Influence on soil aggregation by mycorrhizal inoculation of maize on a sandy soil

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Introduction

In agricultural practice, stable aggregation is of growing importance in times with higher frequencies of droughts. Well-aggregated soils can improve water infiltration and water holding capacity. Biological processes are responsible for the formation and persistence of aggregates but vary in time, and therefore aggregation varies.

The aim of the presented study was to monitor how aggregation varies over time and to test whether inoculation of arbuscular mycorrhizal fungi (AMF) can improve the formation of water-stable macroaggregates of sandy soils.

Material and Methods

From mid of April until the end of July 2018, a randomized field experiment with two variants (+ mycorrhiza (myc), - mycorrhiza (con)) and four replicates was set up on a sandy soil field (Ss to Su2) in Hollage, Lower Saxony. Inoculated maize seeds were coated with propagules of AMF, a mix of *Rizophagus irregularis* (53 %), *Funneliformis mosseae* (27 %), and *Funneliformis caledonium* (20 %), to guarantee mycorrhizal colonization of the maize roots. Whereas the frequency and intensity of AMF colonization were studied within maize roots (Fig. 1), water-stable macroaggregates, soil organic carbon, microbial biomass, and respiration were analyzed within pooled soil samples of the upper 10 cm.

To include soil texture as an explaining variable of soil aggregation, soil samples were taken from a second field, consisting of more loamy material (Sl4 to Ls4) in Belm, Lower Saxony.

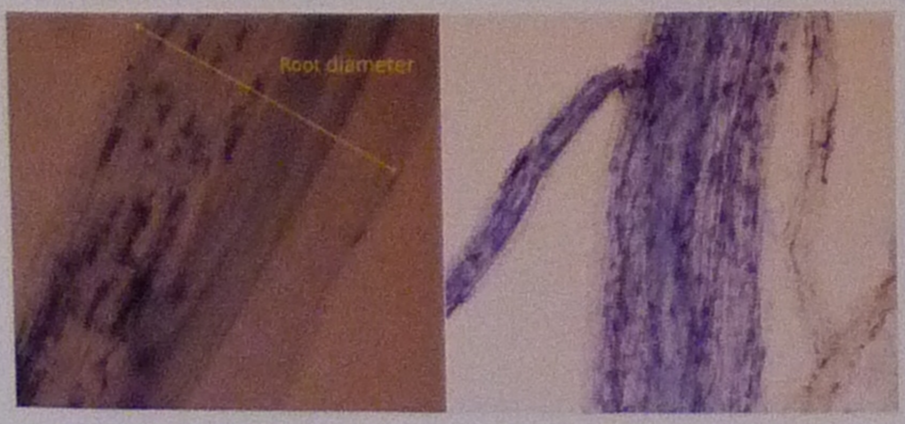

Fig.1: Roots colonized by arbuscular mycorrhizal fungi (left hyphae and arbuscules, 100-times of magnification; right hyphae, arbuscules, and vesicles, 40-times of magnification), the figure shows different states of intensity by mycorrhizal colonization

Results

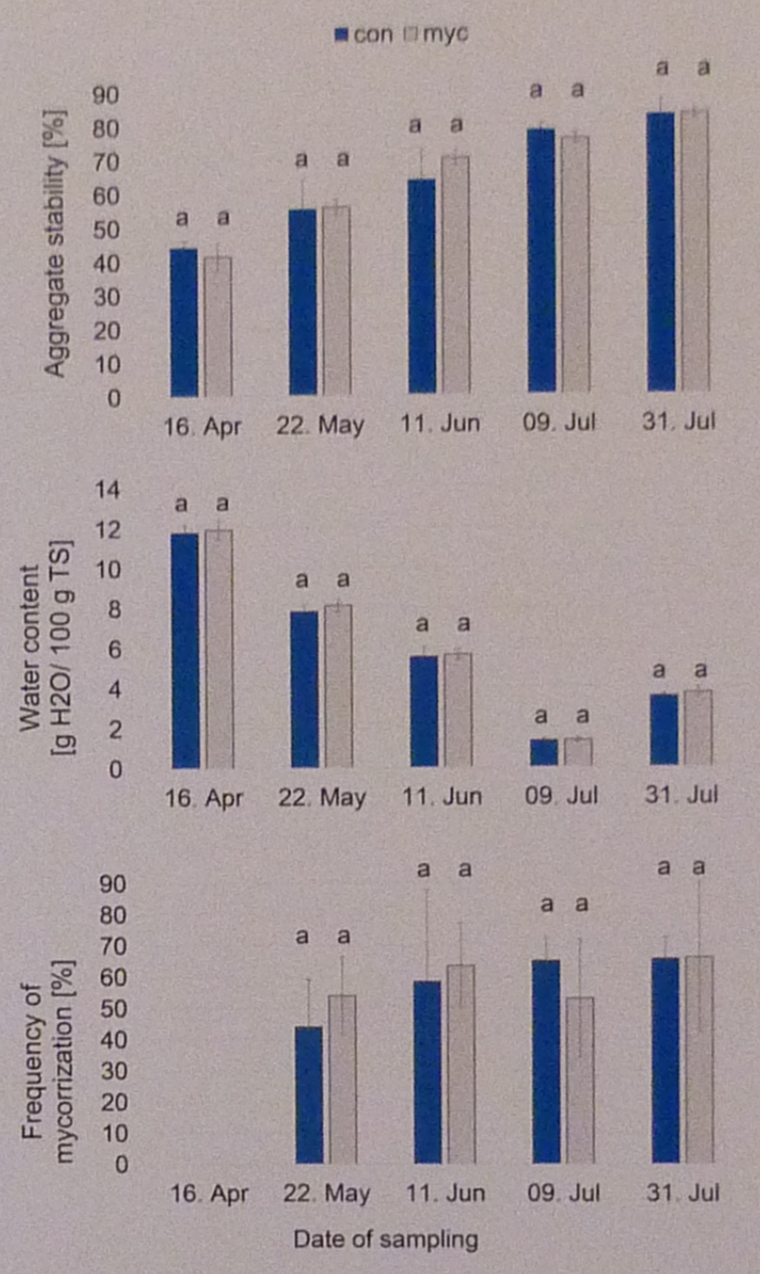

Fig. 2: Aggregate stability, water content and frequency of mycorrhization on inoculated (myc) and control plots (con), the first date of sampling (16. April) was before seeding occurred, arithmetic average ± standard error, n=4 with letters of Tukey's HSD-Test, same letters present no significant differences

Over the investigation period, an almost linear increase in water-stable macroaggregates from 40 to 80 % was observed. The frequency of mycorrhization showed a similar linear increase, whereas water content was decreasing during the period (Fig. 2). An analysis of variance showed no differences in mycorrhizal colonization between the inoculation treatments. Obviously, there was a high occurrence of native AMF in the investigated soil. However, there was a slight tendency that inoculated treatments (+ mycorrhiza) colonized faster at the beginning of the growing season than noninoculated (- mycorrhiza) and native AMF adapted better to drought.

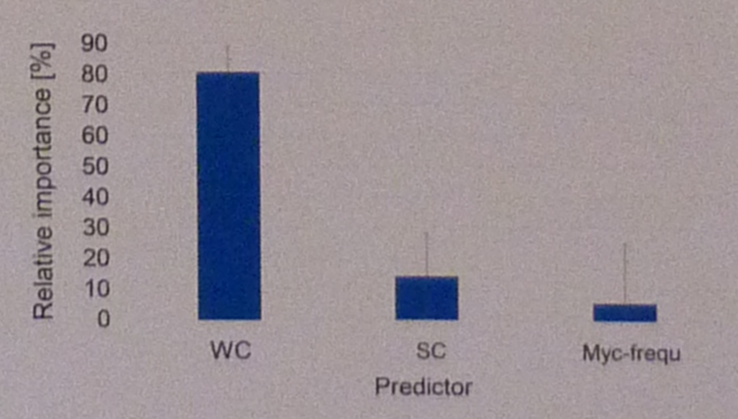

Fig. 3: The relative importance of each predictor with 95% confidence interval, WC - water content, SC - the content of sand, Myc-frequ - frequency of mycorrhization

A multiple linear regression included data of the sandy soil and loamy soil field and indicated that aggregate stability was mainly explained by the frequency of mycorrhization within biological predictors. The water content and soil texture defined aggregate stability best within physical predictors.

All these parameters explained 76 % of aggregate stability. The relative importance of each predictor is shown in Fig. 3.

Discussion and Conclusions

No effect of inoculation on mycorrhizal colonization was observed. Probably native AMF on the sandy soil field was as strong as the inoculated one or even more assertive than inoculated AMF. The presented data can not clarify exactly.

Although no differences in inoculation occurred, the study indicates a significant influence of mycorrhizal frequency on soil aggregation. Fungi stabilize soil aggregates with their hyphal network, and especially AMF foster aggregation due to the production of gluey substances like glomalin related soil proteins. 2018 was a warm year with low precipitation. The strong effect of decreasing water content could overlay the effect of AMF on aggregation. Besides that, decreasing water content can influence the release of gluey extracellular substances and higher their concentration during desiccation (Ritz & Young, 2011). Therefore desiccation can affect aggregate stability via soil microbiology.

References: Ritz, K., Young, I. (2011) (Hg.): The Architecture and Biology of Soils – Life in Inner Space. Oxfordshire, Cambridge: CAB International.

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