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Aggregate stability, root length and root thickness influenced by a mycorrhizal inoculum? - Results from a three-year eco-engineering field experiment on an alpine slope.

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In mountain environments many slopes are covered by coarse grained, glacial-, periglacial- or/and denudation-derived substrate. These slopes show a high geomorphic activity and are susceptible for erosional processes, shallow landslides or debris flows, which can result in a high socio-economic hazard potential. This is especially true for steep slopes, lacking a protecting vegetation cover. Regarding hazard prevention, eco-engineering gained in importance because related techniques provide a sustainable measure to protect erosion-prone hillslopes.
The idea of using plants for sustainable erosion control and protection against shallow landslides, demands some essential requirements, as e.g., a stable seedbed providing appropriate water and nutrient supply. However, degraded alpine slopes are often unstable and the coarse-grained material shows a low retention capacity of water and nutrients. Extreme conditions like this hamper a fast and sustainable development of a protecting vegetation cover even if pioneer plants are used to stabilize the slopes. Thus, the question arises what needs to be done to give planted saplings within eco-engineering projects maximum support developing their above- and belowground structures to promote slope stabilization. Laboratory experiments using potted plants have shown a positive impact of mycorrhizal fungi inoculation plant development and soil structure, i.e. the formation of (stable) aggregates within several months. Soil aggregate stability is an integrating parameter, reflecting several aspects of the plant-soil system and for this also an indicator of soil development and soil stability. Because of this and based on the promising laboratory results, we intended to apply this approach in a field-experiment
We established (i) mycorrhizal and (ii) non-mycorrhizal treated eco-engineered research plots on a field experimental scale, covering a total area of approx. 1000 m2 on an ENE exposed slope (coarse morainic and denudation-derived substrate; inclination ∼40 - 45 °; elevation 1220 – 1360 m a.s.l.) located in the Eastern Swiss Alps, where many environmental parameters can be seen as homogeneous. Soil aggregate stability, the formation of water stable aggregates and the fine-root development was quantified at the end of three consecutively vegetation periods.
Our results show, that an impact of the mycorrhizal inoculum on aggregate stability was not traceable after one vegetation period, which contradicts our expectations and former laboratory experiments. At the mycorrhizal inoculated site, fine roots showed indeed a lower root length density compared to the non-mycorrhizal treated site, but the proportion of roots with thicker diameters tended to be higher. At the end of the third vegetation period this pattern changed. Aggregate stability is then highest at the inoculated site and root length density increased showing the highest values as well. The tendency to thicker root diameters at the mycorrhizal treated site can be confirmed. Our findings show that studies on a field experimental scale are inevitable. Laboratory experiments and field studies complement each other, and lead to a better understanding, having regard to a successful application of sustainable eco-engineering measures on erosion-prone slopes in alpine environments.