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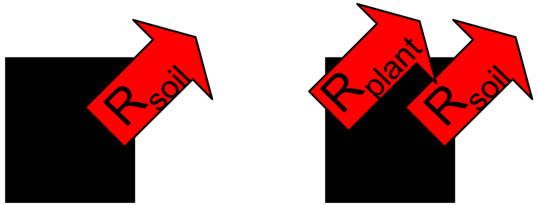
Plant production studies in Haean in 2010

Steve Lindner

Introduction:



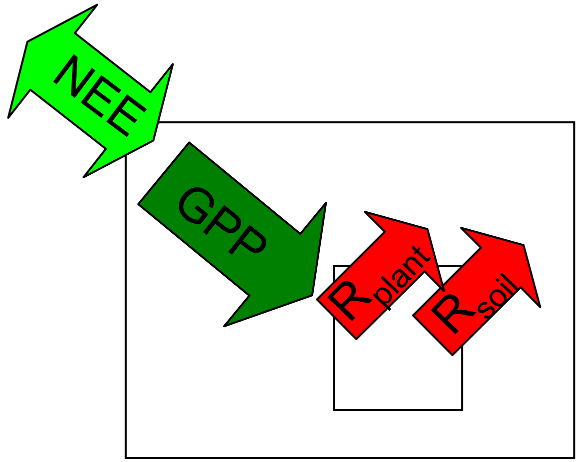
Dark chamber:

Soil respiration R_{soil} = CO_2 release from the bare soil

Ecosystem respiration R_{eco} = CO_2 release from the soil (R_{soil}) + plant (R_{plant})

Light chamber:

Net ecosystem exchange NEE = GPP + Reco



Gross primary production (GPP): rate at which an ecosystem's producers **capture and store** a given amount of chemical energy **as biomass** in a given length of time.

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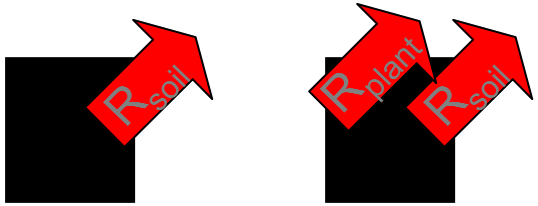

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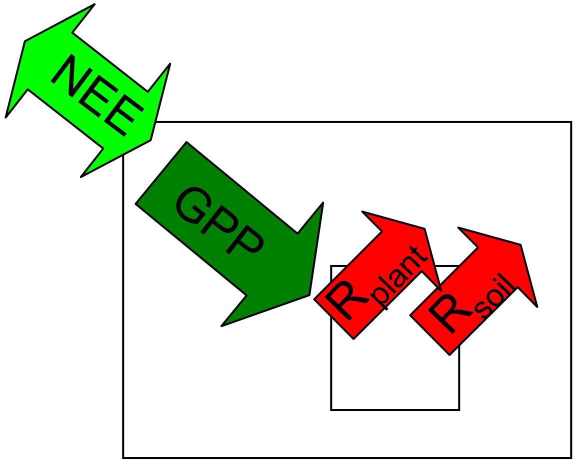

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Introduction

Methods: Portable closed chamber system
CO_2/H_20 porometer CQP-130
Pressure chamber
Ech2o logger

Results

Conclusions & Outlook

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Introduction:

Figure 1: Applied light and dark gas exchange chambers for measuring the NEE and R_{eco}

Figure 2: Installed soil frames (38 x 38 cm^2) as a base for the gas exchange chambers

- 5 crops / 1 field per crop in 2009
- Up to 9 plots per field:
  - 4 crop plots / replicates
  - 3 weed plots (not so successful)
  - 2 bare soil plots

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Methods: Portable closed chamber system

Figure 1: Applied light and dark gas exchange chambers for measuring the NEE and R_{eco}

Figure 2: Installed soil frames (38 x 38 cm^2) as a base for the gas exchange chambers

- Daily courses
- At least 3 times/ growing season and crop
- Intensified measurements on the Radish field with different fertilizer treatments
- NEE, Reco, Rsoil
- Microclimate
- Biomass leaves/ stem/ roots
- C/N content

- Detailed information of plant reaction to environmental factors in small scale (1-2 plants enclosed)

- Up scaling of CO_2 fluxes up to landscape level

TERRECO-02: Spatial assessment of atmosphere-ecosystem exchanges via micrometeorological measurements, footprint modelling and mesoscale simulations Peng Zhao, Johannes Lüers, Thomas Foken, Chong Bum Lee

- Validation of the Pixgro model

TERRECO-15: Comparisons of net ecosystem CO_2 exchange, carbon gain, growth and water use efficiency of agricultural crops in small catchments in Korea Bora Lee, John Tenhunen, Sinkyu Kang

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Methods: *CO_2/H_20 porometer CQP-130*, Fa. WALZ, Effeltrich, Germany

- Measuring leaf gas exchange (photosynthesis or respiration of the leaf can be measured)
- In relation to microclimate

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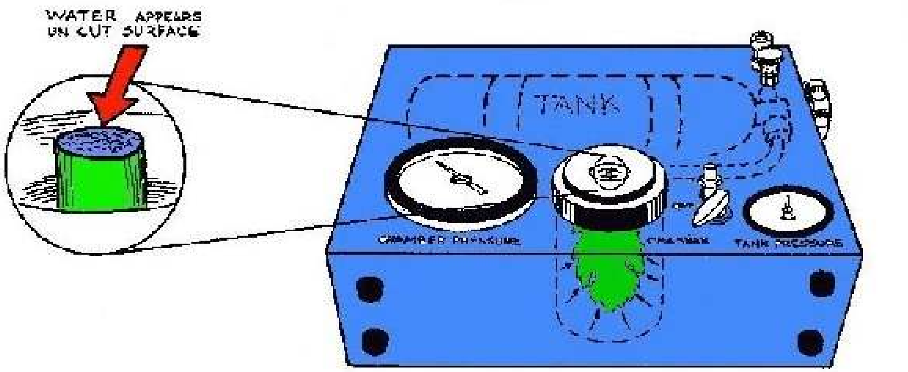
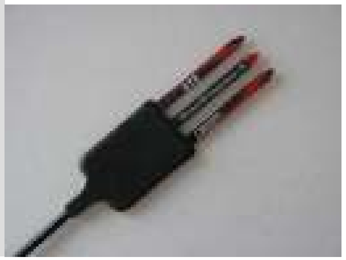
Methods: Pressure Chamber & Ech2o logger

- Plant water relations will be accessed using the scholander pressure chamber





- Soil moisture content and soil temperature
- Automatic Weather Station for continuous recording of climate parameters (air temperature, relative humidity, solar radiation, wind speed and direction, rainfall)

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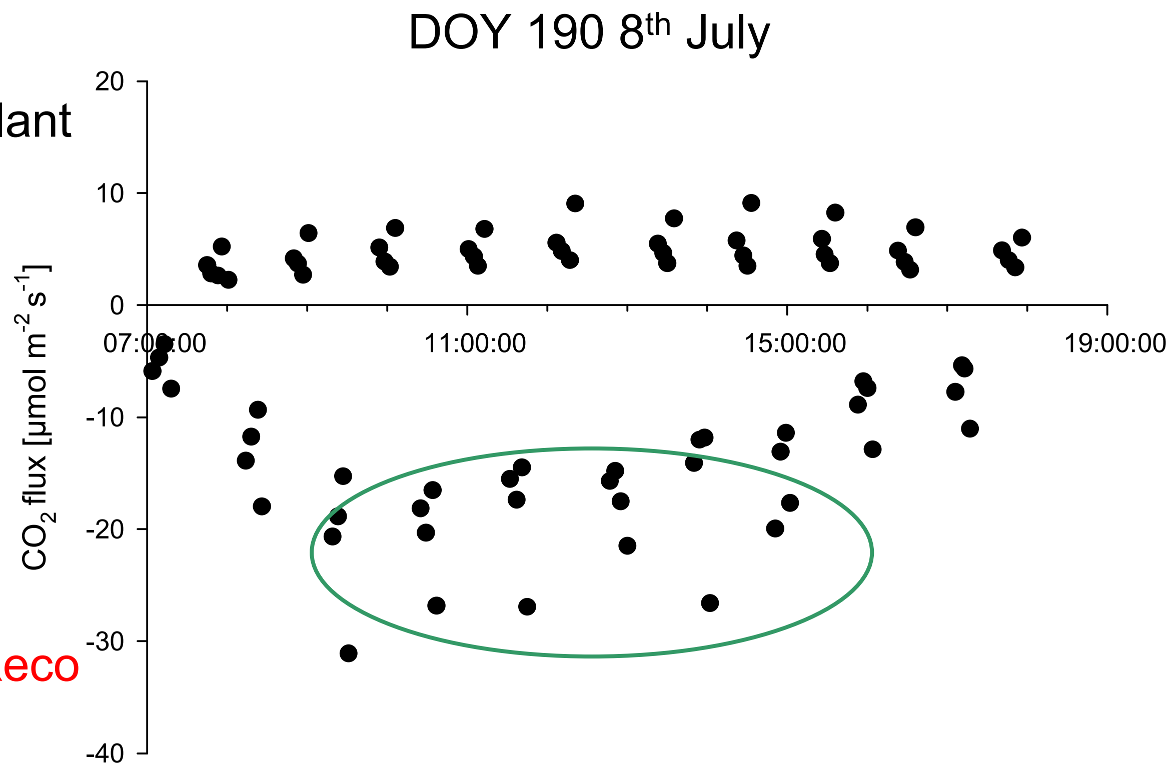
Results from 2009:

Reco=Rsoil+Rplant

NEE = GPP + Reco



Daily course of NEE from a conventional potato field

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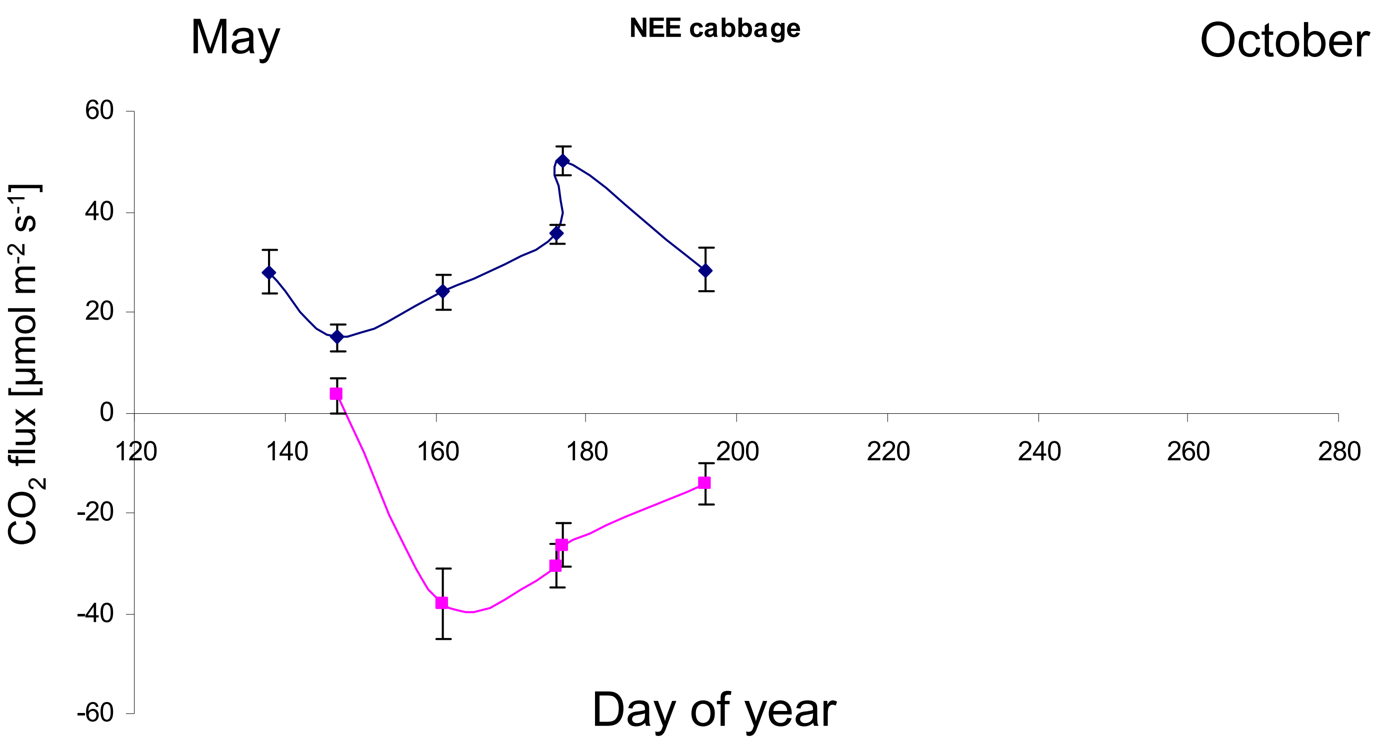
Results:



Seasonal course of CO_2 fluxes from cabbage

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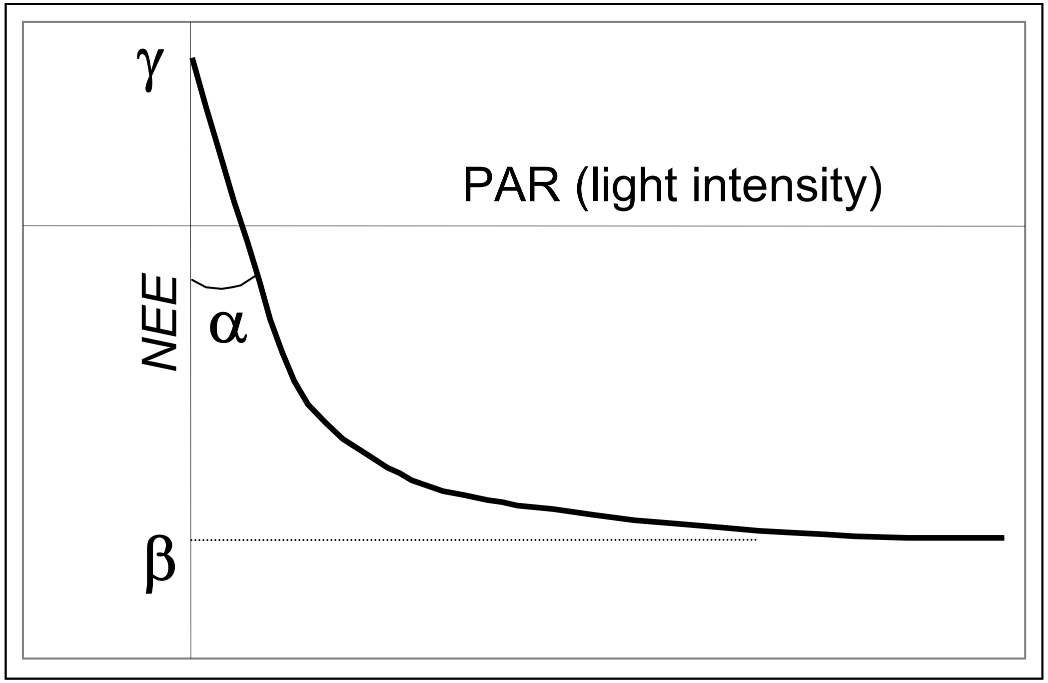
Hyperbolic light response model
(Michaelis-Menten type model)

- Used Michalis - Menten / rectangular hyperbola model to estimate model parameters for ecosystem/ leaf level gas exchange



$$NEE = -\frac{\alpha \cdot \beta \cdot \text{PAR}}{\alpha \cdot \text{PAR} + \beta} + \gamma$$

Gilmanov *et al*, 2003

Physiological parameters:

α is the initial slope of the light response curve and an approximation of the canopy light utilization efficiency

β is the maximum NEE of the canopy

γ is an estimate of the average ecosystem respiration (Reco) occurring during the observation period

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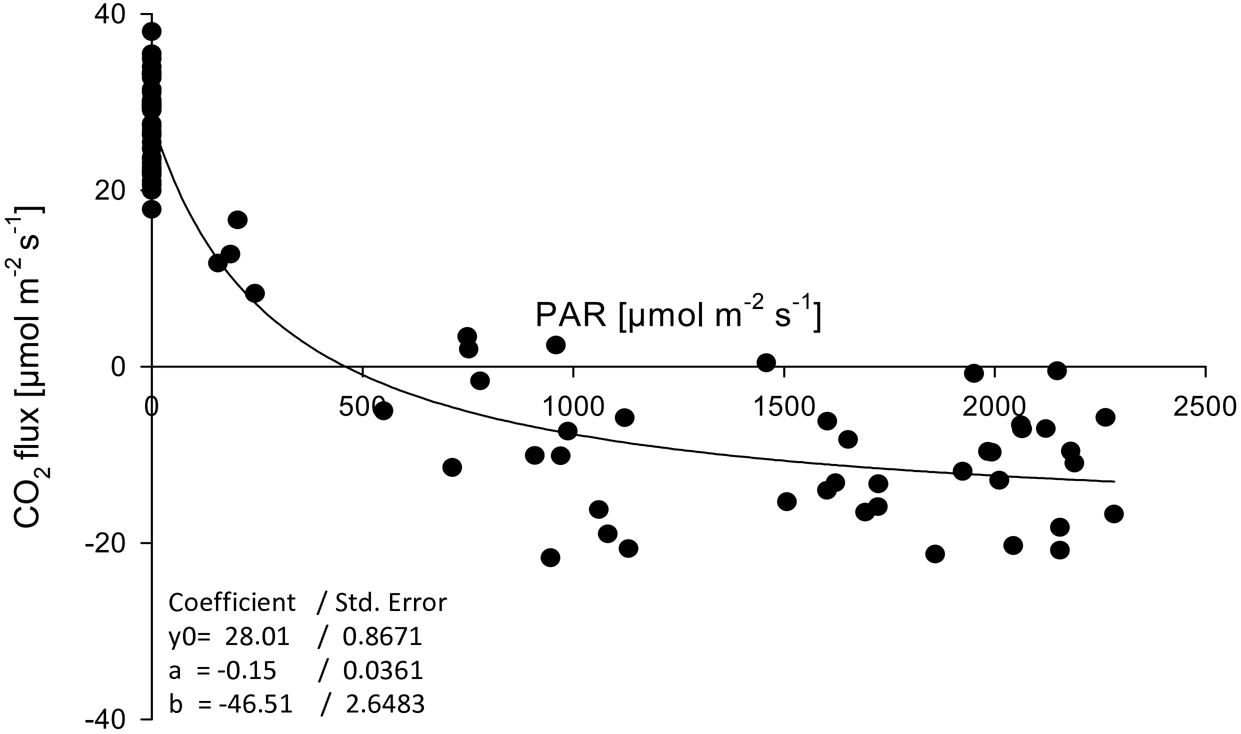
Results:



- Estimated parameters to describe gas exchange capacity of potato

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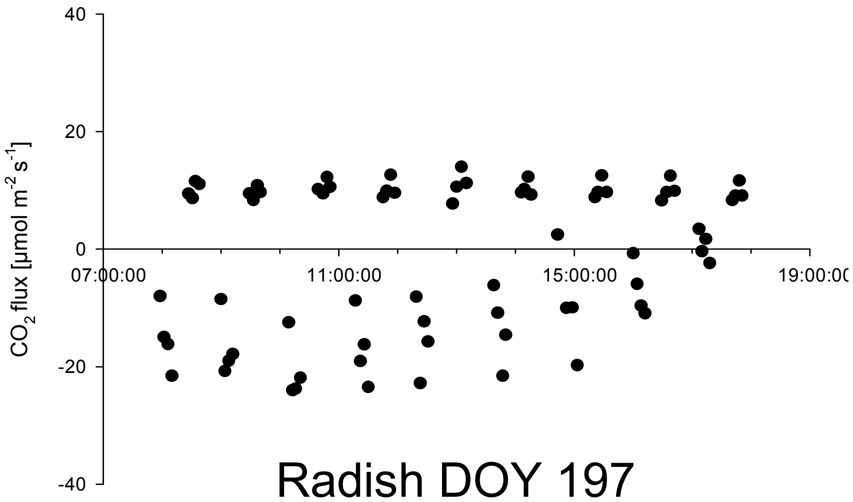
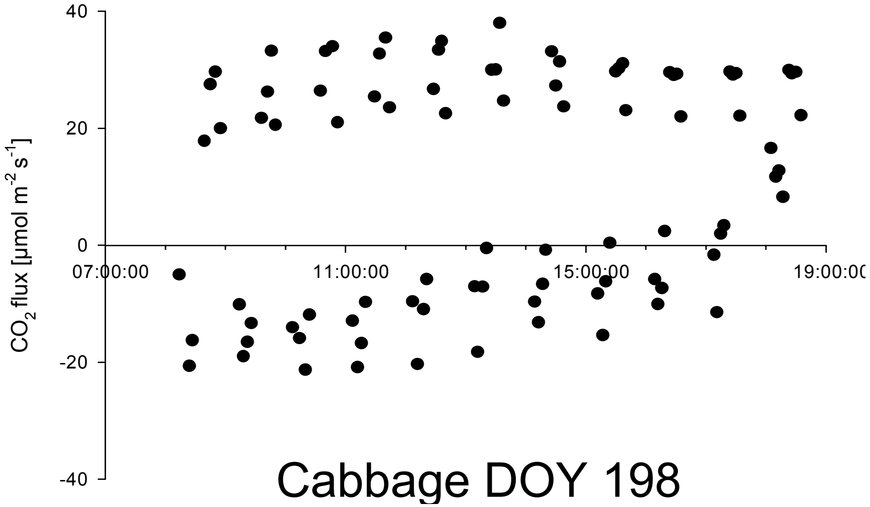
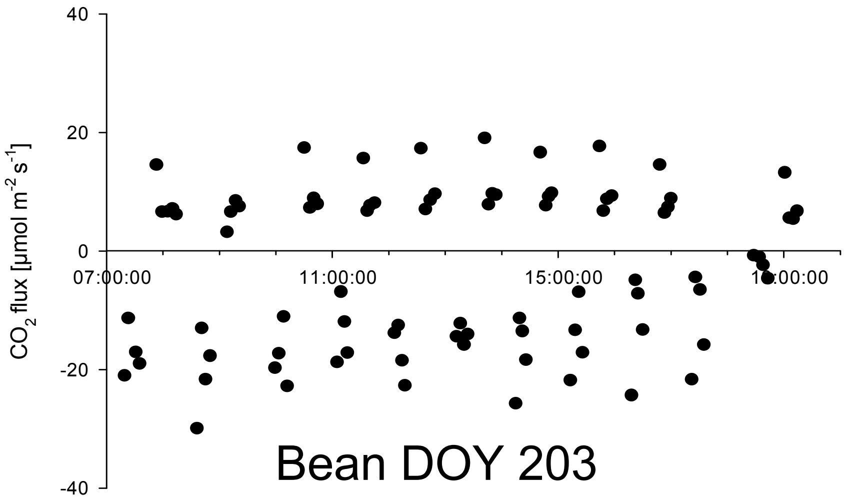
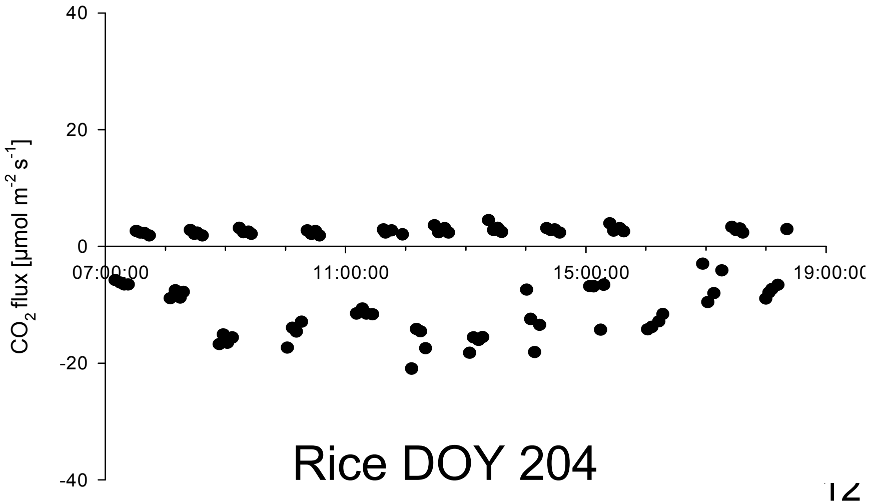
Results: Daily courses of NEE









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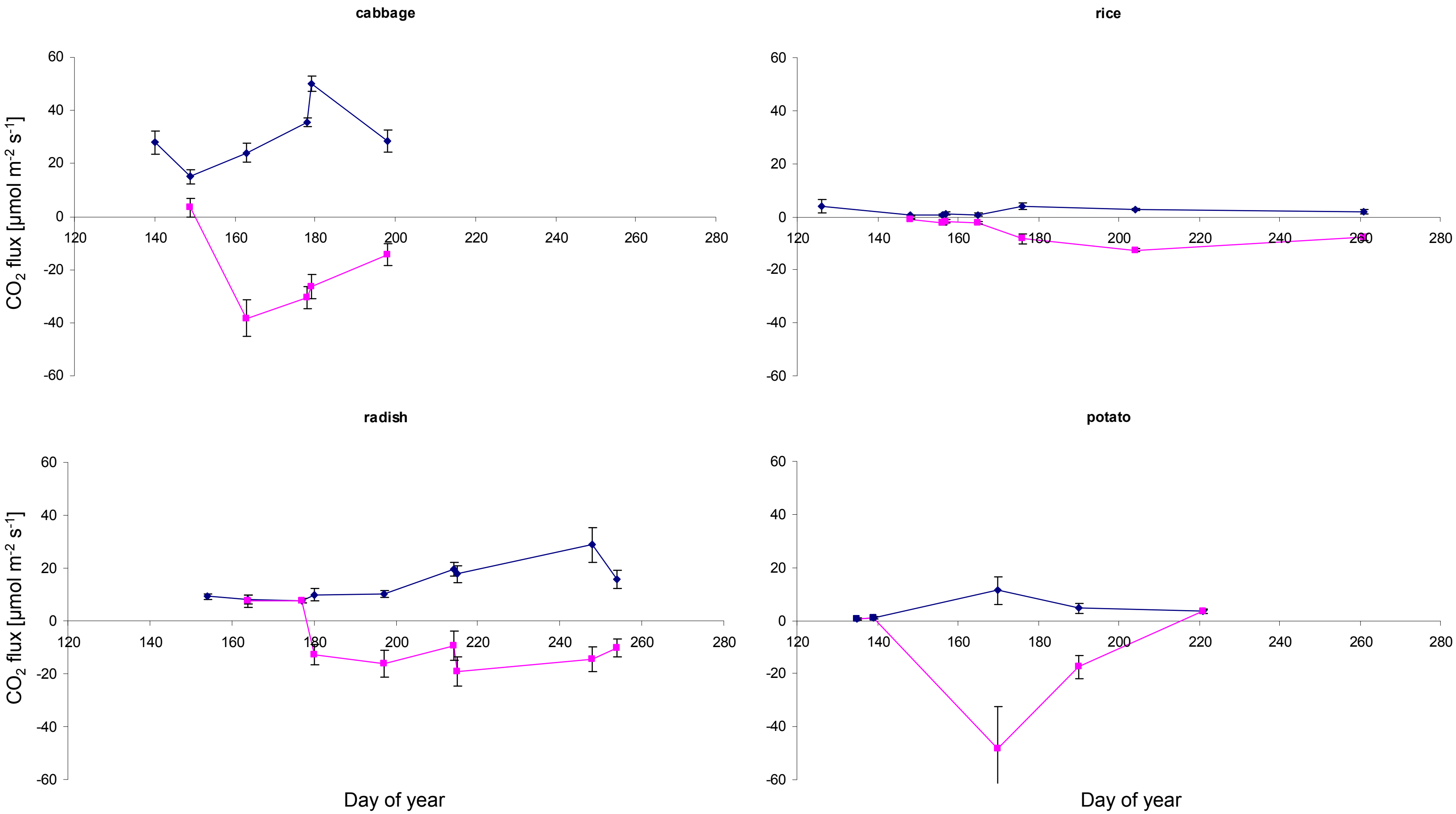
Results:



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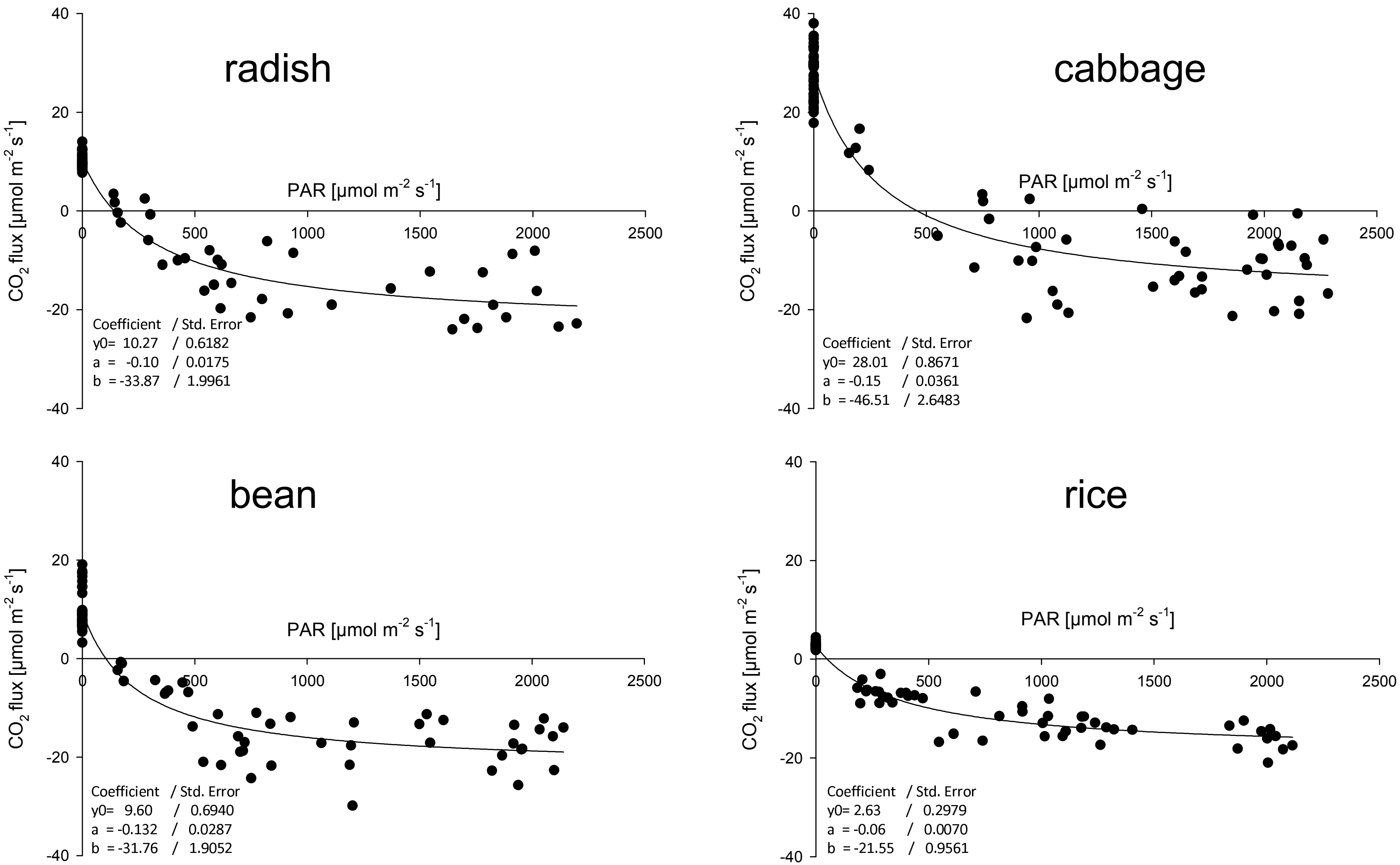

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Conclusions & Outlook:

- One place, one season, gives standardized abiotic conditions for all crops
- Gain basic understanding of how these crops interact with their physical environment
- Use the data for model parameterization using e.g. light response curves, physiological carboxylase - based process model
- Compare the differences in CO_2 exchange rates among crops

→ Why?
Identify the determinants of crop CO_2 exchange rates =
e.g. type of crop, LA, biomass, C/N content, light use efficiency, soil properties

NEE = GPP + Reco

In order to:
→ Identify the most constraining factors on crop production & carbon exchange in Haean
→ Understand and quantify the processes of agro- ecosystem functioning

Objective

Understand ecosystem fluxes and measure their impact on:

1) Environmental sustainability
2) Ecosystem service provision

Main assumption

Ecosystem processes & fluxes both impact functioning and ***interact with each other***

- ➔ Separate measurements of each process cannot account for such interactions
- ➔ In order to fully apprehend the set of parameters that influence production and sustainability, an interdisciplinary approach is necessary

Integrated approach to the measurement of ecosystem processes

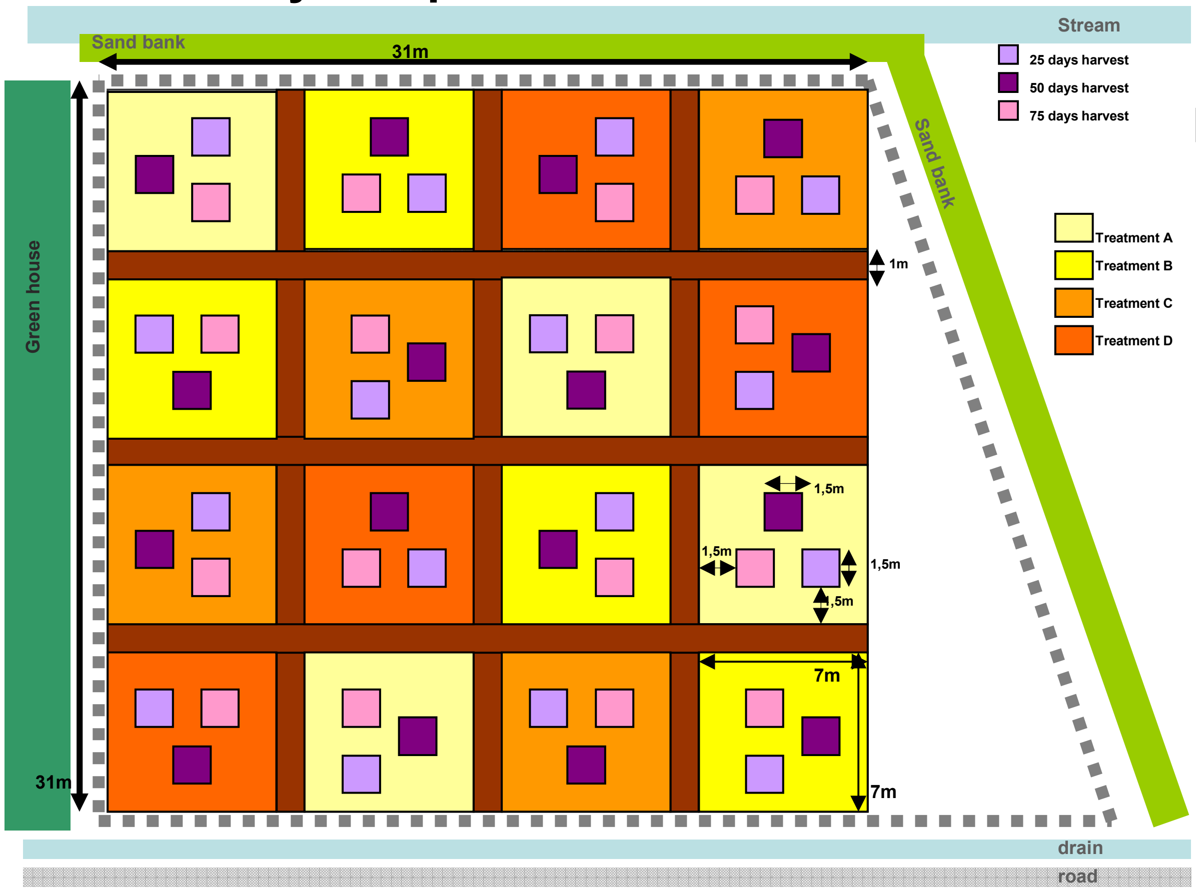
Use of an identical field setup with coordinated measurements by multiple disciplines

Flux Regulation, N Balances and Production in Agroecosystems of Haean Catchment

I. Nutrient cycling: N fluxes and N balances J. Kettering, S. Berger

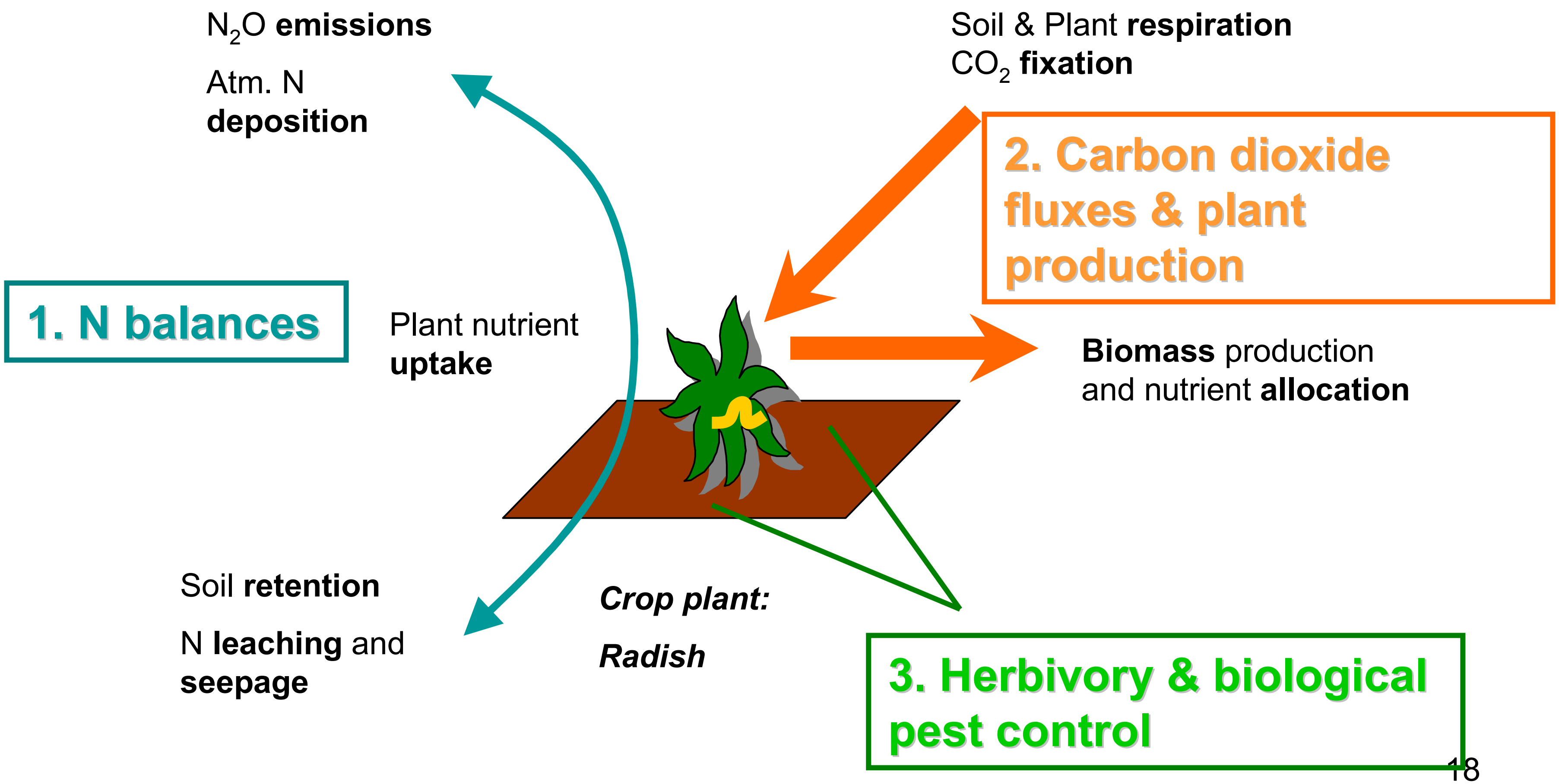
II. CO_2 fluxes and plant production S. Lindner, B. Lee

III. Herbivory and pest control E. Martin



Randomized block designs:
16 plots = 4 * 4 fertilizer levels
→ 50 - 150 - 250 - 350 kg N/ha

What are we measuring?

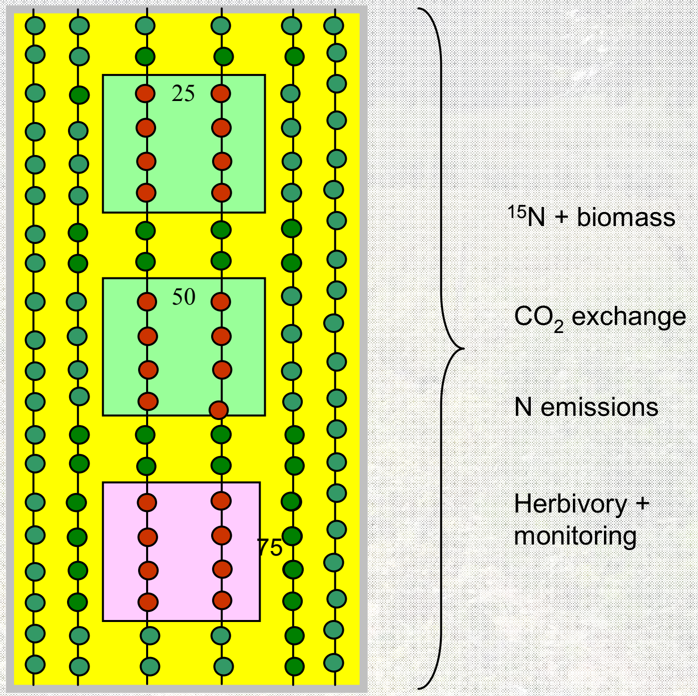


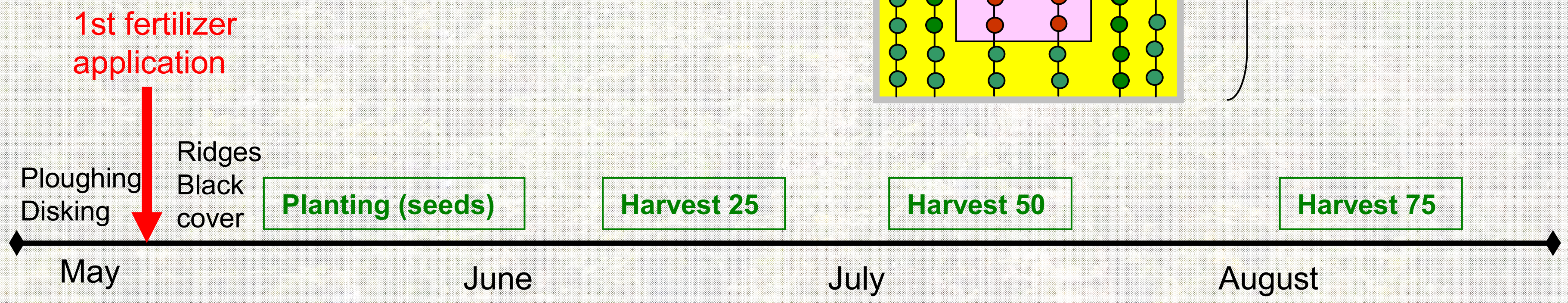
Experimental setup

- 16 plots = 4 * 4 fertilizer levels
  → 50 - 150 - 250 - 350 kg N/ha
- Harvest of subplots after 25, 50 and 75 days
- Fertilizer application: reproduce as closely as possible the practices of local farmers
- granulate *mineral* fertilizer

Recommendation of Korean Agricultural Center: up to 400 kg N/ha

Usual amount in Germany: 50-150 kg N/ha





Thank you!

I appreciate your questions...