Switzerland study site experiment 1: FERTILISATION AND AMENDMENTS FOR IMPROVING SOIL HEALTH

The problem

Main soil threats: Nutrient leaching and decreased humus.

Yield loss is closely linked to soil properties, climatic conditions, selected crops in the rotation and available workload over the year. Although water reserves in Felben-Wellahausen (Switzerland) are abundant the soil suffers from drought during summer months when rain becomes rare. This is due to its high infiltration capacity and low organic carbon content. In autumn, depending of the precipitation intensity, the risk of compaction is high. Yield loss in the corn is typically around 20% in the ruts of heavy propelled harvester. The peaks in workload requirements during September and October often results in a delayed harvest of silage maize and sugar beet. The compaction risk under wet soil conditions causes crop loss. In addition, there is not enough time remaining for cover cropping and green manuring in autumn after harvest. Stubble and organic residues are hardly decomposed and nitrogen mineralization remains blocked prejudicing the next culture. The structure degradation associated with rainfall regime and the harvest calendar is generally limited on the topsoil and disappears in the short or medium term.

The proposed solution

Underfoot fertilisation after Controlled Uptake Long-Term Ammonium Nutrition (CULTAN) should improve the nitrogen supply to the plants – (specific machinery for direct application of fertilization directly to the roots).

Study site description

Location: Felben-Wellhausen

Crop rotation: Meadow + silage maize + grain maize / Rye

Cropping intensity

Both conventional and conservation cropping systems are used at the study site. Depending on the soil moisture conditions and the rut depth after the harvest, a rotary cultivator or plough (furrow wheel) are used before sugar beet and potato crops. All animal excreta (pig liquid manure, rotted manure including straw from beef fattening), straw residues of maize and beet leaves are returned to or incorporated in the soil. Minimum soil tillage (harrow) is used after potato crops. The rotation constellation including artificial meadow and special cultures (strawberries) is not favourable for controlled traffic farming (CTF).

Crop types

The rotation includes the following crops: corn, sugar beet, potato, and cereal (winter wheat or spring barley).

In the case of annual grassland or annual strawberries, planting occurs after the cereals have been harvested.

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Experimental design

The study was undertaken on a conventional farm. The CULTAN technique (2 total fertilisations-first starting fertilisation, same on entire field) was compared with organic fertilisation (pig manure) (2 total fertilisations-first starting fertilisation, same on entire field) and the mineral fertilisation of pig manure and Lonza-Sol (3 total fertilisations-first starting fertilisation, same on entire field), both distributed on the soil surface,

Measurements taken:

Degree of erosion, soil bulk density, water content, mineral nitrogen, available phosphorus, soil organic carbon, pH, nematode score, percentage of weed infestation, earthworm counts, crop yield.

Results

The relatively high mineral nitrogen measured in SICS as compared to the control, can attest to a relative nitrogen assimilation by the plants (Fig. 1). In addition, SOC values relatively improved for some periods (Fig. 2).

Results

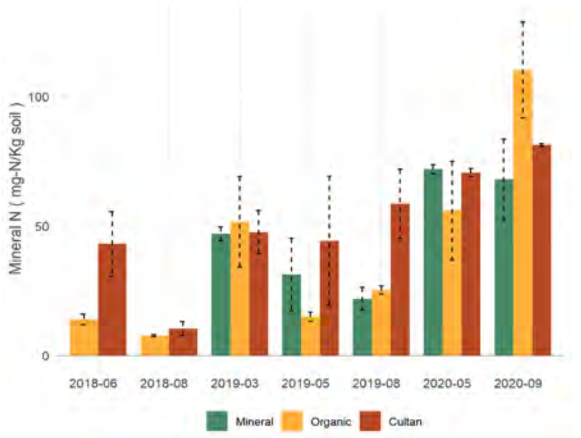

Fig. 1 – Field 1

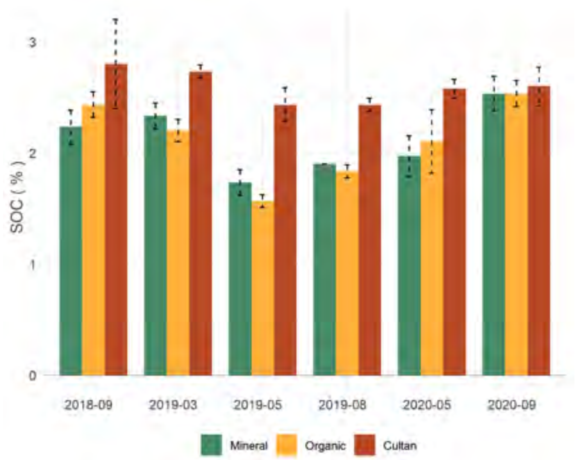

Fig. 2 – Field 1

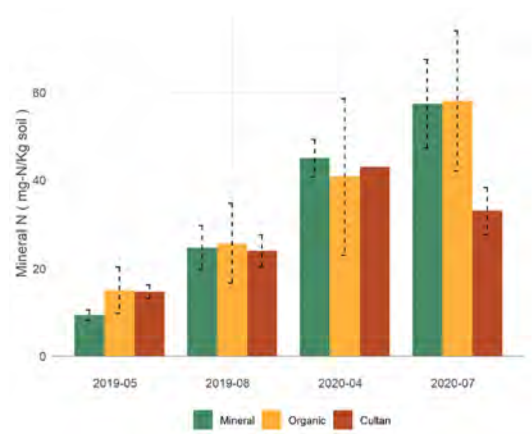

Fig. 3 – Field 2

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Key findings

The relatively high mineral nitrogen measured in the SICS can attest to a relative nitrogen assimilation by the plants. However, this observation cannot be generalized for all study periods, nor for fields (Fig. 3, see page 2).

While SOC values improved in the observation field during some periods, it remain comparable to the SOC value of the control treatment in the second observation field. The comparison between the values of the remaining properties of SICS and control do not show difference (e.g. soil properties and crop yield). Continuous measurements are needed to confirm the long-term benefits of CULTAN.

Conclusions

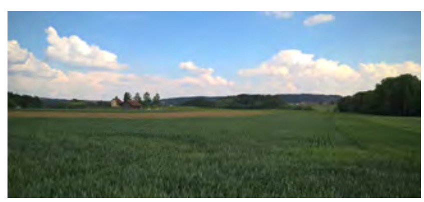
The assessment of the overall sustainability of the SICS (CULTAN) is negative. This is due to the increase in production costs resulting from the fact that special machinery is required. The expected benefit of a more efficient nitrogen assimilation by plants resulting in higher yields is demonstrated during some periods. However, this observation cannot be generalized for all periods. Nevertheless, a positive effect is that the SICS slightly reduces the farmer's workload.

Conclusions

According to the literature, it is hypothesized that CULTAN has the following benefits:

- Frame Ammonium ions is tightly bound to the soil resulting in reduced leaching into the groundwater and long-term nutrition of plants.
- Leaching of mobile nitrates into the groundwater is reduced, as the inhibition of nitrifying bacteria diminishes the conversion of Ammonium ions to Nitrites, then nitrates, and injection confines it to the proximity of the root tips. The formation of detrimental nitrogen oxides NOx, mainly produced during the denitrification process, is assumed likewise to be diminished.
- More efficient nitrogen assimilation by the plants results in an increased crop yield.

Further investigations are needed to shed light on the benefits of CULTAN for a long-term perspective.



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