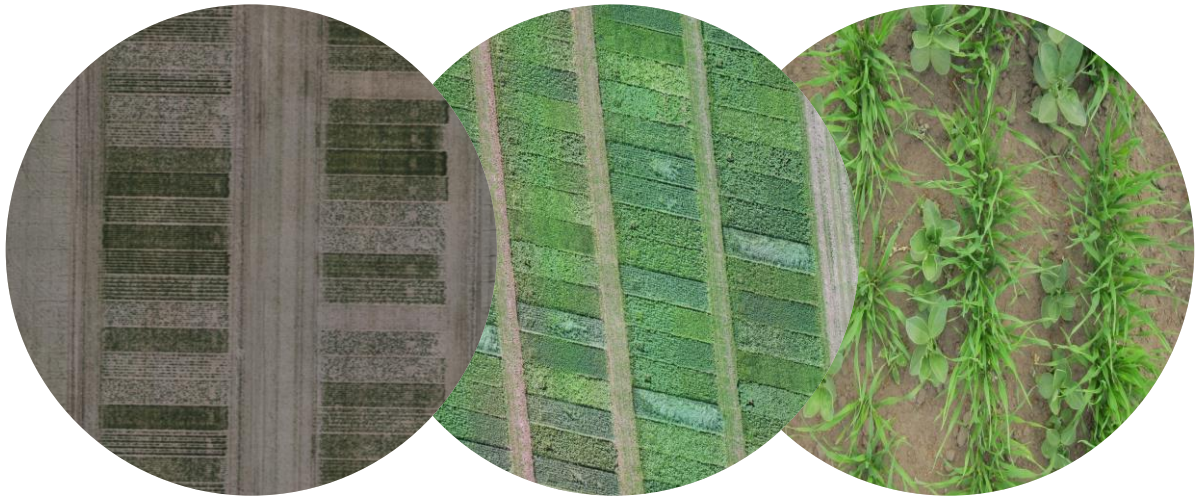
Quantifying the mechanisms of weed suppression in cereal-legume intercrops

EWRS – Physical and Cultural Weed Control, Ede, 29-05-2024

David Kottelenberg, Jochem Evers, Niels Anten, Lammert Bastiaans





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Crop diversity to combat weeds: Intercropping

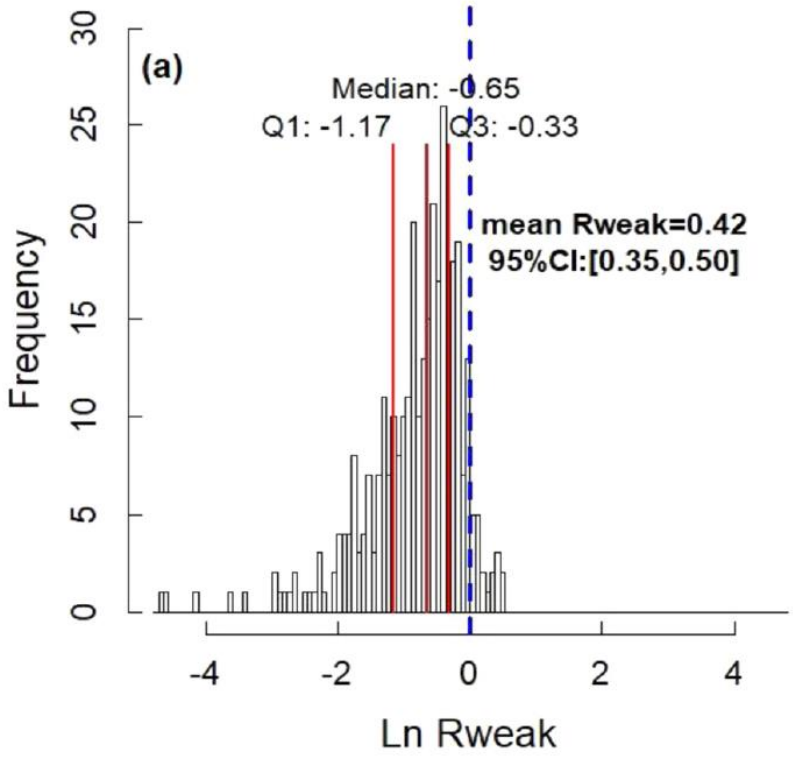
- Two or more crops grown simultaneously on the same plot
- Potential benefits over monocropping
  - Overyielding
  - Increased biodiversity
  - Reduced pests
  - **Reduced weeds**

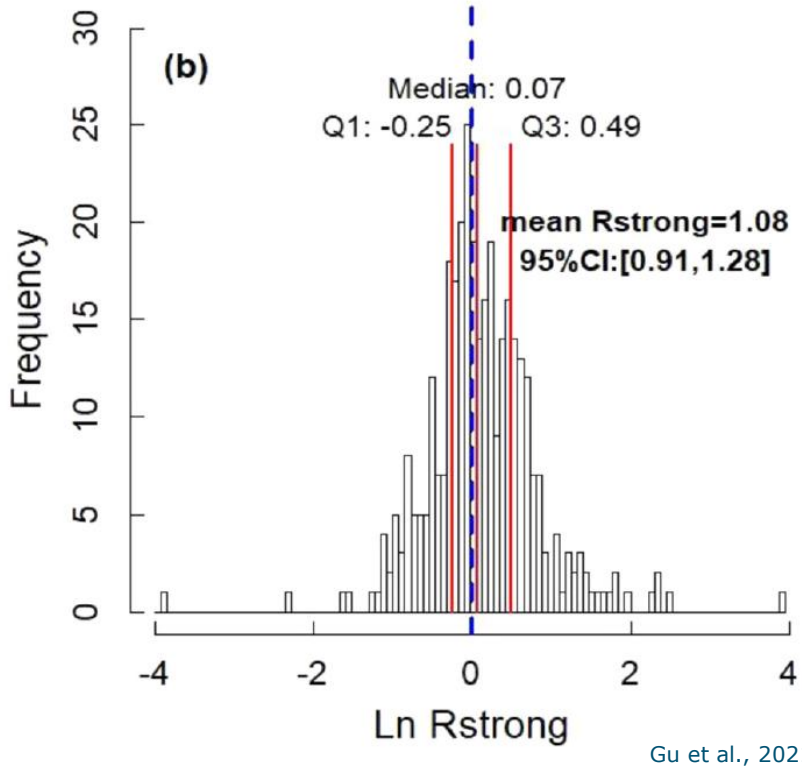


Crop diversity to combat weeds: Intercropping

$$R_{weak} = \frac{Y_{w,ic}}{Y_{w,weak}}$$

$$R_{strong} = \frac{Y_{w,ic}}{Y_{w,strong}}$$

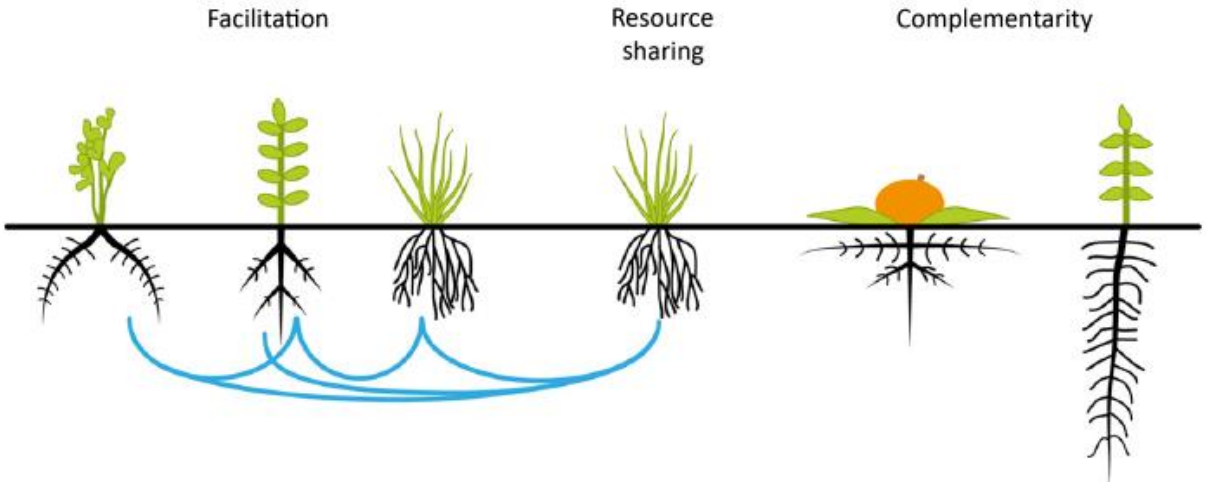




Gu et al., 2021

Proposed weed suppression mechanisms

- Complementarity: more resources together than apart
- Facilitation: crops supporting each other
- Selection: the more dominant species takes more than its fair share in the intercrop

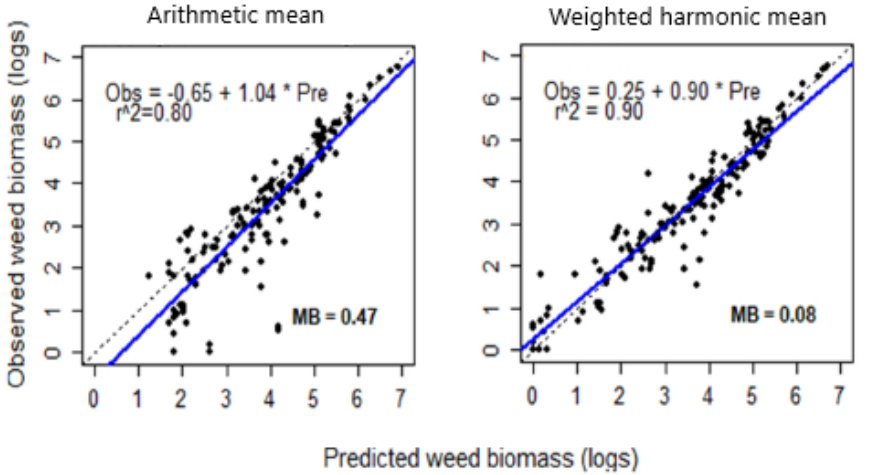


Adapted from Brooker et al., 2015

Weed suppression in intercrops

- Mainly selection effect
- No systematic overestimation -> No complementarity or facilitation
- **Arithmetic mean**: average weed biomass (Y_w) of sole stands (c_1, c_2)
- **Harmonic mean**: accounts for disproportional contribution of component species (i.e. selection)

$$Y_{w,ic} = \frac{\rho_1 Y_{w,c_1} + \rho_2 Y_{w,c_2}}{\rho_1 + \rho_2} \qquad Y_{w,ic} = \frac{1}{\rho_1 \left(\frac{1}{Y_{w,c_1}}\right) + \rho_2 \left(\frac{1}{Y_{w,c_2}}\right)}$$

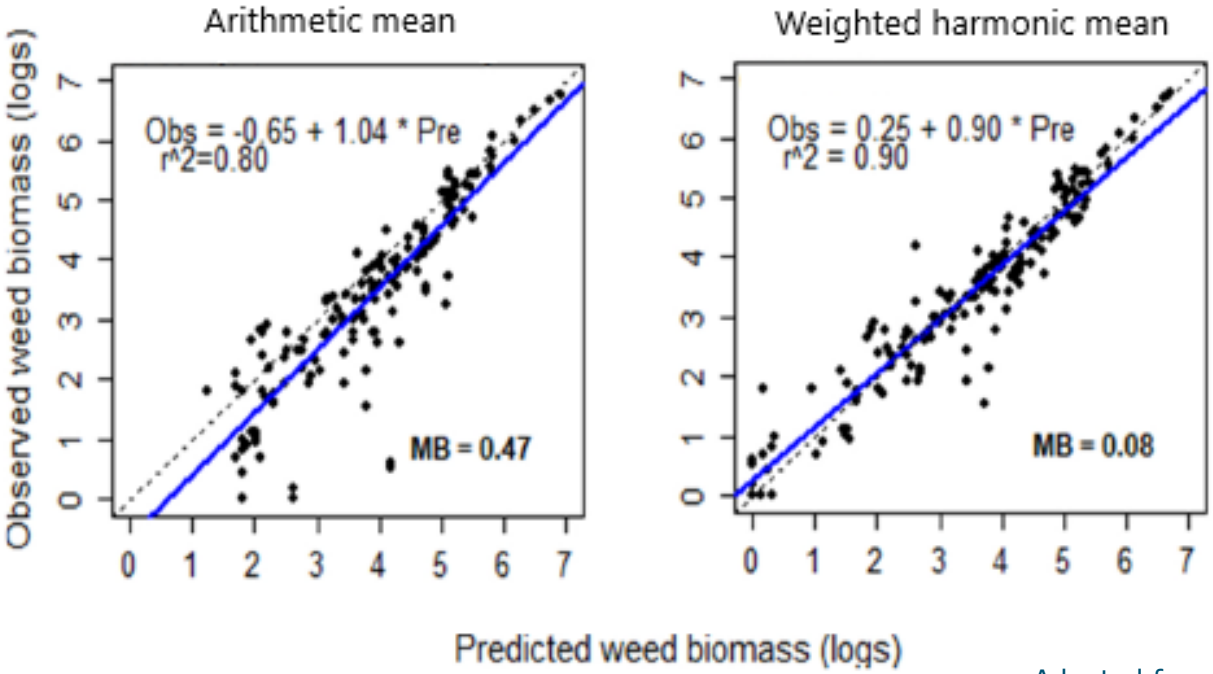


Adapted from Gu et al., 2022

Weed suppression in intercrops

$$Y_{w,ic} = \frac{\rho_1 Y_{w,c_1} + \rho_2 Y_{w,c_2}}{\rho_1 + \rho_2}$$

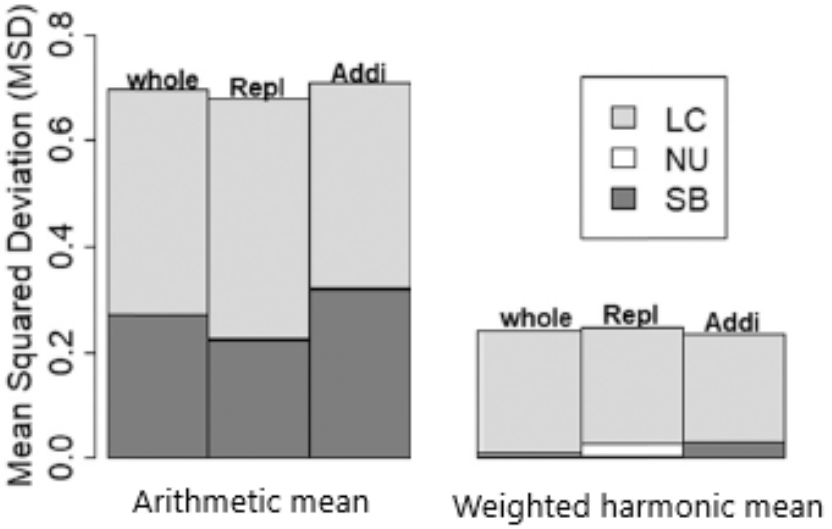
$$Y_{w,ic} = \frac{1}{\rho_1 \left(\frac{1}{Y_{w,c_1}}\right) + \rho_2 \left(\frac{1}{Y_{w,c_2}}\right)}$$



Adapted from Gu et al., 2022

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Adapted from Gu et al., 2022

Understanding and optimising weed suppression

- *What are the mechanisms of weed suppression in cereal-legume intercrops?*
    - Investigating species composition and spatial design
- *How are these mechanisms expressed at the crop level?*
    - Canopy cover
    - Light interception









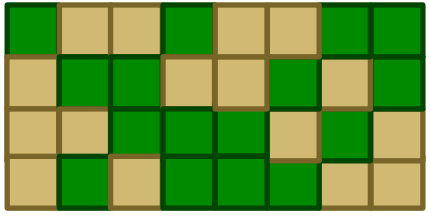
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Experimental design

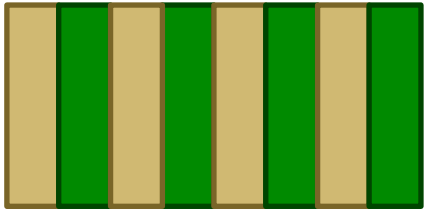
- 2022: Barley, Rye, Triticale, & Wheat with Pea, Lupine, & Faba
- 2023 A: Triticale & Faba, different density and mix designs
- 2023 B: Triticale & Faba, different row distances
- 2024: Triticale & Faba, also looking at root trait plasticity



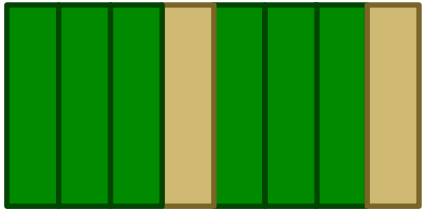
Full mix



1:1 Rows

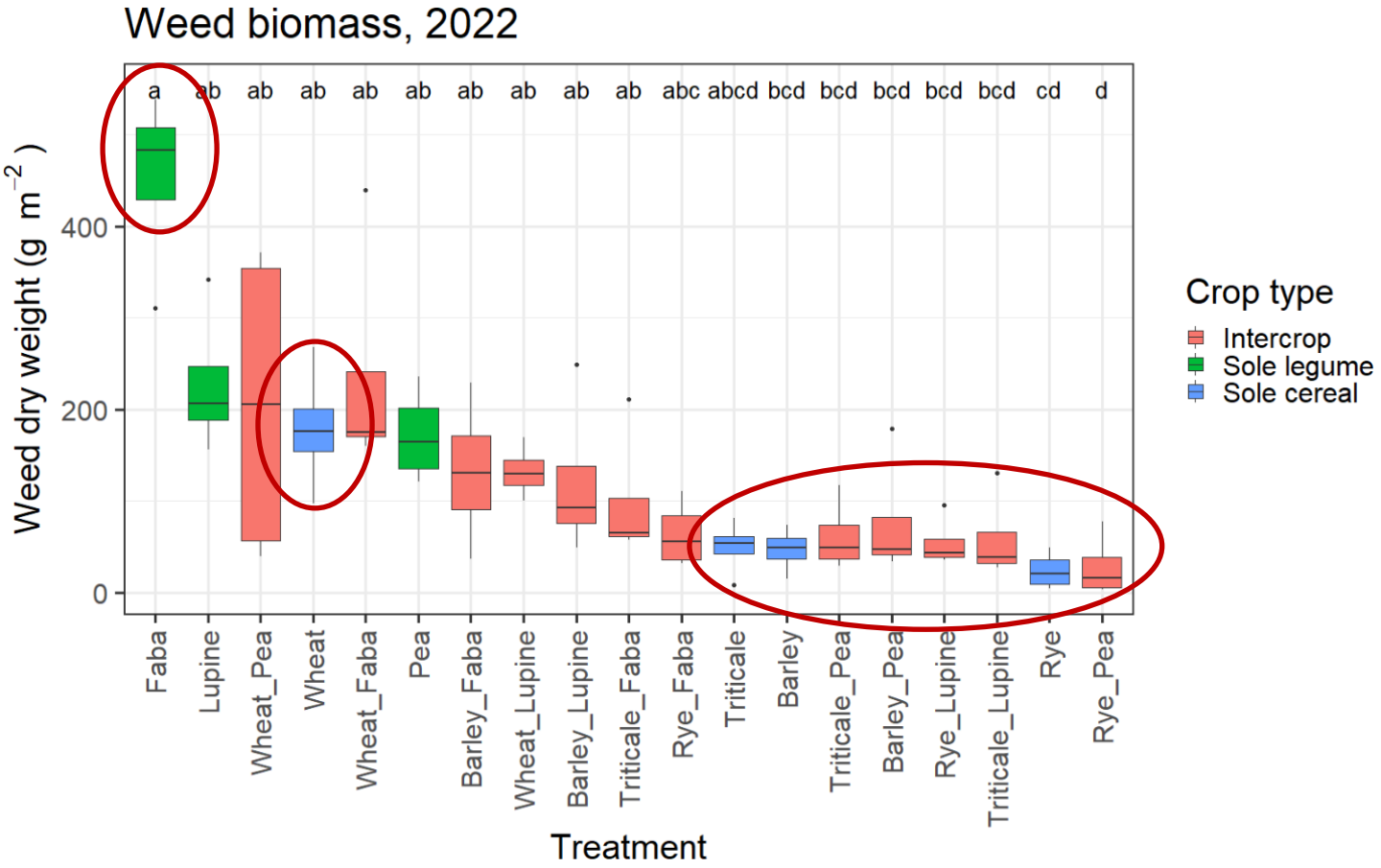


3:1 Strips

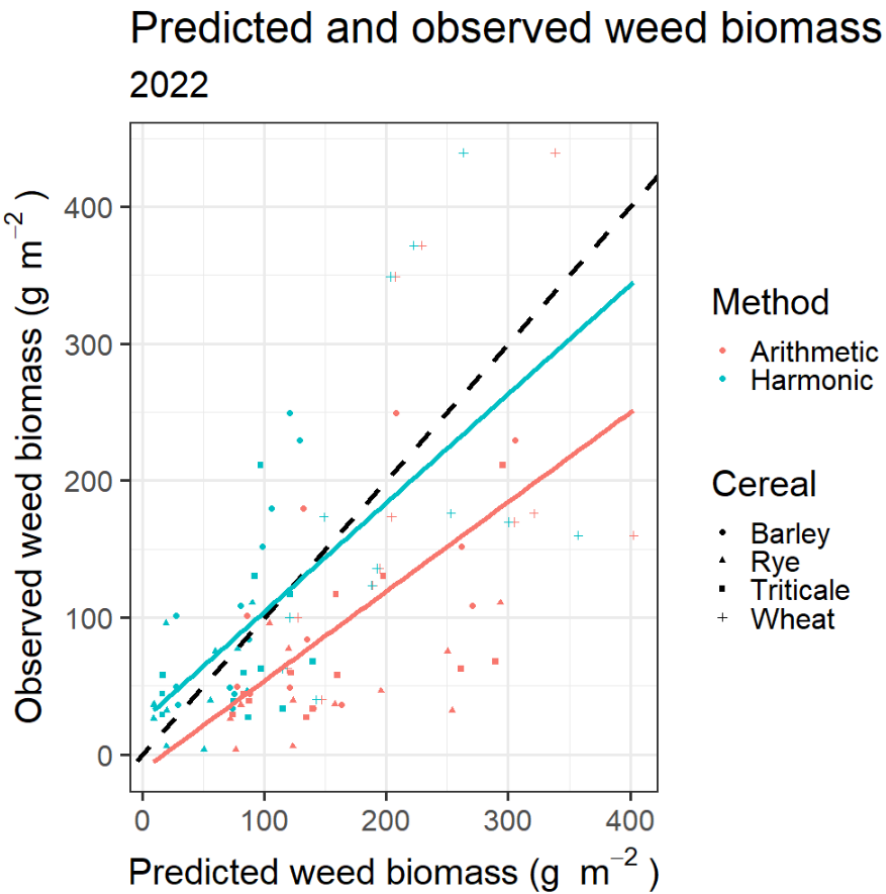


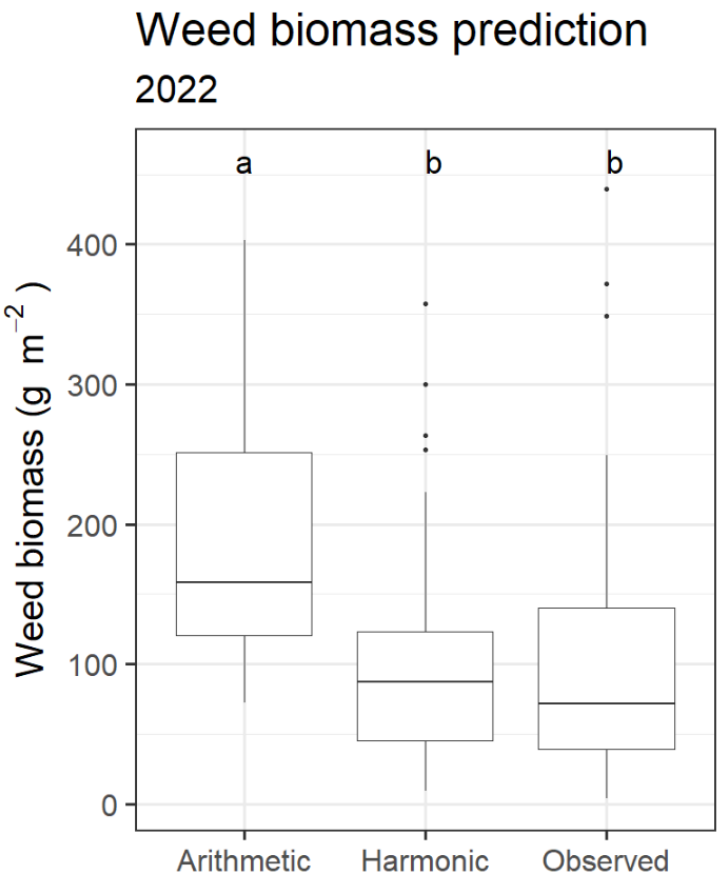
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Results weed biomass



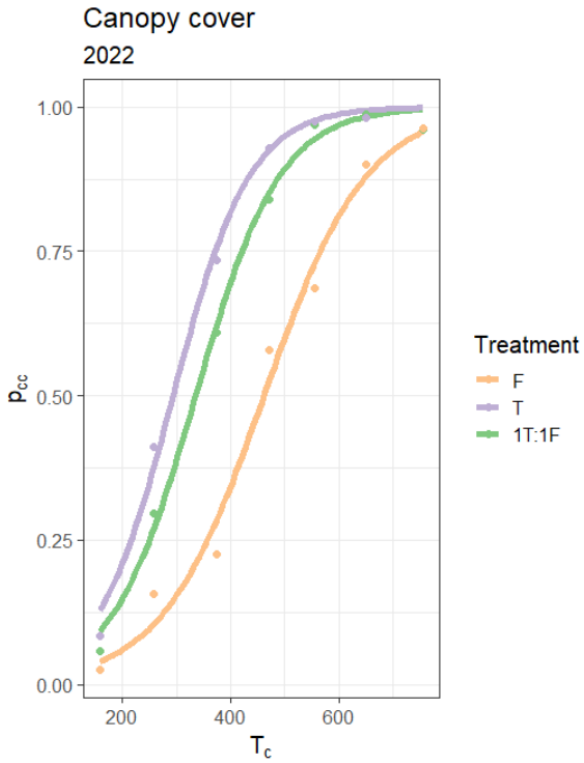
Results harmonic means

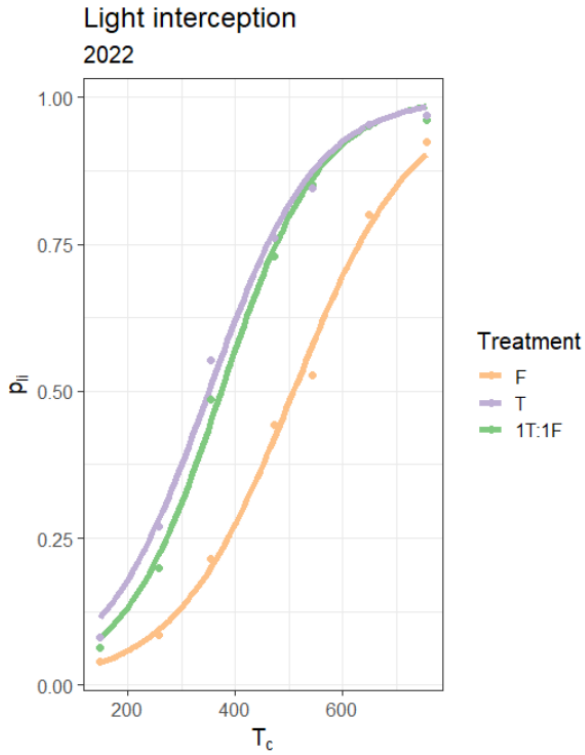




Results

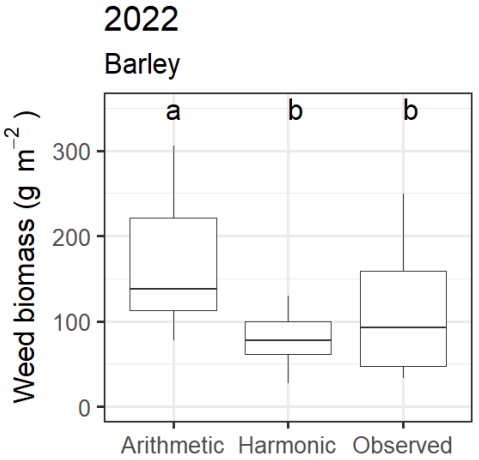
Canopy cover & light interception

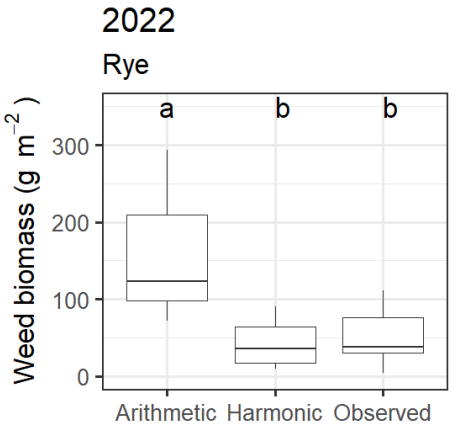


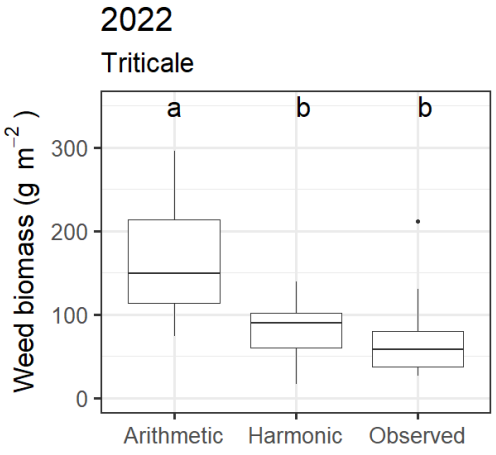


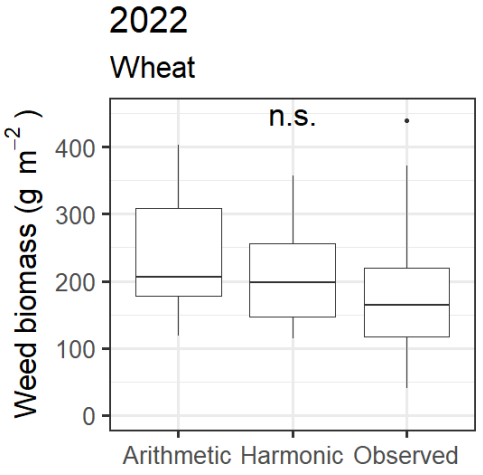
Results

Selection effect









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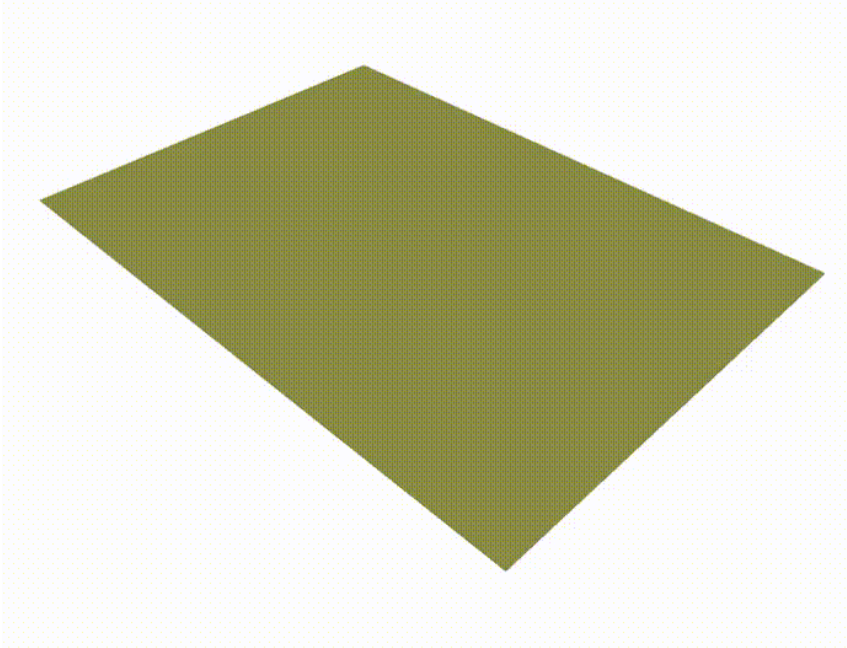
Conclusions

- Cereal-legume intercrop systems have the potential of enhanced weed suppression
- The selection-effect is the main mechanism of enhanced weed suppression
- The selection-effect is expressed in canopy cover and light-interception



Future perspectives

- Plant trait analyses
- Crop modelling
- Identifying and quantifying plant trait plasticity
    - Breeding target selection
- Below-ground plasticity



Questions, comments, discussion points?

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david.kottelenberg@wur.nl



