2023: A soil odyssey - **He**A**t**ed soi**L**-**M**onoliths (HAL-Ms) to examine the effect of heat emission from HVDC underground cables on plant growth

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Renewable energy for sustainable and climate-neutral electricity production

BACKGROUND

High-voltage direct-current (HVDC) transmission via underground cables can connect large production sides with consumer regions

In Germany, almost 5,000 km of new power line projects with an initial start date of 2038 or earlier are planned

Uhlig × DALL-E - Mensch & KI

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Only **little is known** about the effect of long-term heat emission from a HVDC underground cable on root growth, plant development and yield

BACKGROUND

- These cables emit heat during transmission
- Temperature in the root zone can affect root growth in different ways and intensities
  -> **Thermotropism**
  (Muthert und Izzo - 2020 - Root Tropisms: Investigations on Earth and in Space to Unravel Plant Growth Direction)
- Concerns about yield losses and plant health

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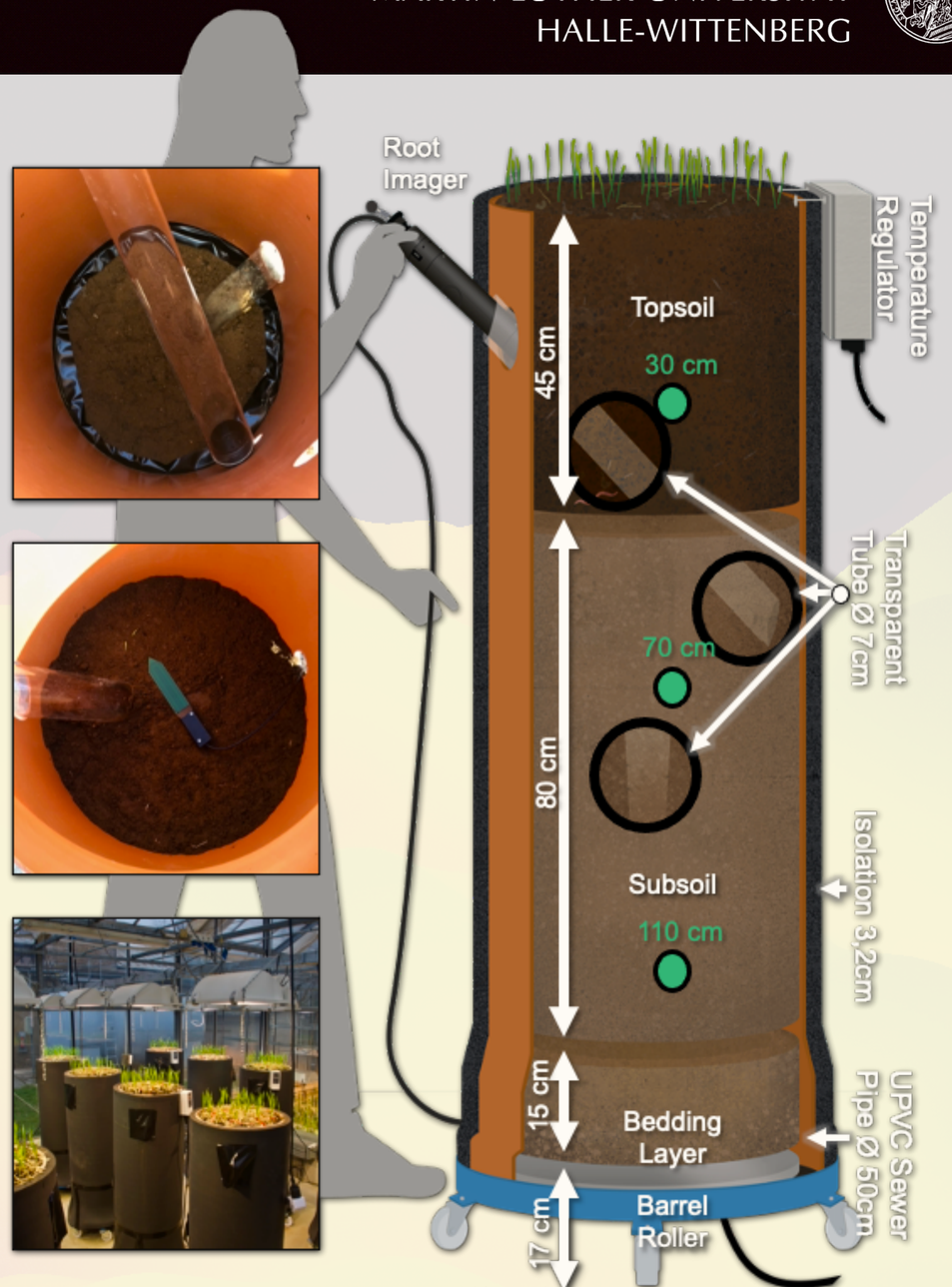
MATERIAL & METHODES

	24x HeAted soiL Monoliths (HAL-M)											
Natural soils extracted from two different sites	12x LOESS (12) Topsoil: **Silt** (10 % Sand, 7 % Clay) Subsoil: **Silt loam** (10% Sand, 12 % Clay)						12x SAND (12) Topsoil: **Loam** (35 % Sand, 23 % Clay) Subsoil: **Sand** (92 % Sand, 5 % Clay)					
Treatment	6x CTRL			6x HEAT 50°C			6x CTRL			6x HEAT 50°C		
Precipitations 407 (DRY), 527 (MID), 678 (WET) mm	2x DRY	2x MID	2x WET	2x DRY	2x MID	2x WET	2x DRY	2x MID	2x WET	2x DRY	2x MID	2x WET
Crop rotation with 4 growth phases (GP)	GP1 spring barley (*Hordeum vulgare*) GP2.sugar beets (*Beta vulgaris*) GP3 spring wheat (*Triticum aestivum*)											
	(Setup changed! Only MID precipitation) GP4 lucerne (*Medicago sativa*) and spring barley											



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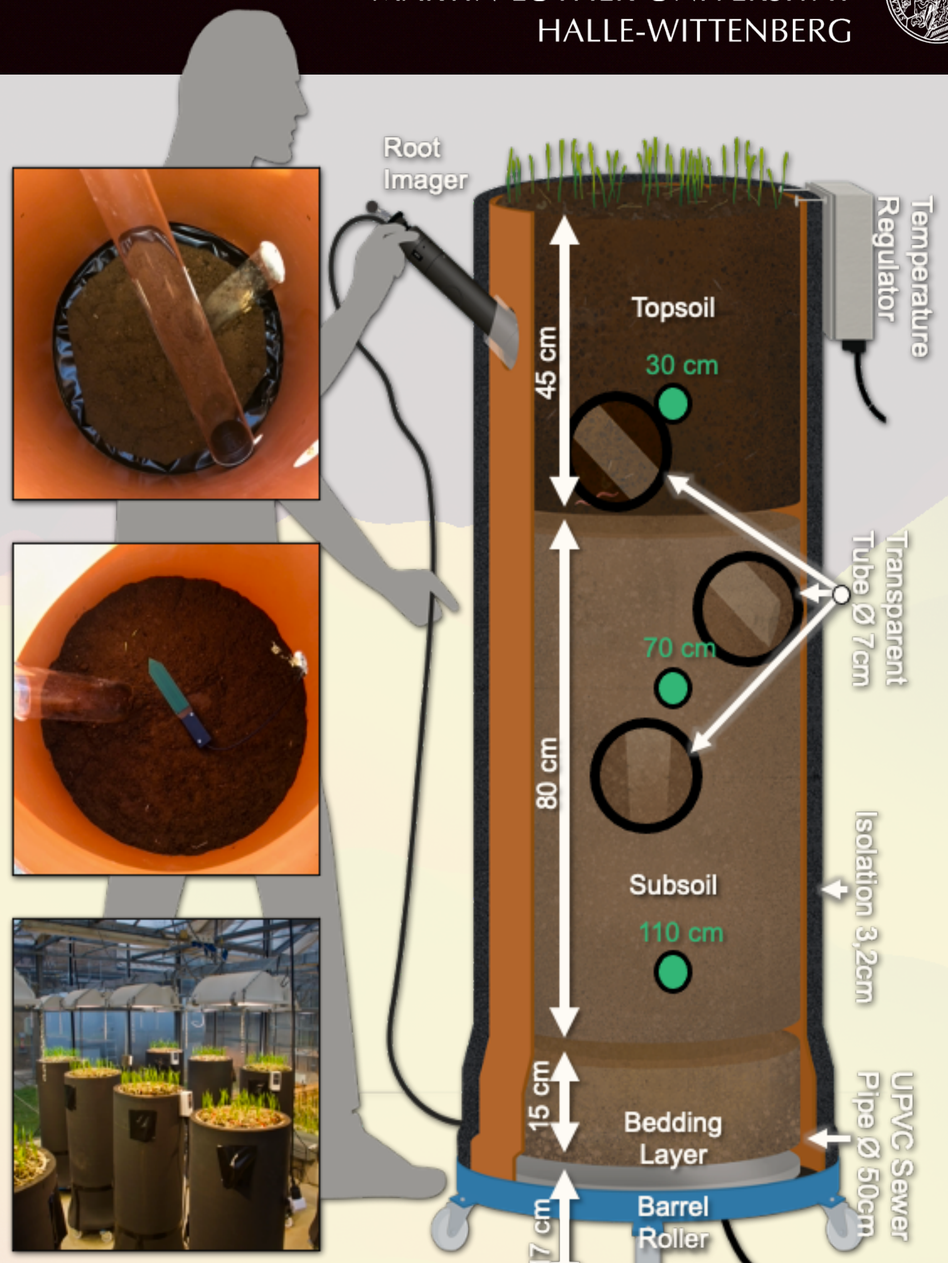
MATERIAL & METHODES

Picture: Uhlig



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Some results

- **Soil Temperature**
- **Yield** (dry mass of grain, beet root and above biomass)
- **Root Intensity** (as intersection per 1 m gridline; range 22- 53 and 71-101 cm below ground; maximum occurring values were averaged over all depths)

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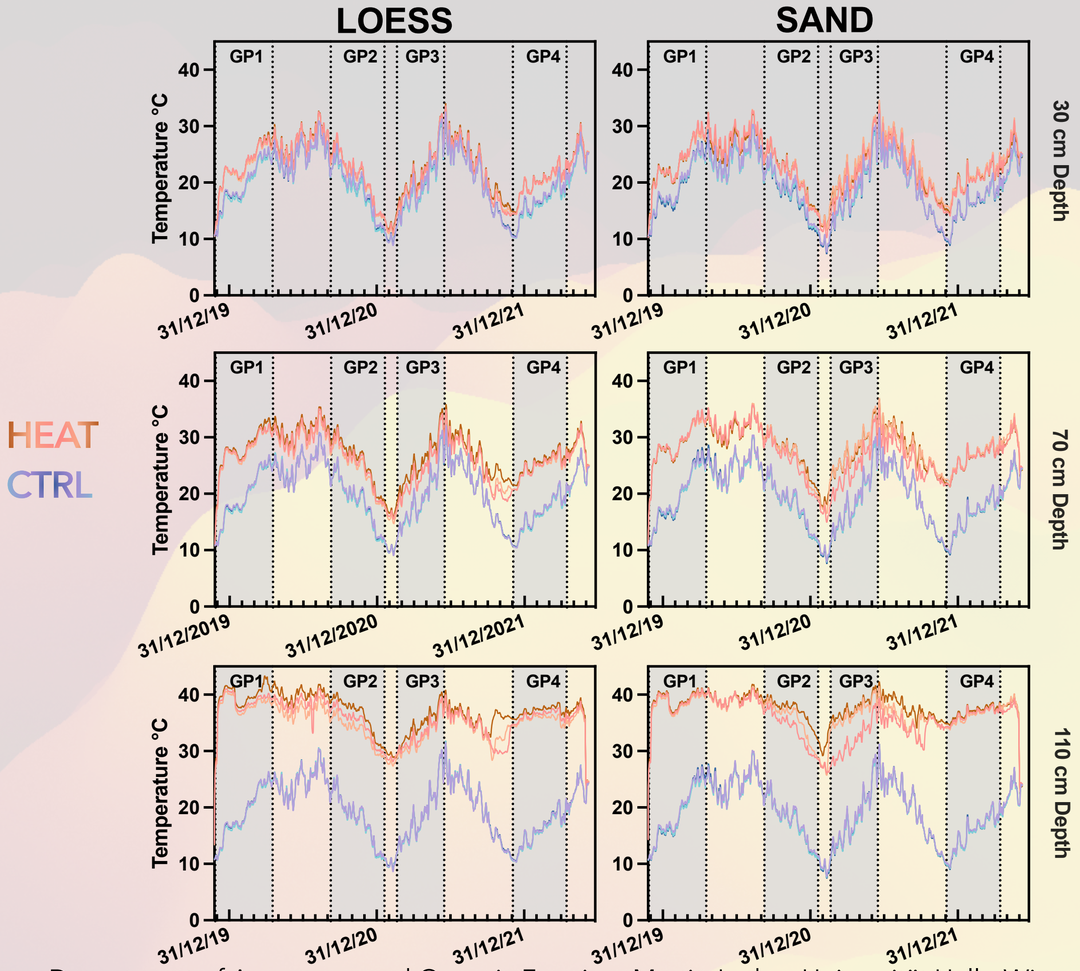
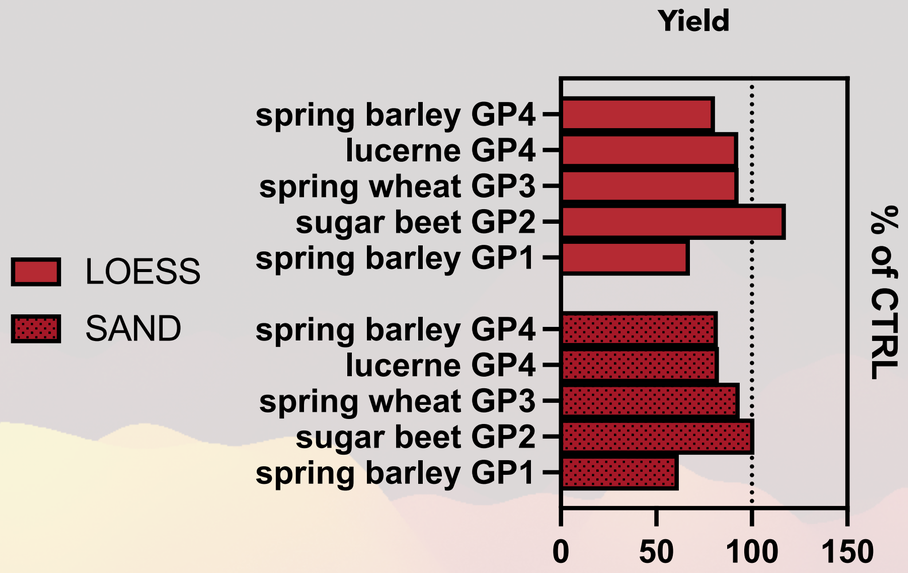
RESULTS

Temperatures in 30, 70 and 110 cm depth were on average **3.2 (± 0.7), 7.8 (± 1.4) and 17.9 (± 2,8) °C higher** than the control



RESULTS



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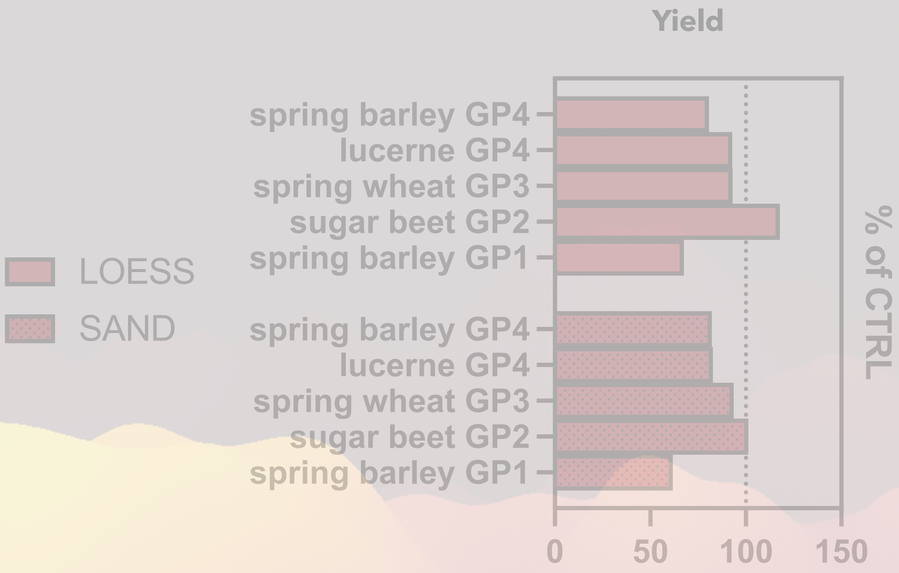
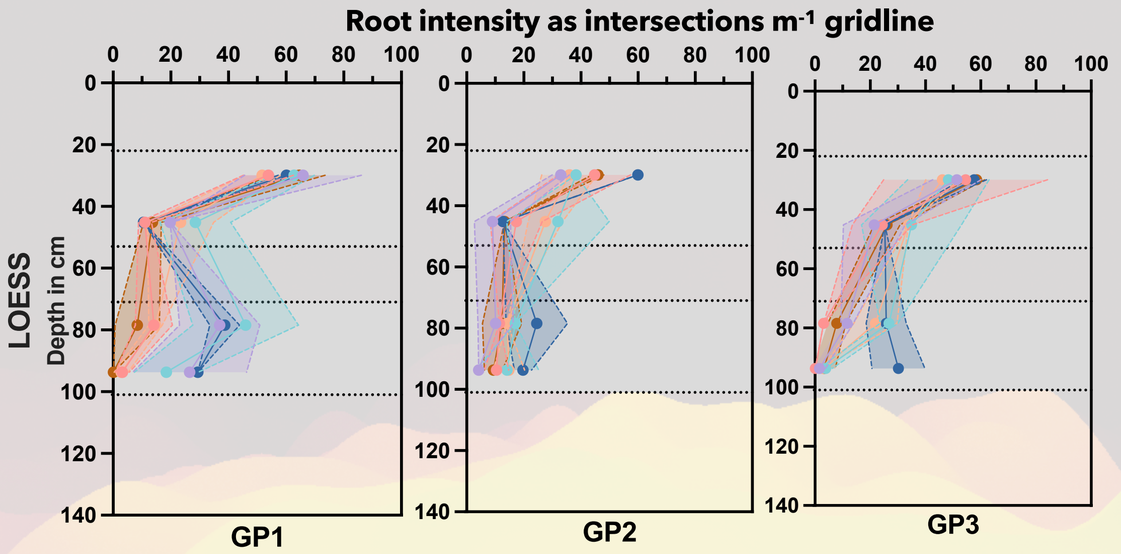
RESULTS





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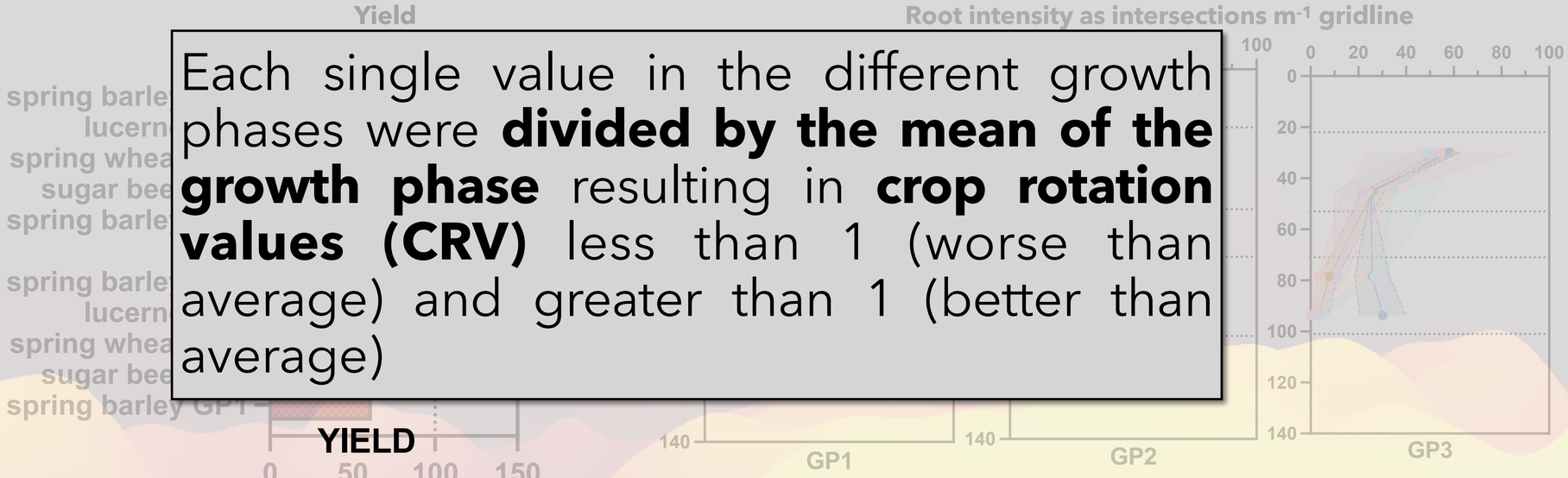
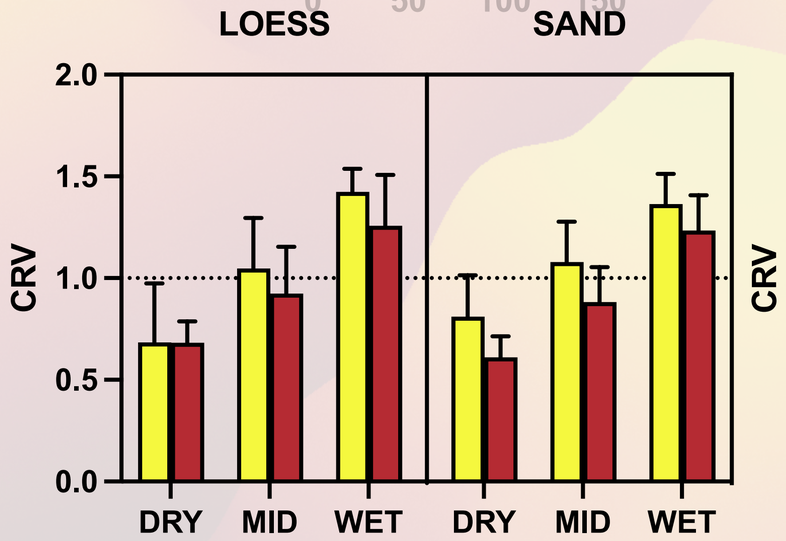
RESULTS

Each single value in the different growth phases were **divided by the mean of the growth phase** resulting in **crop rotation values (CRV)** less than 1 (worse than average) and greater than 1 (better than average)





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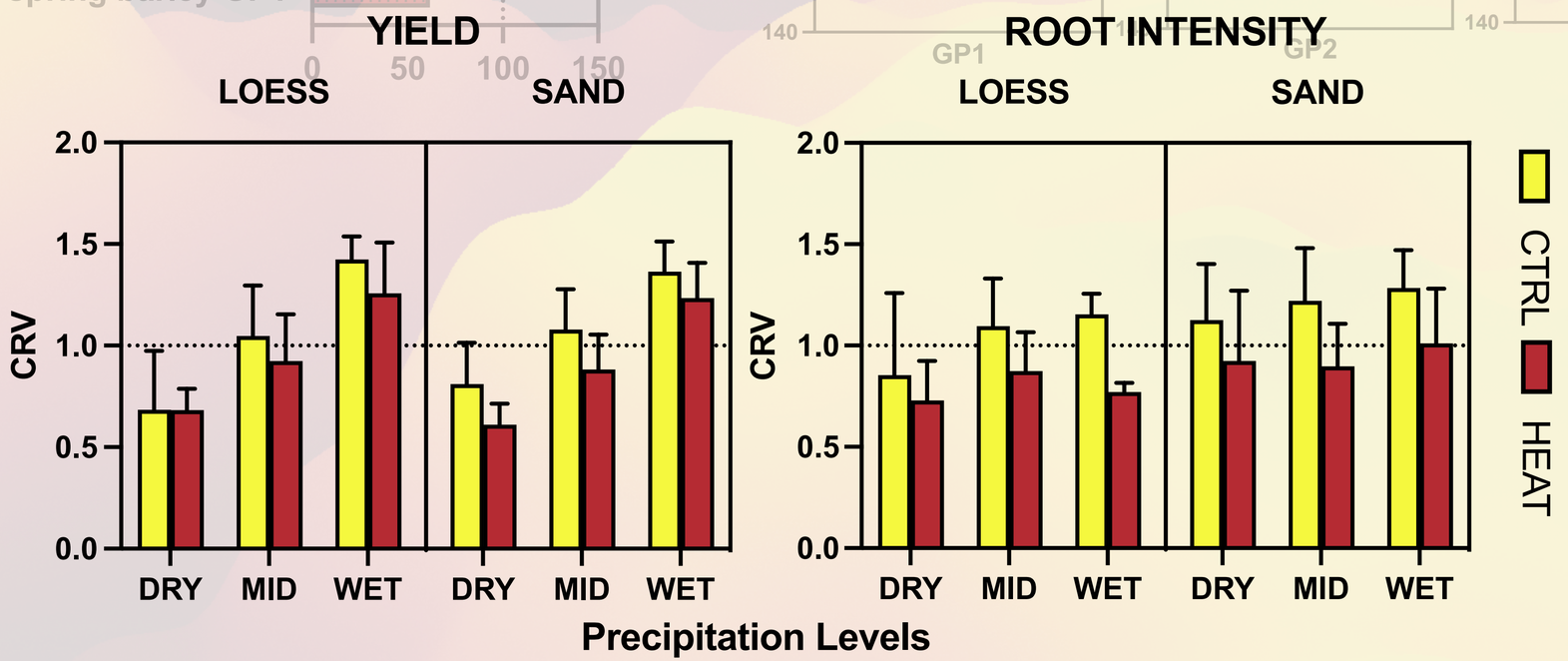
RESULTS

Yield (p = 0.0038) and **root intensity (p < 0.0001)** was affected by the heat emission. **Precipitation influenced yield (p < 0.0001)**, while root intensity was **affected by soil type (p = 0.0032)**



Conclusions

- This experimental design **could serve as a low-cost, fast and reliable standard for investigating thermal issues** related to various soil compositions and types, precipitation regimes and crop plants affected by similar projects
- Beyond our research question, the **HAL-M technique could serve as a link between pot and field** trials with the advantages of both approaches
- This method **could enrich many research areas** with the aim of controlling natural soil and plant conditions

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