Characterisation of microclimatic indicators in coffee production systems under varying biophysical contexts and its relation to fungal coffee diseases

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• Understanding shade effects on coffee pests and diseases has been a challenge because:

- Its complex. Direct, interactive, indirect effects
- Space & time dependence
- Focus on few factor → 1 response
- Tools to evaluate networks of causal relationships?

The complexity of the system, including spatiotemporal variations, should be addressed in a framework describing direct, indirect & interactive effects.
Research questions

1. How are spatiotemporal variations in microclimate and CLR characterized?

2. What are the indications for the underlying causal relationships of system? Are effects direct, indirect or interactively?
Study Area & Sampling Design

- 49 sample plots
- Altitudinal gradient (1100 – 2300 m)
- 3 coffee production systems
- CLR monitoring (6 weekly) and microclimate recordings (Temp, RH, hourly) over one growing season (15/16)

CB = Coffee Banana system
CO = Coffee Open system
CT = Coffee Tree system
Analysis

Method

Research questions

1. Selection of microclimatic indicators important in explaining CLR variability: \( \rightarrow \) Literature and Sparse partial least square (sPLS)
2. Analysis of spatiotemporal variations in microclimate and CLR: \( \rightarrow \) Graphical analysis

2. To estimate direct and indirect effects of altitude and coffee production system on microclimate and CLR: \( \rightarrow \) Piecewise structural equation model
Spatiotemporal variations in microclimate (1)

Results

Low (< 1300m)  Mid (1300 – 1700)  High (> 1700m)

Temperature (°C)

Diurnal Temp. Range (°C)

Coffee System

- Coffee Banana
- Coffee Open
- Coffee Tree
Environment (altitude) and coffee system affect seasonal and daily pattern microclimate.
Spatiotemporal variations in CLR

Results

Environment (altitude) and coffee system affect seasonal pattern of CLR

Coffee System
- Coffee Banana
- Coffee Open
- Coffee Tree
CS = Coffee System, CT = Coffee Tree, CO = Coffee Open, RH > 95 = The accumulated number of hours with the RH > 95\% (May / June), Temp = Average temperature (May / June)

Shipley’s test of d-separation was used to estimate the overall fit of the model (chi-squared test on the Fisher’s C statistic = p > .05, Fisher’s C, AIC = 65.85).

Effects of the environment and production system on CLR are directly or indirectly mediated by microclimate.
Conclusions

→ Spatiotemporal variations in microclimate: There are no consistent altitude or system effects

→ E.g. At high altitudes, highest humidity was found in unshaded systems (Vapor pressure deficit? Energy balance?)

→ “Relative humidity and leaf wetness are increased in shaded systems”?

→ Spatiotemporal variation in microclimate affects spatiotemporal CLR development

→ Structural equation modelling is a useful framework to describe interaction networks and causal relationships of agroecosystems
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