Catch crops affect the root system distribution of subsequently grown maize

Diana Heuermann[1], **Stefanie Döll[2]**, **Nicolaus von Wirén[1] and the CATCHY consortium**

[1] Leibniz Institute of Plant Genetics and Crop Plant Research, Corrensstr. 3, 06466 Gatersleben, Germany
[2] Leibniz Institute of Plant Biochemistry, Weinberg 3, 06120, Halle (Saale), Germany

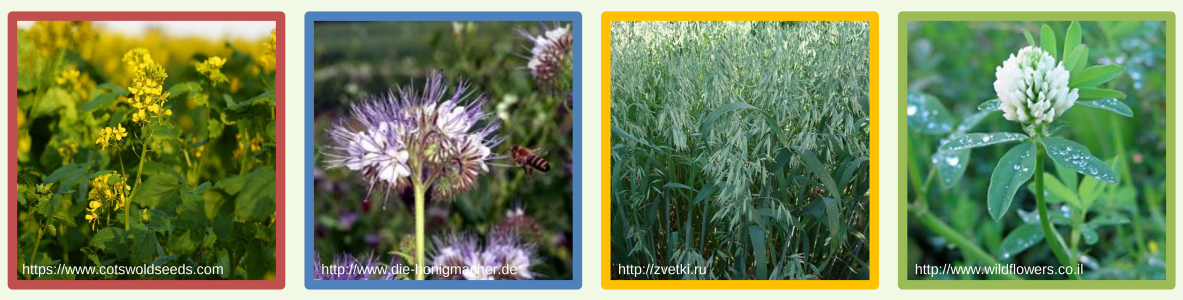
Introduction

Maize is one of the most important agricultural crops and worldwide with a production area ranked second in 2019 (www.fao.org). But with progressing climate change due to increased drought and heat periods, yield losses are expected (Zampieri et al., 2019). A deep root system of plants improves water uptake as water availability is higher in deeper soil horizons (Lynch, 2013). Also, the uptake of easily leachable nitrate profits from deep rooting (Heuermann et al., 2019; Lynch, 2013), while reservoirs of less soil-mobile nutrients like phosphorus and potassium may be more efficiently explored when roots proliferate in the topsoil (Lynch, 2019). When roots die and decompose they leave low-resistant, nutrient-rich pores providing favorable conditions for roots of following plants penetrating the soil (Athmann et al., 2013). This study aims at identifying the impact of four catch crops with different root system distributions on the root growth of a following maize crop.

Catch crop variants:

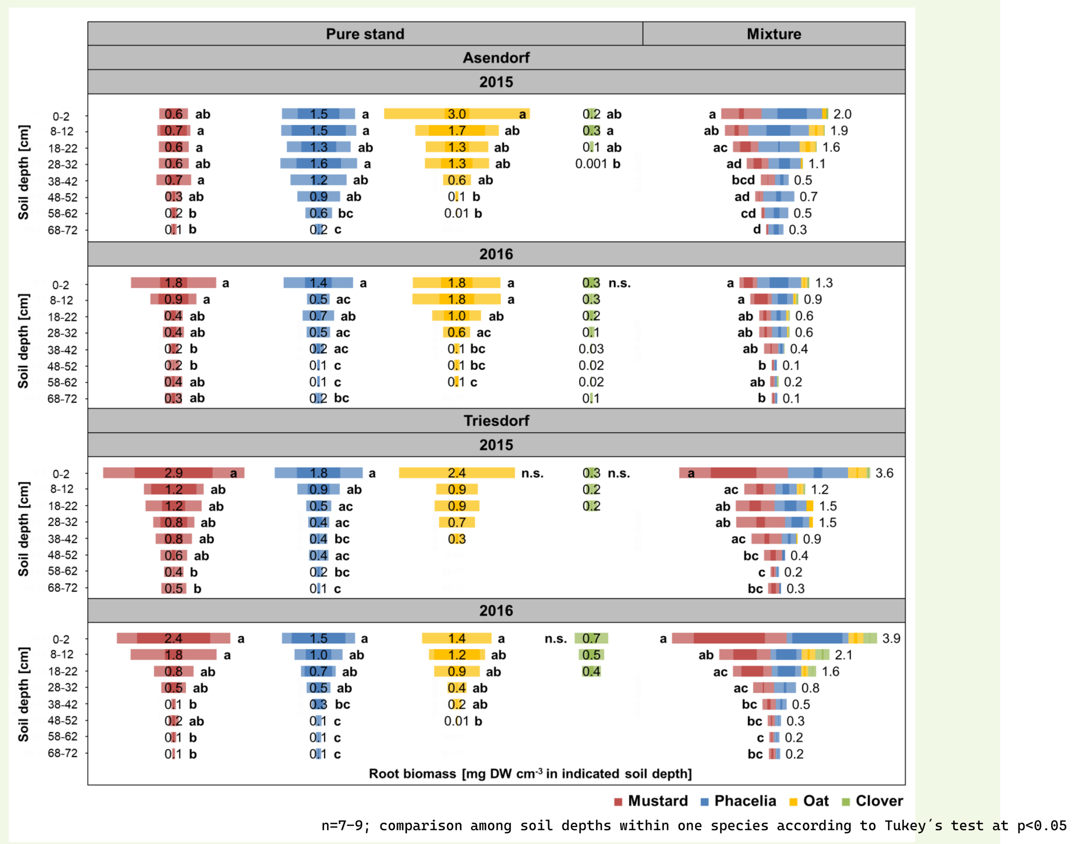
Pure stands

White mustard	Lacy phacelia	Bristle oat	Egyptian clover
Brassicaceae	Hydrophyllaceae	Poaceae	Fabaceae



+ 4-species mixture / + control (fallow)

qPCR-based root biomass quantification in soil cores using ITS1/2 for species specification



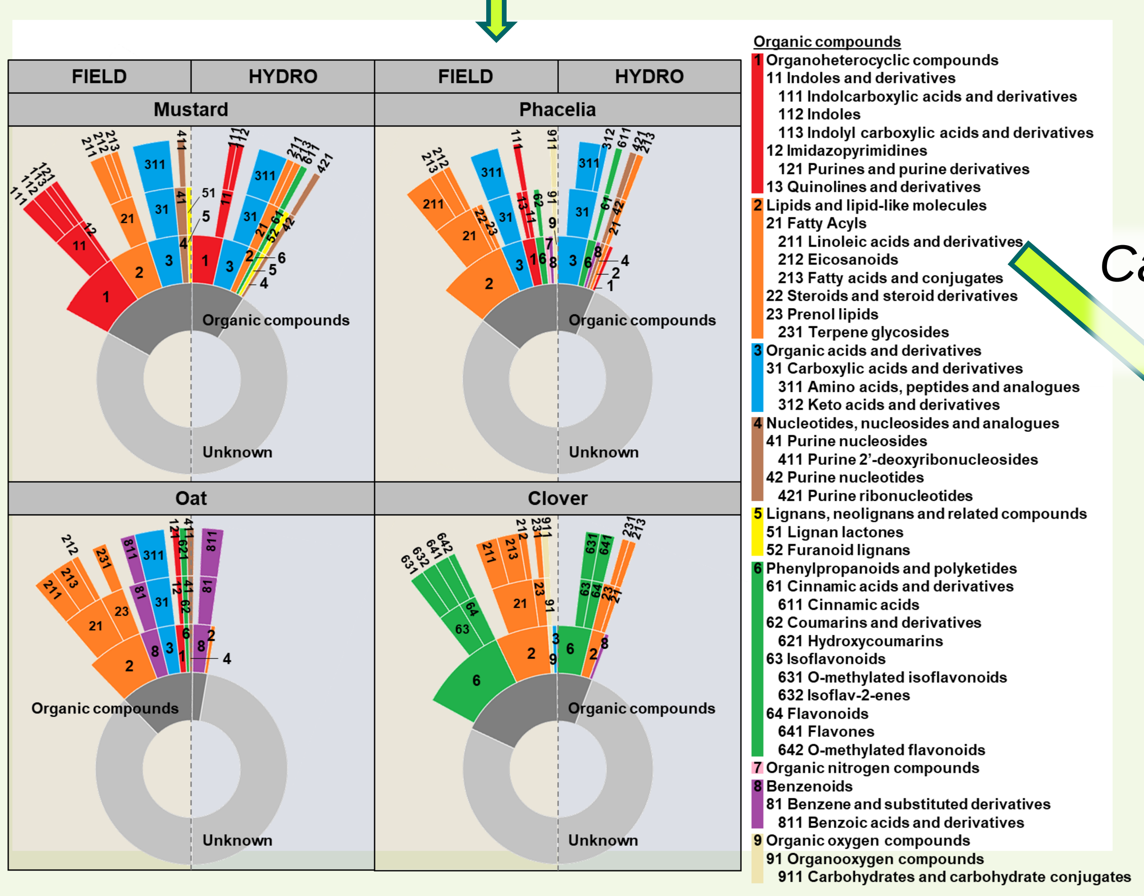
Mustard and phacelia developed deepest root systems, while clover only reached 20-30 cm

Soil nutrient and water distribution before maize sowing were not related to its root biomass distribution

(not shown here)

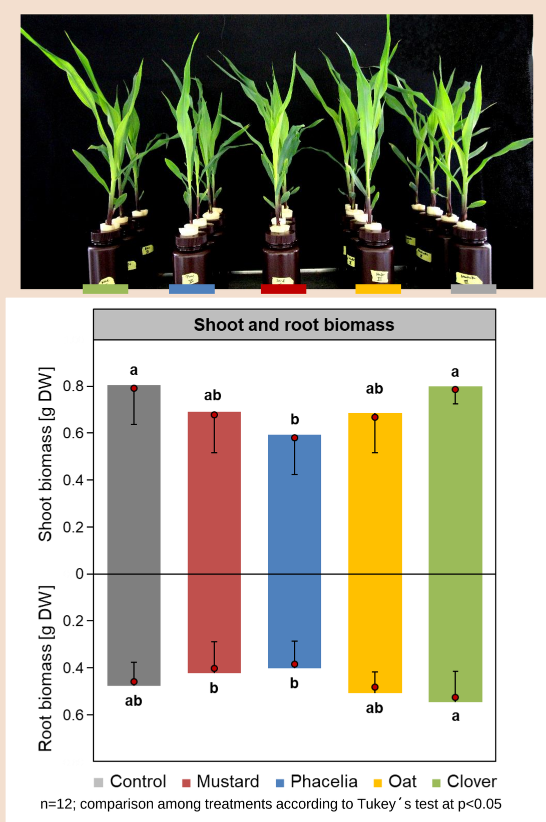
Deep-rooting catch crops had no benefit for rooting depth of maize

Non-targeted metabolite profiling in root exudates from field and hydroponic sampling, classification of annotated compounds

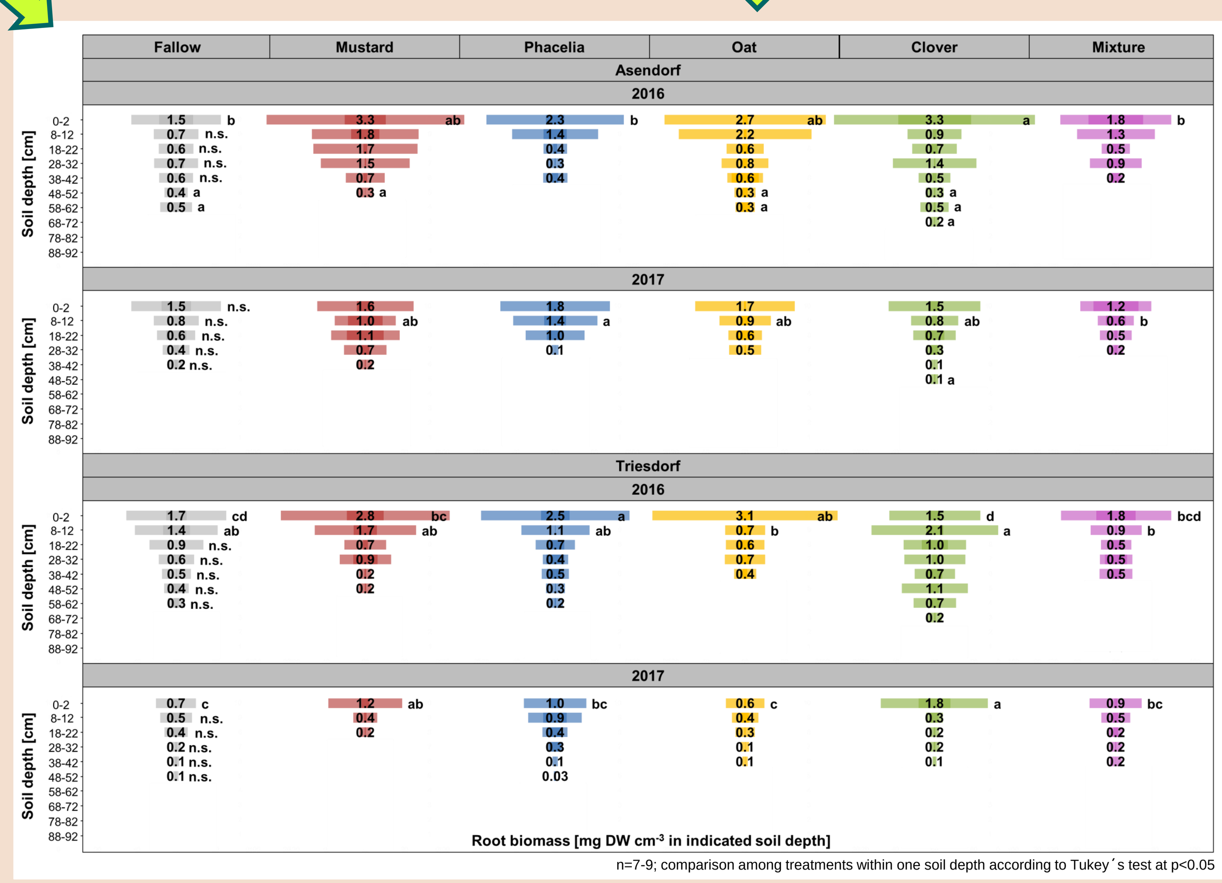


Catch crops released species-specific root exudate profiles

Catch crop root exudates affected root growth of maize



In a bioassay, mustard and phacelia tended to inhibit maize root growth, while clover improved it



In the field, clover stimulated rooting depth of maize, while other catch crops impaired deep-rooting

Conclusion & Outlook

Metabolites released by catch crops may to a certain extend affect the root system distribution of maize. However, since root exudates are rapidly converted in soils (Jones et al., 2003), **metabolite profiling in soil solution** at maize sowing may hint to compounds with potential allelopathic effects on maize. Additionally, the **impact of root exudates on the soil microbiome** will be investigated to study if root exudates stimulate beneficial or detrimental communities in the soil.

Zampieri et al. (2019) When Will Current Climate Extremes Affecting Maize Production Become the Norm? Earth's Future 7. // Lynch (2013) Steep, cheap and deep: an ideotype to optimize water and N acquisition by maize root systems. Annals of Botany 112. // Heuermann et al. (2019) Interspecific competition among catch crops modifies vertical root biomass distribution and nitrate scavenging in soils. Sci. Rep. 9:11531. // Lynch (2019) Root phenotypes for improved nutrient capture: an underexploited opportunity for global agriculture. New Phytologist 223. // Athmann et al. (2013) Root growth in biopores—evaluation with in situ endoscopy. Plant and Soil 371. // Jones et al. (2003) Organic acid behavior in soils – misconceptions and knowledge gaps. Plant and Soil 248.

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