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Investigating the link between soil and plant silica content in the context of research on wheat resistance to drought stress under Mediterranean climate

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Silicon (Si) is known to have many beneficial effects for plants, among which an improved resistance of plants against drought stress. Such effect might be extremely valuable in some Mediterranean regions, where global climate change is expected to result in warming by 1-1.5°C, combined with a decrease in precipitation by up to 10% by the end of the 21st century. Silicon is present in many different forms and pools in soils, which can be more or less easily accessible for plants. In general, a higher content of easily accessible Si (bioavailable Si) should translate into a higher Si content in the plants. The aim of this project is to test the potential of Si fertilisation for wheat cultivation under Mediterranean climate. In order to better assess the need for Si fertilisation and the type of soils that would benefit the most from it, we carried out a series of measurements on soils and plants collected from a selection of 39 wheat fields from the regions of Rabat and Settat in Morocco. Different Si pools in soil samples (mobile Si, adsorbed Si, Si bound to soil organic matter (SOM), Si occluded in pedogenic oxides and amorphous silica) were quantified using the sequential Si extraction of Georgiadis et al. (2013). These Si pools are then compared with various soil parameters and with the Si content of plants growing on these soils. The tested soils include Leptosols, Cambisols, Luvisols, and Vertisols.

Our first results show a complex pattern. Contents of mobile Si, for example, vary only little between the different soil types (35 $\pm$6 μg/g; $\pm$1SD). Si bound to SOM is the only soil Si fraction that shows a limited correlation with plants' total Si content. Surprisingly, contents of Si bound to SOM show no correlation with SOM contents. Finally, amorphous silica, which is often regarded as a key Si source for plants because of its high reactivity in comparison to lithogenic Si sources, shows the highest variability between different soils, spanning one order of magnitude (from 0.2 to 1.4 mg Si/g), but is not related to plant Si content. Plant Si content measured in wheat (above-ground biomass) varies from 0.8% to 2.3% of the dry plant weight. These first results of a comparison between soil Si reservoirs and plant Si contents are still preliminary and should not be overinterpreted. As they were obtained from crops growing in usual fields, the plant-growth conditions were less well-constrained than under greenhouse conditions. However, our preliminary results exemplify the difficulty to establish a direct relation between plant Si content, soil properties and the soil Si pools. We hypothesize that a plant Si content that is apparently independent from the bioavailable Si in the soil may indicate that mechanisms of active Si uptake compensate for the lack of bioavailable Si in soils (e.g., increased active Si uptake, increased active mineral dissolution by the plant).