Mathematical modeling of Miscanthus x giganteus

Introduction

* Dedicated biomass energy crops will be needed to meet the goals of the billion ton report.
* Miscanthus x giganteus is one of the most productive crops at higher latitudes (40 degrees and above).

Materials and Methods

The model used was WIMOVAC (Windows Intuitive Model of Vegetation response to Atmospheric and Climate Change) http://www.life.uiuc.edu/plantbio/wimovac/

Briefly, WIMOVAC was mechanistic sub-models for photosynthesis, transpiration, light interception and canopy microclimate, to predict carbon uptake, water use, and productivity. The model includes mechanistic sub-models for partitioning net carbon uptake among the organs of the canopy microclimate, to predict carbon uptake, water use, and productivity. The model includes mechanistic sub-models for partitioning net carbon uptake among the organs of the plant. Partitioning is governed by a table which accounts for the thermal periods devoted to phenological stages typical of grasses (i.e. Emergence, Juvenile, Induction, Post-induction, Flowering and post-Flowering).

Objective

* To parameterize a mathematical model for simulating Miscanthus x giganteus.
* To validate model simulations with independent data sets.

Fig. 1 Schematic representation of M. x giganteus growth for the first three growing seasons.

Fig. 2 Validation of carbon dioxide assimilation for four diurnal measurements in Thailand. The model is based on Collatz et al. (1992) and the data is from Beale, Bint and Long (1996).

Fig. 3 Validation of WIMOVAC with independent data from experiments conducted in research stations. Each panel is a country/year combination. (A) Observed and simulated dry biomass (Mg ha-1). Prediction is very good (R2 = 0.92) for all countries. Phenology in Italy was not predicted as well as other countries possibly due to water stress effects on delayed development at this location. (B) Observed and simulated leaf area index (LAI). The model tends to overpredict as it does not account for agronomic limitations (e.g. water stress, poor nutrient supply, weed control or less than optimal management).

References

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* Cellulosic ethanol is one of the most exciting and challenging technologies needed to supply enough fuel to meet the nations’ needs and Miscanthus x giganteus can play an important role in feedstock supply.

* To parameterize a mathematical model for simulating Miscanthus x giganteus.
* To validate model simulations with independent data sets.

* Several improvements to the model are being currently develop. Parameter estimation methods and global optimization are being developed. Additionally, the model will be used to predict dry biomass production in Illinois and the Midwest at the regional scale.

* Miscanthus x giganteus can play an important role in feedstock supply.

* To parameterize a mathematical model for simulating Miscanthus x giganteus.
* To validate model simulations with independent data sets.

* Miscanthus x giganteus can play an important role in feedstock supply.

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