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Soil processes evolved by the establishment of tree plantations on croplands/grasslands – evaluation of afforestation effect on the Great Plain (Hungary)

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In Hungary, there was a great increase in the acreage of forested areas during the last century (1.1 to 1.8 million ha). Most of the plantations were established on non-profitable grasslands/croplands (National Forest Strategy, 2009). The forests affect hydrologic and climatic elements of the physical habitat and induce alterations in the soil properties, as well.

Soil and groundwater of 70 plantations (Poplar, Common oak and Black locust) and nearby control plots (grassland/cropland) – representing former land use - were investigated over the Great Hungarian Plain. Sampling sites were located by a gradient of climatic water balance, initial water table depth and salinity, soil layering, tree species and plantation age.

Short- and long-term effects in groundwater levels (GWL) were found under the woody vegetation. GWL depression evolved beneath forests (poplar and oak provably) compared to control, in 78.8% of the cases. GWL depression was the most significant in the growing season, then the difference between GWLs decreased. Since evapotranspiration (ET) is the main driving force for water consumption of trees, and the ET of trees can be three times higher than that of the grassy control in the growing season, greater (ground)water uptake could be measured, giving rise to higher GWL depression. Short-term effect of the plantation was the daily fluctuation of GWL in the woods that can be twice as much as that of the control. Water uptake is influenced by the type of the groundwater zone (recharge/discharge), where the sample area is located, and by tree species (diverse water demands).

Afforestation raised the salt content of the groundwater slightly. In 52.9 % of the cases, salt content of groundwater was higher under the forest, than under the control.

Below the forests, salts concentrated in the soil profile and formed a salt accumulation zone surrounding the root zone. In 52.9 % of the cases, salts accumulated in the profile: in the subsoil under the trees (3.7-4.3 m) and in the upper soil (0-1.5 m) under the grassy areas. Subsurface salt accumulation is generated by the water uptake of trees from salty groundwater due to the ion exclusion of tree roots. Plantation age and biomass are the factors enhancing salt accumulation, according to growth rate of the tree species.

Differences between the soil salt content of the woody and grassy vegetation along the whole profile (from ground to water level) showed decreasing salt accumulation in the order of Poplar > Common oak > Black locust (0,0484; 0,0304 and 0,0246 dS/m, respectively). The rate of accumulation tends to be slight due to the infiltration of precipitation during the rest period of the deciduous forests that leaches the salts from the profile each year, preventing high rate of salt accumulation.

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