SMALL SCALE CO2 FLUXES IN A RAINFED MAIZE FIELD UNDER N FERTILIZATION

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Abstract:

Carbon-dioxide (CO_2) fluxes in the soil-plant-atmosphere system contain bidirectional material transport with organic and inorganic components, and various pathways. All are influenced by environmental and biotic conditions, from air temperature to plant development or soil microfauna. Our aim by quantifying certain components of CO_2 exchange between surface and the atmosphere, and observing the controlling factors is to develop a methodology for upscaling plot and leaf scale measurements to the canopy scale.
The site is a sowing time–fertilizer–maize variety field experiment near Martonvásár. We carried out simoultaneous observation of soil respiration (Rs) leaf scale photosynthesis (A), soil temperature and soil water content, root growth, and plant height under 60 kg N/ha and 180 kg N/ha fertilizer treatments.
Synchronized measurements were repeated in the vegetation period to detect relationship among them and to optimize the labour intensive protocol for this experimental setup. The results suggest that Rs correlated with air temperature measured by the gas analyser, and with soil temperature at 6-8 cm depth. In spite of the sometimes rapidly changing conditions during field measurements, A measurements showed reliable response to environmental factors.

Site description
Continuous maize sowing date experiment in four replicates with the combination of four sowing dates, five maize varieties and five inorganic nitrogen fertilizer doses.

Treatments
We focused all activities to one variety (Mv Tarján) one sowing date (the last one, beginning of May) combined with two contrasting fertilizer treatments, 60 kgN/ha and 180 kgN/ha. Each treatment consists of two rows of maize with 70 cm row spacing.

Soil information
The soil of the experiment site belongs to the chernozem FAO soil unit as well as to the medium textural class (sand fraction: 51.4%, silt fraction: 34.0%, clay fraction: 14.6%) with a deep (>50 cm) A horizon. The average bulk density is 1.47 g cm^{-3} while the humus content of the top soil ranges between 2.82 and 2.92% across the site. Saturated hydraulic conductivity of the soil surface is 9 cm d^{-1} in average.

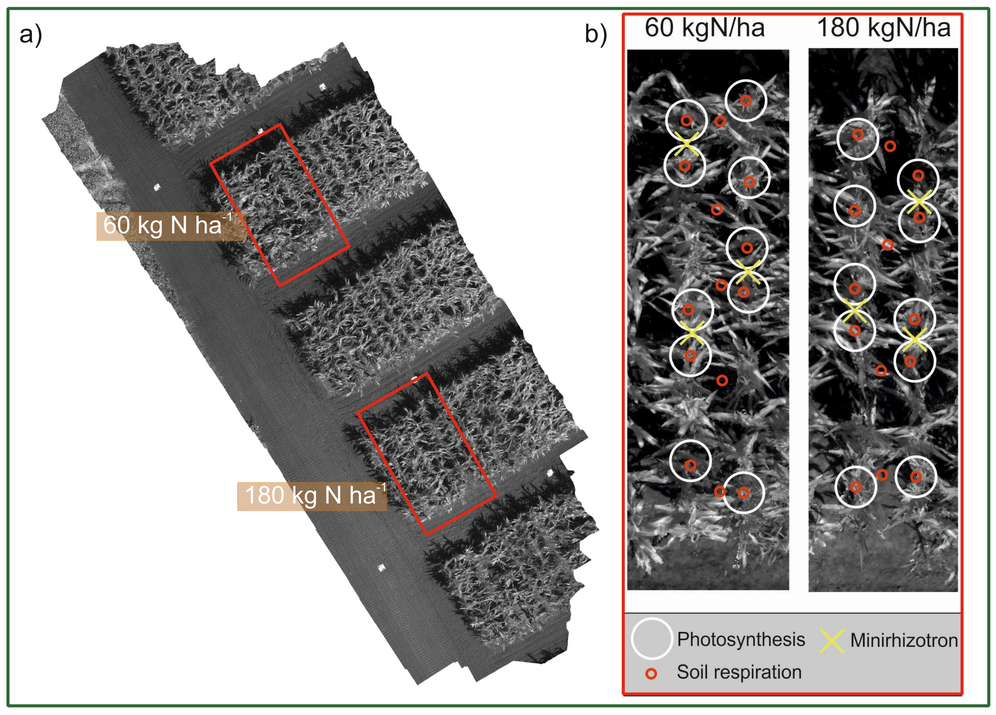


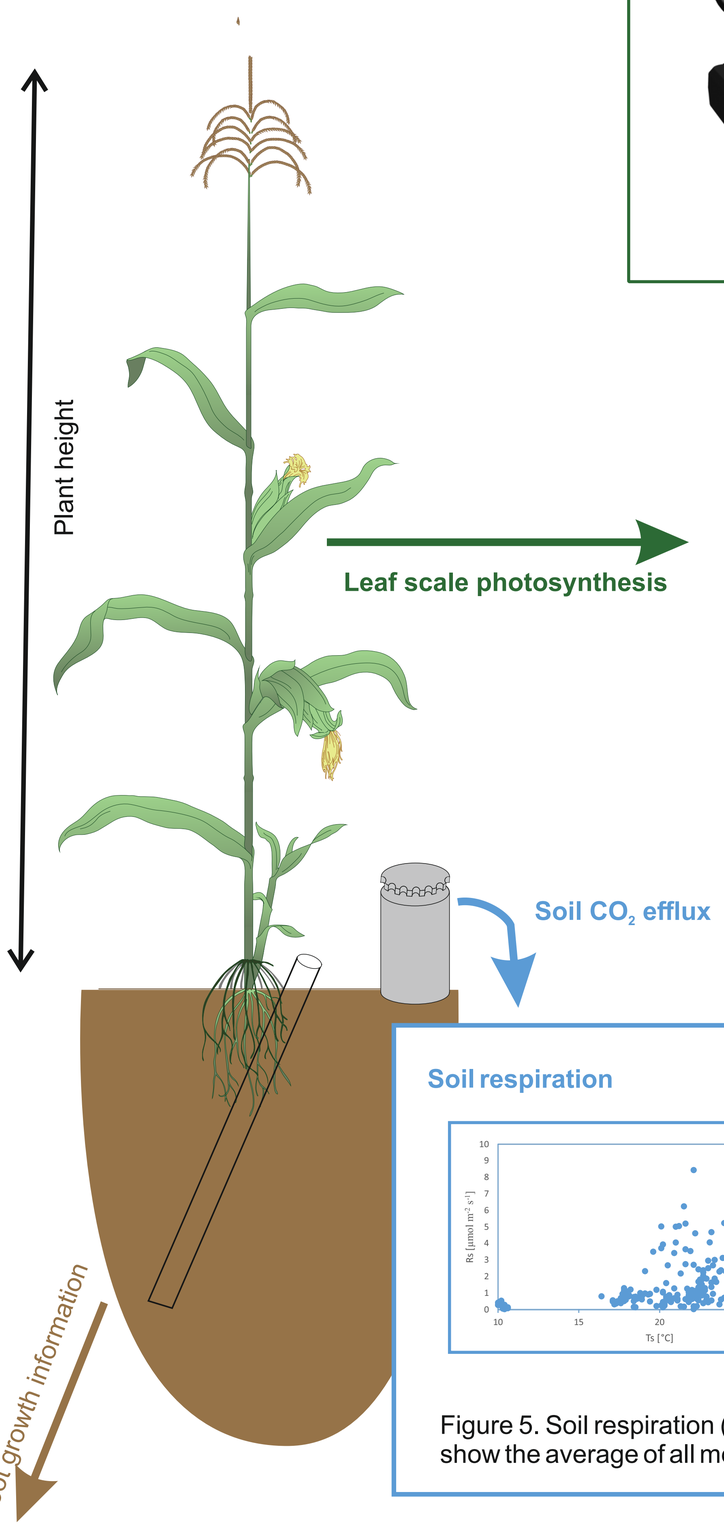
Figure 1. a) orthophotograph of the experiment; b) Aerial photograph of the study sites indicating photosynthesis (white circles), soil respiration (red circles) measurements and installed minirhizotron tubes (yellow X).

Ancillary measurements

Plant height measurement was repeated on each plant in the two rows per treatment. Plant height at flowering (24 July) was higher in the low fertilizer dose (60 kg N/ha) treatment (189 cm versus 176 cm in the 180 kgN/ha plot), although the height of individual plants varied considerably (42 cm and 41 cm standard deviation in the 180 and 60 kg N/ha plots, respectively).

Soil water content: Hydrosense II (Campell Sceintific)

Soil temperature: STP-2 soil temperature probe



- CIRAS-3 Portable Photosynthesis System (PPSystems, Amesbury, MA USA) (Figure 2a)
- Photosynthesis data show close relation to light availability (Fig 4b)
- Lower leaves show typically lower assimilation rates but at the uppermost leaves it decreased again, in every single measurement occasion (Figure 3)

Photosynthesis

Figure 2. a) CIRAS-3 analyzer, b) Light response of assimilation in the two fertilizer treatments.

Soil respiration

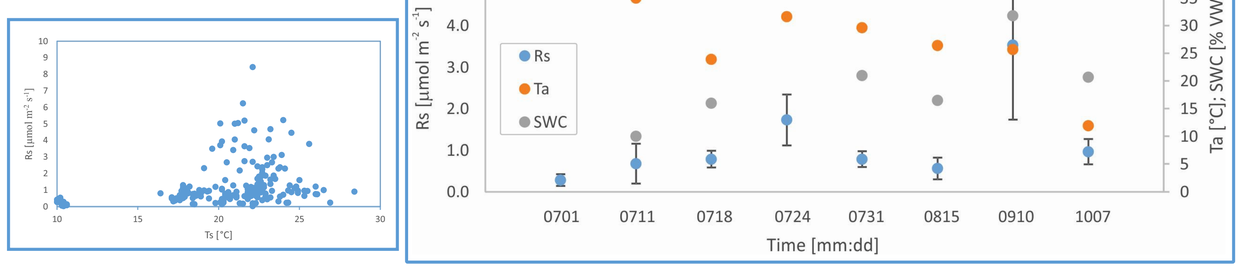


Figure 5. Soil respiration (Rs) and its abiotic drivers: soil water content (SWC) and air temperature (Ta). Values show the average of all measurements in both treatments. Rs error bars represent ± standard deviation.

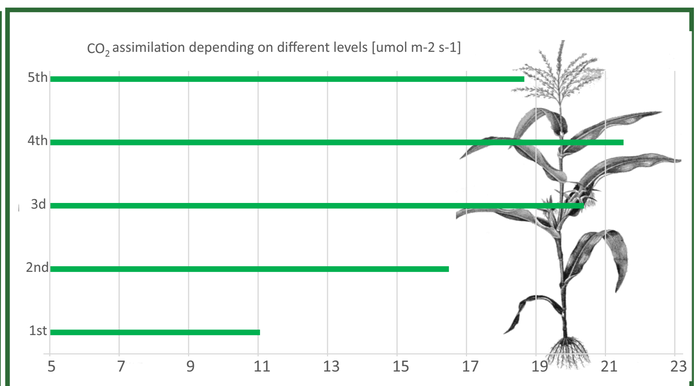
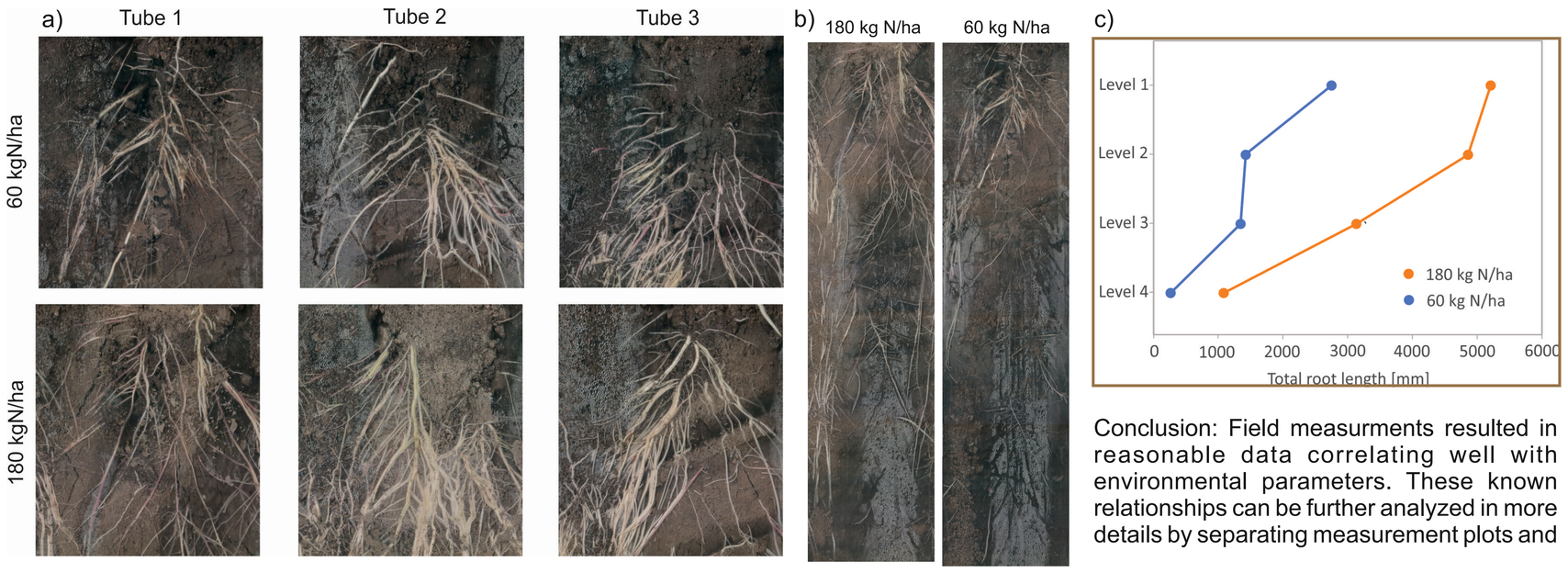


Figure 3. CO_2 assimilation in the 60 kg N/ha and 180 kg N/ha treatments. Data shown by levels in the maize canopy was firts averaged over measurements on five plants and the whole measurement period.

Minirhizotron

Figure 6. Root tubes installed in two rows of the 180 kgN/ha treatment.and the CI-600 minirhizotron camera (CID BioScience).

Figure 7. a) Root images taken on 11th July in the two fertilizer treatments. For tube locations see Figure 6). Profile in the upper 1 m indicated higher root count and root lenght in the 180 kg N/ha treatment (Figure 5 b and c)



Conclusion: Field measurments resulted in reasonable data correlating well with environmental parameters. These known relationships can be further analyzed in more details by separating measurement plots and

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