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Assessing Carbon Allocation of Maize Canopy with Leaf Mass per Area Profile

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Introduction

Crop yield estimation depends on carbon allocation between plant organs. A large fraction of carbon is allocated to the leaves during the vegetative stage to support later reproductive stage. Yet, many crop models do not describe allocation at the individual leaf level, losing potential interaction with other physiological processes.

The purpose of this study is to collect **individual leaf area and biomass** as a proxy for leaf-level carbon allocation and test **common assumptions** made in crop models.

Common assumptions (H_0)

1. Specific leaf area (**SLA**) or its reciprocal leaf mass per area (**LMA**) is maintained constant regardless of leaf **age** and **rank**.

2. Sink strength corresponds to leaf area development, so allocation **finishes** when the leaf is **fully expanded**.

3. Source-sink **distance** is negligible, so the effect of external sink change (*i.e.* ear development) is **identical** to all leaves.

Methods and Materials

- Dataset from field experiment in Maryland (2005)
- Originally randomized complete block design (3 blocks x 2 subplots)

- **Cultivar**: Pioneer hybrid 34N43

- Assuming **non-limiting** condition
- **Nitrogen**: twice (pre-planting, V12)
- **Water**: rain-fed with additional irrigation
- **Row spacing**: 0.76 m (6.05 plant m^{-2})

- **Planting**: 05/15
- **Sampling**: 06/22 (V6), 07/06 (V12), 07/27 (R1)

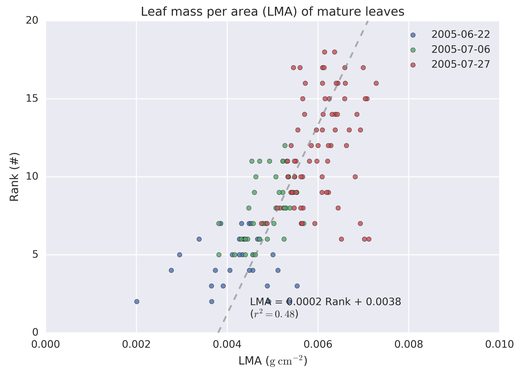
- **Measurement**: individual leaf biomass, area

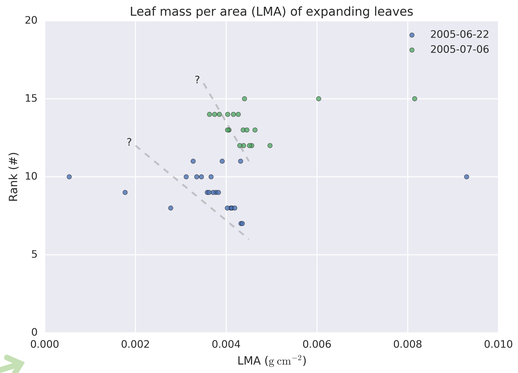
Result

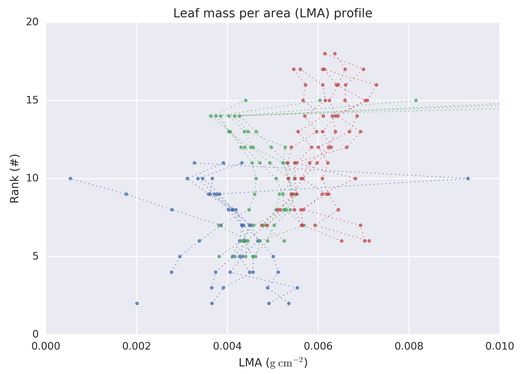
Leaf mass per area (LMA) of individual leaves from 18 samples (6 groups x 3 sampling points) were analyzed.

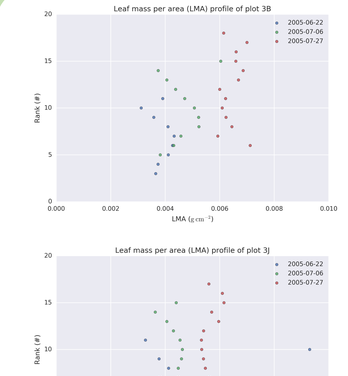
1. LMA changed over leaf age and rank.

- Unlike a traditional constant (*i.e.* 250 cm^2 g^{-1} = 0.004 g cm^{-2})
- LMA kept increasing when leaf **ages**
- LMA was **maximum** at the youngest mature leaf
- Ranks of **fully expanded** leaves were **positively** correlated
- Correlation of **expanding** leaves were **unclear**, but could be **negative**
- **High** LMA often found at **high ranks**, but sometimes at very **low ranks** under reproductive stage
- **Outliers** from newly expanding leaves



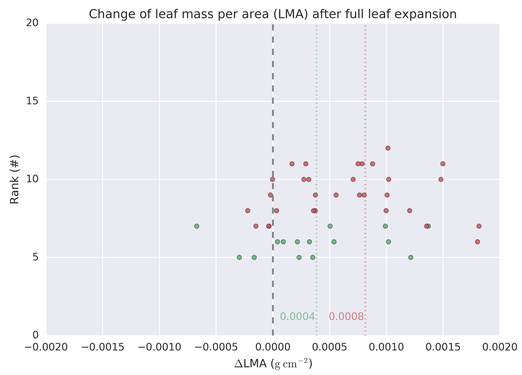






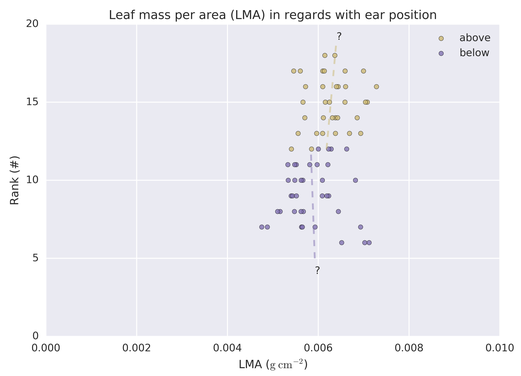
2. Carbon allocation continued after leaf expansion.

- Leaf area expansion stopped with ligule formation, but biomass accumulation continued
- Mature leaves saw LMA increase **even after leaf expansion**
- Leaves of **higher ranks** received **larger LMA increase** (0.0008 vs. 0.0004)
- Occasional decrease could be due to measurement error or leaf starch remobilization



3. External sink effect from ear was not clear.

- Assumed developing ear to be a strong external sink, expecting declination of LMA change with source distance
- Ear was developed around the rank 11-12 ('<' shape)
- Correlation was not significant, but could be **negative** on the leaves **below** ear, and **positive** on the leaves **above** ear



Conclusion

This study revealed interesting dynamics of LMA profile of maize canopy. We will continue building carbon allocation model that can capture individual leaf-level processes.