method

- N concentration data from multiple miscanthus biomass experiments obtained from a review by Cadoux *et al* (2012).
- Maximum N concentration was bounded using the maximum N concentration for maize, a C_4 warm season annual grass for which the N dilution curve is well established.
- Minimum N concentration was bounded using the biomass partitioning equation equation with estimates of leaf and stem N concentration.
- A range of stem and leaf N concentrations were calculated based on upper and lower bounds from measured data.
- A model for N_c dilution was estimated based on so-called critical N concentration for stem and leaf N, and assuming that stem and leaf N concentrations are fixed as biomass accumulates.

Results

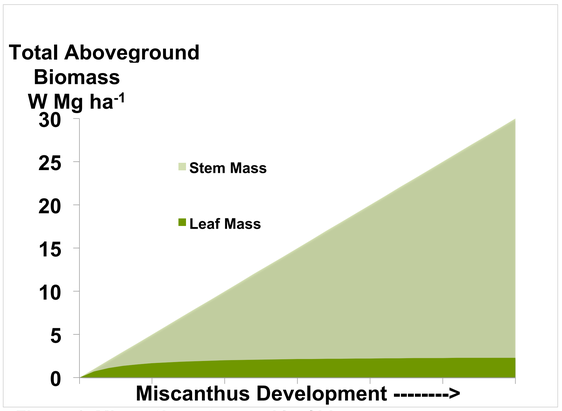

Figure 1. Miscanthus stem and leaf biomass.

Figure 1 shows the stem and leaf biomass during the vegetative development estimated for miscanthus. These values were used to estimate N dilution curves, along with fixed values of stem and leaf N concentration.

Results (cont'd)

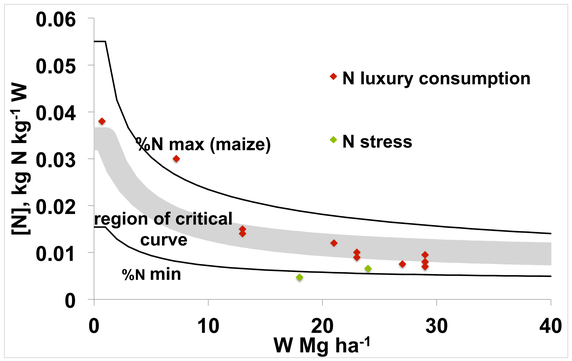

Figure 2. Upper and lower bounds of critical N dilution curve determined using maximum N dilution curve for maize (%N max) and minimum N dilution curve based on partitioning equation.

Figure 2 shows the estimated upper and lower bounds for the critical N dilution curve for miscanthus.

Table 1. N dilution-model equations

N Dilution Curves	
N maximum (N_x, kg kg^{-1})	$N_x = 0.055W^{-0.37}$
N minimum (N_n, kg kg^{-1})	$N_n = 0.015W^{-0.32}$

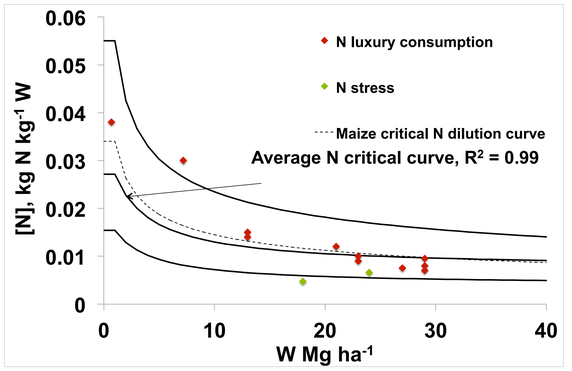

Figure 3. Proposed critical N dilution curve for miscanthus using averaged stem and leaf N concentration of 3.5% and 0.75% respectively

Figure 3 shows the estimated critical N dilution curve for miscanthus calculated using the biomass partitioning equation. It was assumed that stem and leaf N concentrations were constant during the growth of the plant. It should be noted the critical N dilution curve is lower than that of maize.

Results (cont'd)

Proposed N_c curve for miscanthus:

$$N = 0.027W^{-0.30}$$

Table 2 Range of N concentrations for plant structures used to determine critical N dilution curve

Plant Structure	Range of %N	Avg. %N
Leaf	2 - 5%	3.5%
Stem	0.4 - 1.1%	0.75%

Conclusion

The biomass partitioning equation and N dilution framework can be used to estimate N_c for W < 20 Mg ha^{-1} in miscanthus. It also offers a framework to understand the differences between miscanthus and other C_4 grasses like maize and switchgrass.

Future Work

- Proposed dilution model will be tested by sampling stem and leaf N concentrations in N limiting and non-limiting conditions for several biomass levels.
- Validated curve will enable parameterization of miscanthus crop models for N dynamics.
- Validated curve will enable better estimates of N requirements, biomass yield, N losses, and N retention.

References

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