Temporal and Spatial Changes in Photosynthetic Parameters in Rainfed Peanut

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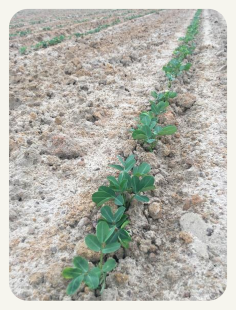
Introduction

- Photosynthetic performance in peanut (*Arachis hypogaea* L.) is susceptible to variations in soil and weather conditions.
- Stomatal conductance is sensitive to environmental changes and can serve as an indicator of drought stress.
- Under more severe environmental changes, leaf fluorescence becomes a limiting factor for photosyntetic efficiency.



- However, the temporal and spatial variability in photosynthetic parameters within a field and their relation with soil texture and soil matric potential has not been documented in peanut.

Objectives

To identify 1. the photosynthetic parameter that has greater contribution to variability within a peanut field; 2. the impact of soil texture and soil matric potential on spatial and temporal variability.

Materials and Methods

Site: Commercial rainfed peanut field in Pearson, GA.

Geographic coordinates: 31º22'00'' N, 82º54'54'' W

Experimental design: 31 plots, completely randomized design, with three subplots.

Cultivar: Georgia-06G

Planting date: May 10, 2022

Measurements:
27, 47, 74, 90, and 105 days after planting (DAP)

Stomatal Conductance and Fluorescence

- Stomatal Conductance (g_{sw}; mol m^{-2}s^{-1})
- Actual quantum yield of photosystem II (Φ_{PSII})
- Electron transport rate (ETR; µmol m^{-2}s^{-1})
- Transpiration (E; mmol m^{-2}s^{-1})
- Leaf temperature (T_{leaf}; ºC)

Soil

- Sand (%)
- Matric potential (kPa)

Weather data

- Rainfall (mm)
- Max. and min. temp. (ºC)

Data Analysis:

- Principal Component Analysis (Kaiser criterion: eigenvalue > 1) and relative contribution of photosynthetic parameters for PC1 and PC2.
- ArcGIS for spatial and temporal variation in g_{sw}.
- ANOVA and Tukey's HSD post-hoc test at $p < 0.05$.
- Pearson correlation between g_{sw} and sand %, matric potential, rainfall, and air temperature.

Results and Discussion

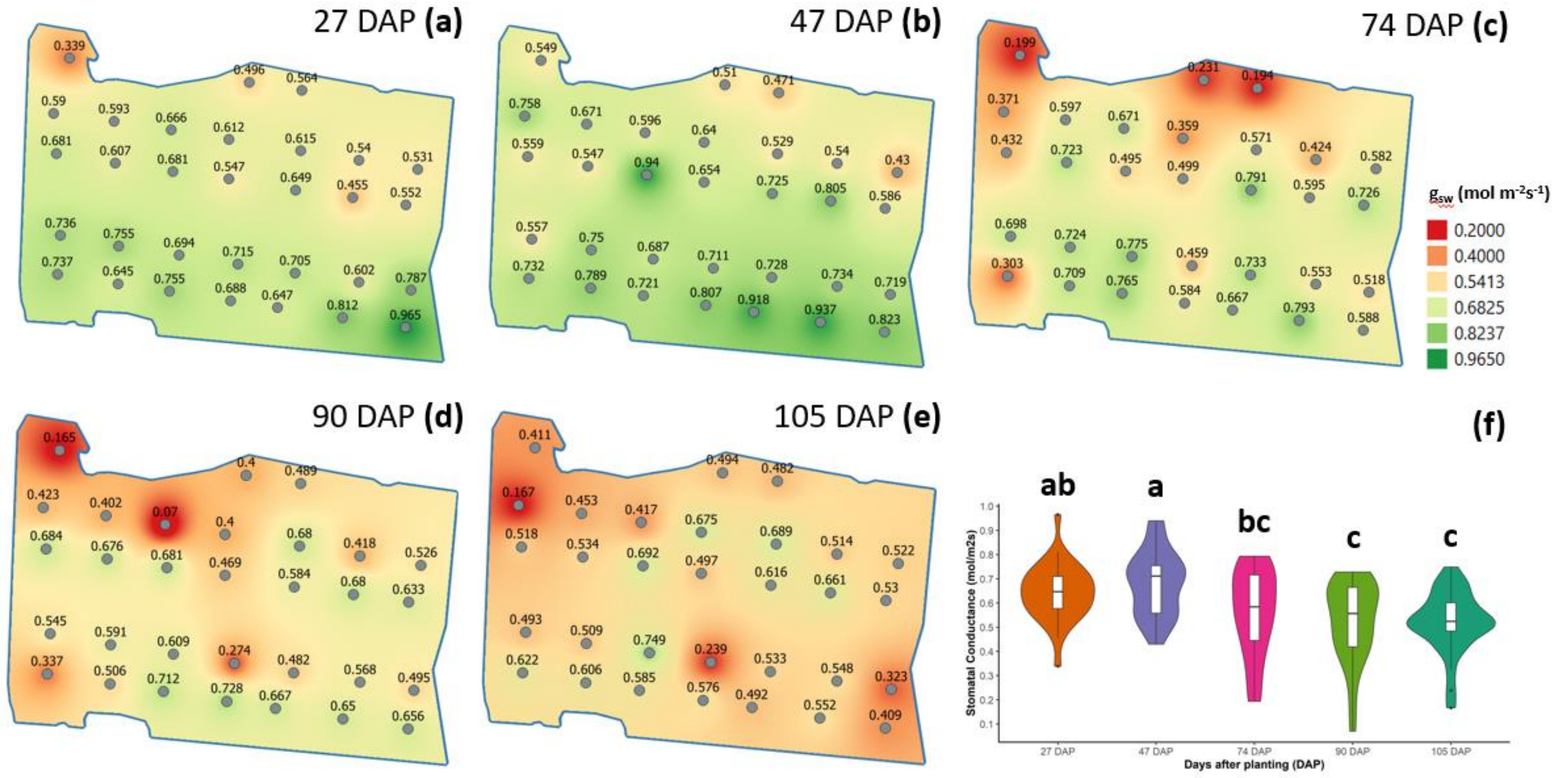


Figure 1. Spatial and temporal variability in stomatal conductance of peanut leaves measured in 31 points across the field over five dates, 27 days after planting (DAP; a), 47 DAP (b), 74 DAP (c), 90 DAP (d), and 105 DAP (e). A seaborn violin (f) represents the difference in stomatal conductance across dates.

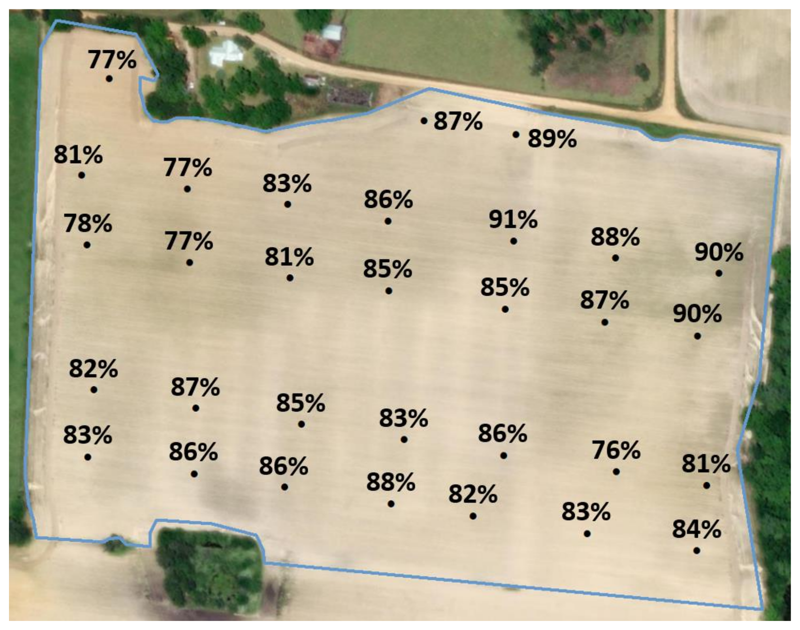


Figure 2. Field map with soil sand percentage for the 31 sampling points. Soil sand varied from 76 to 91%.

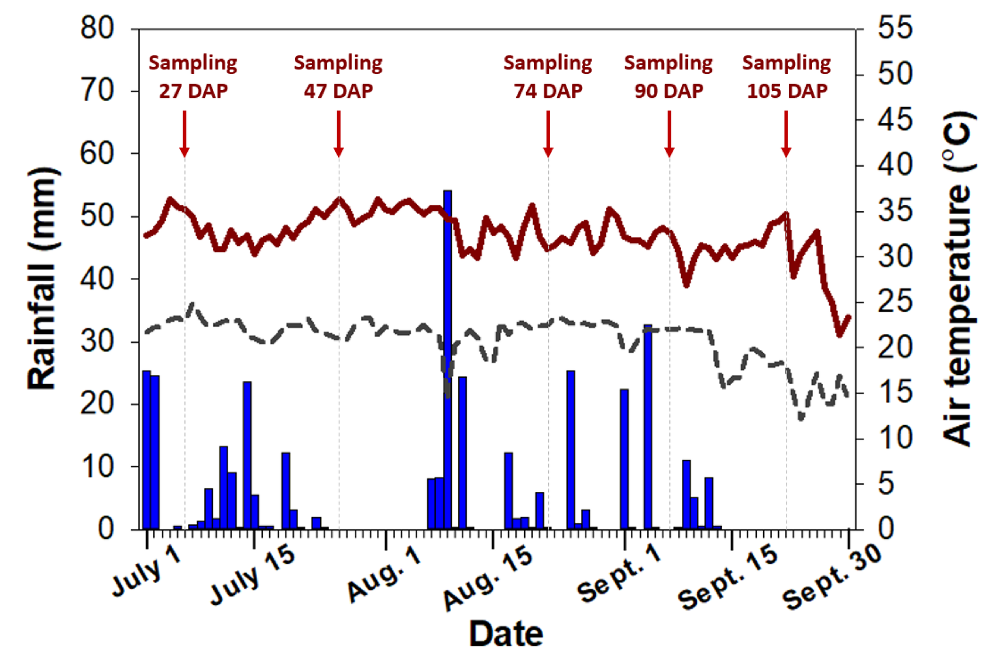


Figure 3. Rainfall (mm) and maximum and minimum daily temperatures (ºC) from July-Sept. of the 2022 peanut season. Red arrows represent the date measurements were taken.

- ✓ PC1 and PC2 explain 71% variance in the data.
- ✓ 53% of total variance is accounted for by stomatal conductance.
- ✓ Stomatal conductance in peanut leaves was spatially variable within the field (Fig. 1a-e).
- ✓ No correlation between g_{sw} and matric potential, sand%, rainfall, and air temperature (data not shown).

- ✓ Although variability in soil texture exists, the spatial variability in g_{sw} was not significantly correlated with sand percentage (Figs. 1 and 2) likely due to soil matric potentials around 15 kPa (very wet) (data not shown).
- ✓ There was temporal variability in g_{sw}, but rainfall and air temperature alone were not directly correlated with it (Figs. 1 and 3).

Conclusions

- ✓ Stomatal conductance was the photosynthetic parameter with greatest contribution to variability within a peanut field.
- ✓ Soil texture (sand percentage) or soil matric potential did not impact spatial variability in stomatal conductance for this peanut field, whereas rainfall and air temperature did not influenced temporal variability in leaf stomatal conductance.

Future Research

- ➢ Analyze the soil characteristics and weather data altogether and build a model with the contribution of each input on the variability of the photosynthetic parameters in peanut leaves grown under rainfed conditions.

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