Soil moisture suction in no-till and tilled soils: analyzing long-term tensiometer measurements in the Swiss Central Plateau

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Fertile soils are crucial for human well-being, yet the intensification of agriculture and use of heavy machines increasingly threatens their quality. Agricultural practices with heavy machines expose soils to a high risk of irreversible subsoil compaction. Research has shown that from a sustainable land management perspective, soils should not be trafficked with heavy machines when soil conditions are wet (soil moisture suction <6 cbar at a soil depth of 35 cm). However, there is a lack of knowledge about the frequencies of wet soil conditions in Swiss agricultural soils and about potential influences of soil management systems on soil moisture. This study aims at closing these research gaps by analyzing the long-term (1996–2019) dataset of the Canton Bern including 13 different locations on six sites in the Swiss Central Plateau. Soil moisture suction data measured with five tensiometers per location at a soil depth of 35 cm and precipitation sums per site for three measurement days (md) per week are used. On every site, at least one permanent grassland and one crop rotation location are present. Furthermore, two tillage systems (no-till and mouldboard plough) and 11 different crops occur in the dataset. After data correction and validation, 22'947 md with available soil moisture suction data are analyzed. To put the results into a larger context, spade tests are performed at every location, and a climate and weather characterization of the years 1996–2019 is undertaken. Periods with wet soil conditions (<6 cbar at 35 cm soil depth) during the vegetation period from April to October range from 41 to 48% of the md for different locations (average over all sites), while site-specific differences range from 31 to 76% on permanent grassland locations. The duration of wet soil conditions can exceed three months in extreme cases. Furthermore, a seasonal curve in soil moisture suction is found and influences of the longer-term (≥3 months) weather conditions, as well as of single precipitation events on soil moisture suction fluxes are apparent. Differences in soil moisture suction fluxes are big between different sites and years: comparing a specific md over different sites and years shows that soil moisture suction values can cover the whole measurable range between 0 and 80 cbar. While the seasonal curve and the annual fluctuations likely originate from climate and weather influences, the differences between the sites cannot be attributed to a specific influence factor. Differences between permanent grassland and crop rotation locations can mostly be attributed to different crops' seasonal evapotranspiration rates. Other systematic differences which hold for all sites and years cannot be identified. Differences between no-till and mouldboard plough are present, but non-systematic based on the analysis on one site. The spade tests show that tillage systems impact physical soil properties. In conclusion, the results point to a highly complex human-climate-soil-system. This study lays a valuable basis for future research, among others, by providing concrete recommendations for future study designs. Further research about soil moisture suction is needed to promote sustainable land management in Switzerland.

Keywords: *Soil Moisture, Tensiometer, Soil Compaction, Tillage Systems, Sustainable Land Management*