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The impact of land use change and earthworm activity on Si pools and plant uptake

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It is increasingly acknowledged that silicon (Si) is a key plant nutrient. Current conventional agricultural management and cropping can result in depletion of the plant available Si pool in soils. Further, it is likely that the cycling of Si in plant-soil systems is dependent on interactions with soil organisms. However there are minimal studies that investigate this. Here we present the results of an investigation into the influence of land use change and earthworm activity on the availability and uptake of Si by winter wheat.

Arable-to-ley conversion transects (3 m wide, 70 m long, ley mix of Lolium and Trifolium) were established in long-term arable wheat fields to determine the impact of ley conversion on soil health and resilience (as part of the SoilBioHedge experiment). Earthworm abundance and species diversity were monitored over 2 years at defined distances from the field hedge, margin and up to 64 m along the ley transects. Changes in soil health in the ley conversion were compared to a control transect established in the arable wheat field. Earthworm abundance and diversity increased in the ley conversion transects compared to the arable control.

In order to assess changes in Si availability due to land use conversion (2 years post-conversion), soil was collected from one representative ley transect and one wheat control transect. The soil was sieved to < 2mm whilst field moist and then 340 grams were transferred to plastic containers (14 cm high, 9 cm diameter). Soil moisture was amended to 25% using deionized water. Earthworm-, Wheat-, Earthworm+Wheat and Control-treatments were established with 5 replicates per treatment. Winter wheat (Skyfall) was germinated on wet filter paper and then 3 plants transferred to each wheat-bearing container. Green morphs of Allolobophora chlorotica (endogeic, soil-feeding) earthworms were collected from the ley transects, weighed and three individuals added to each earthworm-bearing container. The containers were transferred to a 15C controlled temperature room and kept under artificial light (286 – 370 lux) on a 12 hour light: 12 hour dark cycle. Deionised water was added regularly to the containers at the amount needed to maintain a constant weight in the control (bare soil) containers. After 4 weeks the wheat plants were harvested 1 cm above the soil surface. Shoot biomass was determined (fresh weight and after drying at 60C). Roots were removed from the soil, washed clean of soil, dried at 60C and dry biomass was measured. Dried roots and shoots were analysed for their Si content by X-ray fluorescence (XRF). Earthworm survival rates were noted. Moist soil was extracted with deionized water (Henriet et al., 2008, Biogeochemistry, 90(2), pp.209-223), 0.01M calcium chloride (Georgiadis et al., 2013, Geoderma, 209, pp.251-261) and 0.2M sodium hydroxide (Georgiadis et al. 2015, Soil Research, 53(4), pp.392-400) to determine pools of Si (water soluble, plant available and amorphous Si respectively). Our data show the impact of land-use change and earthworm activity on the availability and mobility of Si in agricultural soils.