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Amorphous silica increases the water holding capacity of soils – from mechanistic understanding to field experiments

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A main problem currently facing agriculture is drought. More frequent and longer drought periods are predicted to threaten agricultural yields in future. The capacity of soils to hold water is a highly important factor controlling drought stress intensity for plants during the growing phase. Amorphous silica (ASi) has been suggested to be able to mitigate these problems. Amorphous silica pools in natural soils are in the range of 0-6%. However, ASi pools have declined in agricultural soils since the development of high intensity agriculture to values of <1% due to yearly crop harvests, decreasing the water holding capacity of the soils. Here, we analyzed the effect of ASi on the water holding capacity (WHC) of soils. ASi was mixed at varying rates with different soils. Afterwards, the retention curve of the soils was determined. Here we show that ASi increases the soil water holding capacity substantially, by forming silica gels with a water content at soil saturation higher than 700%. An increase of ASi by 1% or 5% (weight) increased the water content at all studied water potentials and plant available water increased by >40% and >60%, respectively. In a lysimeter experiment we found that ASi strongly increased the WHC of soils, too. In a field experiment we found an increase of soil moisture after ASi fertilization over the whole growing season. Furthermore, wheat plant grown in this field experiment suffered less from drought and had a later onset of senescence. Our results suggest that ASi is a main control on soil water availability, potentially decreases drought stress for plants in future.