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The effect of modifying rooting depths and nitrification inhibitors on nutrient uptake from organic biogas residues in maize

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Optimizing the application of and nutrient uptake from organic nutrient sources, such as the nutrient-rich residues ("digestates") from the biogas industry, is becoming a viable option in remediating fertility on previously unsuitable soils for agricultural utilization. Proposedly, concurrent changes in root system architecture and functioning could also serve as the basis of future phytomining approaches. Herein, we evaluate the effect of spatial nutrient availability and nitrification on maize root architecture and nutrient uptake.
We test these effects by applying maize-based digestate at a rate of 170 kg/ha in layers of varying depths (10, 25 and 40 cm) and through either the presence or absence of nitrification inhibitors. In order to regularly monitor above- and below-ground plant biomass production, we used the noninvasive phenotyping platform, GROWSCREEN-Rhizo at the Forschungszentrum Jülich, using rhizotrons (Nagel et al., 2012). Measured parameters included projected plant height and leaf area, as well as root length and spatial distribution. Additionally, root diameters were quantified after the destructive harvest, 21 days after sowing (DAS).
Spatial nutrient availability significantly affected root system architecture, as for example root system size -the area occupied by roots- increased alongside nutrient layer depths. Fertilization also positively affected root length density (RLD). Within fertilized layers, the presence of nitrification inhibitors increased RLD by up to ∼30% and was most pronounced in the fine root biomass fraction (0.1 to 0.5mm). Generally, nitrification inhibitors promoted early plant growth by up to ∼45% across treatments. However, their effect varied in dependence of layer depths, leading to a time-delayed response in deeper layers, accounting for plants having to grow significantly longer roots in order to reach fertilized substrate. Nitrification inhibitors also initiated the comparatively early on-set of growth differences in shallower layers, where their effect on plant growth was temporarily most pronounced. At final harvest (21 DAS) however, effects of nitrification inhibitors on plant height were visible only in deeper layers. Furthermore, the statistically significant interaction between the factors time x layer depths x nitrification inhibitors underlined the dynamic influence of nitrification inhibitors on plant growth over time and across rooting depths.
This study offers insights into optimizing nutrient uptake and plant productivity by (re-) using residues from the biogas industry. It is among the first to monitor and try to explain the dynamics of nitrification inhibitors on root system architecture over time. A modified N-fertilization application scheme might also serve as a promising tool in optimizing phytoremediation and phytomining techniques through predictably altering root structure in fertilized layers.

References: Nagel, K. A. ; Putz, A. ; Gilmer, F. ; Heinz, K. ; Fischbach, A. ; Pfeifer, J. ; Faget, M. ; Blossfeld, S. ; Ernst, M. ; Dimaki, C. ; Kastenholz, B. ; Kleinert, A.-K. ; Galinski, A. ; Scharr, H. ; Fiorani, F. ; Schurr, U. (2012): GROWSCREEN-Rhizo is a novel phenotyping robot enabling simultaneous measurements of root and shoot growth for plants grown in soil-filled rhizotrons.
Functional plant biology 39(11), 891-904.