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Spatial variability of moisture and temperature in relation to soil compaction and mulching

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Maintaining or adding crop residue improves numerous physical, biological and chemical characteristics and thereby increases soil quality. The effect of the residues on soil wetness and temperature largely depends on soil compaction and weather conditions. It was shown that the effect of straw left on soil water conservation is positive under periods with scarce rainfalls due to slowly evaporation. However, in periods with greater rainfall events part of water can be absorbed by straw and thereby reducing quantity of rainwater entering the soil. In case of abundant rainfalls surface mulch may enhance water infiltration by promotion of soil stability and increase storage of water to higher extent in loose than compacted soil. High water storage in the soil is an important factor affecting crop production in many countries in Europe. The surface mulches can also reduce transfer of heat to the soil surface and thus delay increase of soil temperature due to very low thermal conductivity of the mulch. In wet and compacted soil this effect can be enhanced by a greater requirement for radiation energy to heat the water at the expanse of heating the soil. Our objective is to understand the effect of the straw mulch on spatial variability of moisture and temperature of variously compacted soil during the year including growing season of soybean. Moreover, the use of the geo-statistics methods in this study allows obtaining spatial distributions of moisture and temperature in the field that are close to the reality. The study is being conducted in the project Soil Water Energy Exchange (SWEX AO-3275) in the framework upcoming Soil Moisture and Ocean Salinity (SMOS) mission.

The experimental area was 256 $m^2$and consisted of four sections. In three of them the 0, 3 and 5 tractor passes were applied. The fourth part corresponded to the headland. This resulted in a wide range of soil compaction (1.2 to 1.65 Mg m^{-3}) that can occur in the arable fields. Each section consisted of 6 micro-plots (7 m^2). Half of each micro-

plot was mulched with straw (0.5 kg m^{-2}) and another one – not. Soil water content was measured with 23 TDR at depth 0-5cm and with 8 probes at depths 10-15, 25-30 and 50-55 cm and temperature with 29 thermocouples at depths 2, 5, 10, 20, 30, 50, 70 and 100 cm on selected micro-plots, equally represented by all compaction and mulch treatments. We analyzed the data collected in selected days at spring, summer and autumn.

The results showed the substantial effect of straw mulch and soil compaction on the distribution of soil moisture and temperature both in horizontal and vertical planes. Both values were the most variable in topsoil and tended to be less variable in deeper soil. The variability was less in cloudy than sunny days especially with respect to soil temperature. The semi-variance parameters indicated existence of the spatial dependence of the topsoil moisture with the range from 6 to 10 m. However, the soil temperature was spatially dependent or not dependent on the depth considered. Random distribution of temperature was observed mostly in topsoil. However, in deeper layers the spatial dependence was found and had linear or exponential form. The spatial dependence of temperature was also influenced by weather conditions including sun radiation and rainfalls. To visualize the results 3D maps were obtained by ordinary block kriging based on the semivariogram models. The 3D mapping allowed identifying the areas of highest soil moisture and temperature.

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