Canopy Cover Evolution of Banana Plantations:

Drought Effects, Diurnal Patterns and Leaf Area Index Relationships

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1. Introduction

- **Banana (*Musa* spp.)** is important staple crop
  - (Fourth in Africa) ➔ 400 kg yr^{-1}
- Large **yield gap**: 50 – 70 MT ha^{-1} $year^{-1}$
- **Drought** is most important abiotic stress
  - Climate change: water use efficiency = defining!

ISSUE:

Easy to use indicators of drought are lacking

RESEARCH QUESTION

How does canopy cover (CC) behave under moisture stress**?**

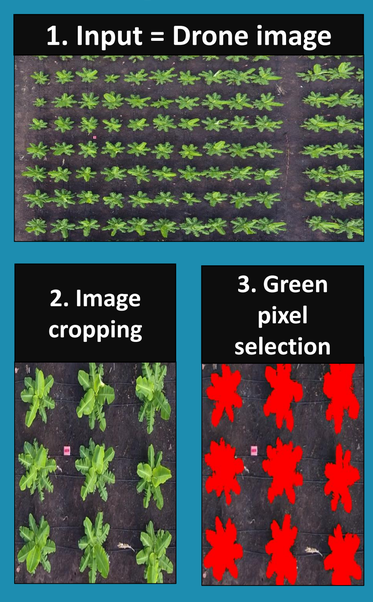
STUDY

CC and Leaf area index (LAI) evolution under different moisture regimes

2. Materials and methods

- **Field trial 2017-2018, Arusha, Tanzania**
- **2 cvs:** Mchare Huti Green (HG) (AA); Cavendish Grand Naine (GN) (AAA)
- **2 irrigation treatments:** Full (FI) and Deficit Irrigation (DI)
- Experimental unit = field plot (n = 3 for HG and n= 4 for GN)
- **Measurements until harvest of first crop cycle**
  - Soil moisture with TDR 200
  - Monthly plant growth measurements: leaf length, width, functional leaves, LAI and CC
    - CC = Drone image analysis procedure
      - (hourly pictures between 8h to 16h)
- **Statistics:**
  - Repeated measures design: linear mixed model
    - Unit is plot level
  - CC curve: nonlinear least squares regression
  - CC-LAI: exponential regression: Lambert Beer with extinction coefficient (b)

Canopy Cover Pipeline



3. Results

3.1 Soil Moisture

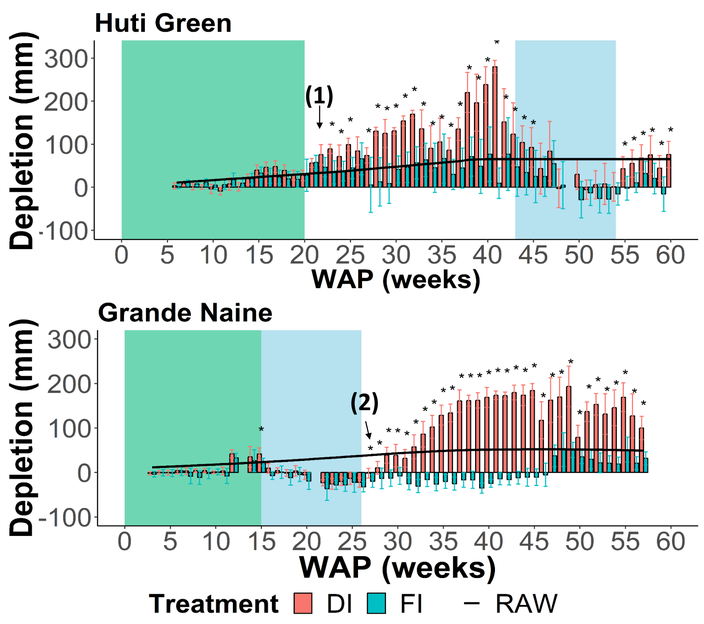


Fig. 1: Soil moisture depletion in root zone (0-60 cm) of Huti Green (up) and Grand Naine (down). Green area is establishment under optimal irrigation and blue area is rainy season. (1) notes start of diverging moisture values for HG, whilst (2) notes start of diverging moisture values for GN.

- **Moisture at different developmental stages**
- **Effect on CC**
  - 9 weeks after stress = first CC difference
- **CC growth curve**
  - Growth rate is affected by DI (HG and GN)
  - Maximum CC is affected by DI (GN)

3.2 Canopy Cover evolution

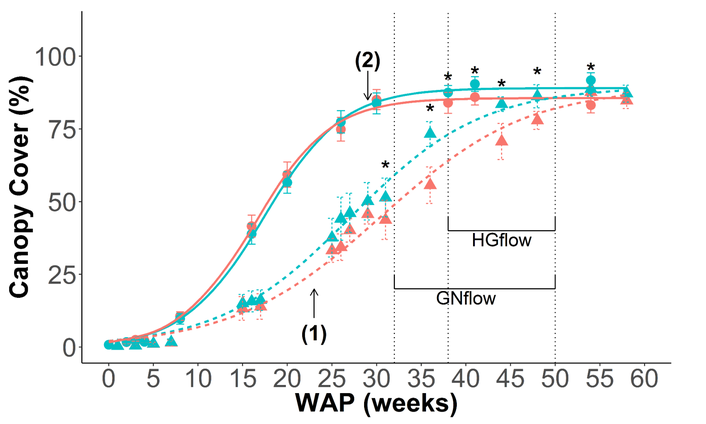


Fig. 2: Canopy cover evolution over time for Huti Green (HG) and Grand Naine (GN). '*' notes significant difference (*p*<0.05). (1) notes start of moisture divergence for HG, and (2) notes start of moisture divergence from GN. Flowering periods are also given for each cv.

3.3 Diurnal Pattern

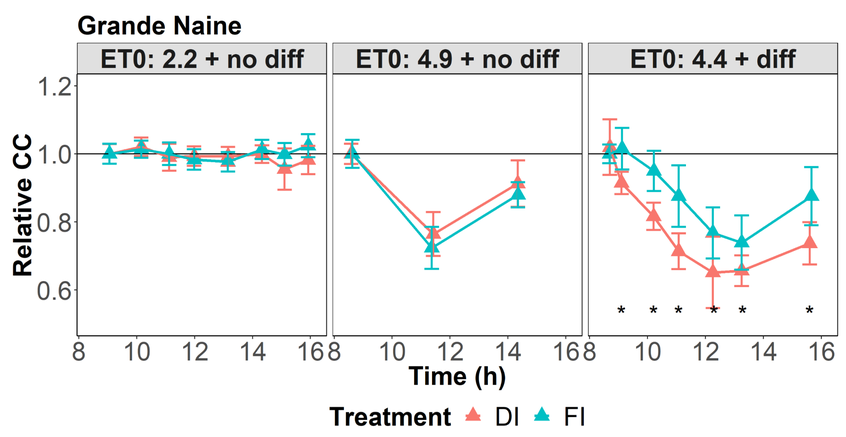


Fig. 3: Diurnal CC variation. '*' notes significant difference between FI and DI plots (*p*<0.05)

Morning: 8h

Midday: 12h

- **CC changes diurnally**
  - Evaporative demand (ET0)
  - Soil moisture stress increases folding
- **Pattern**
  - Drops in the morning
  - Minimum values during midday
  - Recovery in the afternoon/evening

3.4 CC – LAI relationship

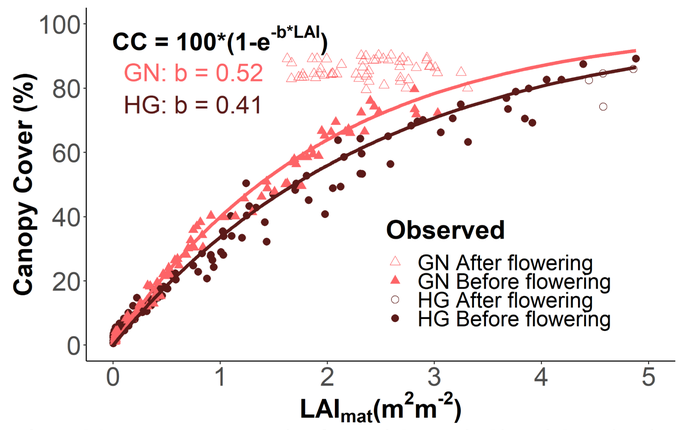


Fig 4. CC-LAI curve regression for Huti Green (HG) and Grand Naine (GN). B indicates the extinction coeff. of the Lambert-Beer equation

- **Good fit until flowering of cycle 1**
- HG has a lower extinction coefficient (diploid) than GN (triploid)
- Significant drop in LAI after flowering due to leaf pruning of oldest leafs ➔ keeps similar CC values
  - Wide range of CC values at a single LAI

4. Conclusion

1. **CC divergence at plot level** (*p*<0.05) may be indicator of drought stress in the field
2. **CC diurnal pattern** due to evaporative demand, increased under moisture stress
3. **CC-LAI** differs between cvs. Diploïd has lower extinction coefficient than triploïd

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Acknowledgements

Emmanuel Richard Nasolwa, Erick 'Seouri' Wangaely, Salim Ramadhani, Stanley Bayo and Joshua Jackson are gratefully acknowledged for their fieldwork and technical assistance. The authors are grateful for the financial support from VLIR-UOS and the VLADOC scholarship that made the research project possible.