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A rainfall simulation experiment on soil and water conservation measures – Undesirable results

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Sediment and nutrient inputs from agriculturally used land into surface waters are one of the main problems concerning surface water quality. On-site soil and water conservation measures are getting more and more popular throughout the last decades and a lot of research has been done within this issue. Numerous studies can be found about rainfall simulation experiments with different conservation measures tested like no till, mulching employing different types of soil cover, as well as sub soiling practices. Many studies document a more or less great success in preventing soil erosion and enhancing water quality by implementing no till and mulching techniques on farmland but few studies also indicate higher erosion rates with implementation of conservation tillage practices (Strauss et al., 2003).
In May 2011 we conducted a field rainfall simulation experiment in Upper Austria to test 5 different maize cultivation techniques: no till with rough seedbed, no till with fine seedbed, mulching with disc harrow and rotary harrow, mulching with rotary harrow and conventional tillage using plough and rotary harrow. Rough seedbed refers to the seedbed preparation at planting of the cover crops. On every plot except on the conventionally managed one cover crops (a mix of Trifolium alexandrinum, Phacelia, Raphanus sativus and Herpestes) were sown in August 2010. All plots were rained three times with deionised water (<50 μS.cm-1) for one hour with 50mm.h-1 rainfall intensity. Surface runoff and soil erosion were measured. Additionally, soil cover by mulch was measured as well as soil texture, bulk density, penetration resistance, surface roughness and soil water content before and after the simulation. The simulation experiments took place about 2 weeks after seeding of maize in spring 2011.
The most effective cultivation techniques for soil prevention expectedly proved to be the no till variants, mean erosion rate was about 0.1 kg.h-1, mean surface runoff was 29 l.h-1. These plots had a mulch cover of more than 70%. The mulching techniques exhibited a mean erosion rate of 2.2 kg.h-1 and mean surface runoff of 174 l.h-1 .and were thus prone to more erosion and runoff compared to the conventional plots with a mean erosion rate of 1.0 kg.h-1 and a mean surface runoff of 93 l.h-1. We identified two reasons for this unexpected behaviour. The soil cover of the mulch seed plots only amounted to about 8%. In addition the deep ploughing of the conventional plots caused higher infiltration rates than the mulching techniques with shallow soil management. This was also shown by an earlier runoff start on the shallow managed plots.
About 18% of the arable land in Austria is cultivated with maize. Within this 18% about 40% is cultivated with mulching techniques; this conservation measure is part of the funded agri-environmental programme and is subsidised. To prove the practical effectiveness of the conservation measures employed at regional level, we surveyed soil cover of all fields cultivated with mulching techniques for a headwater catchment with 260 ha size where the experiments had taken place. Only one field with a satisfying mulch cover of about 50% was detected, mulch cover of all other fields was around 10%. These results are probably a result of climate, amount and type of cover crop – it was a rather wet year, cover crops were sawn late and could not fully develop and the type of cover crop chosen may have been not adequate for generating an effective mulch cover. This demonstrates that mulching may be an effective means of soil protection. However, for a successful use in agricultural practice, the quality of the mulch cover are a key for successful implementation and have to get more attention whenever talking about mulching as an effective conservation measure.

References:
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