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Amorphous silica increases the water holding capacity and the phosphorus mobility in soils - solving the two main problems of agriculture

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The two primary problems currently facing agriculture are drought and the availability of mineable phosphorus minerals used for fertilization. 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. High phosphorus availability in soils is necessary for high agricultural yield. For both drought and phosphorus availability in soils 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 water the holding capacity of the soils. Here, we analyzed the effect of ASi on the water holding capacity (WHC) of soil and how the ASi effects the mobilization of phosphorus. 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. Additionally, we fertilized soils with ASi and measured phosphorus mobilization from the solid phase into the soil pore waters. We found a strong mobilization of phosphorus by ASi. In a lysimeter experiment we found that ASi strongly increased the WHC of soils. Furthermore, as expected from the batch experiments the ASi is decreased phosphorus sorption to soil minerals and consequently increased its mobilization. Our results suggest that ASi addition to soils enhances the water availability, potentially decreases drought stress for plants as well as increasing phosphorus mobility in soil of terrestrial ecosystems.