

The effects of one-time inversion tillage on soil physical properties after long-term reduced tillage

Michael Kuhwald, Katja Augustin, and Rainer Duttmann

Physical Geography, University Kiel, Germany (kuhwald@geographie.uni-kiel.de)

The positive effects of reduced tillage on soil stability and on various soil functions such as infiltrability or saturated hydraulic conductivity are known in general. However, long-term employment of conservation tillage can increase weed pressure, damage by mice and soil compaction. Thus, the application of one-time inversion tillage (occasional or strategic tillage) is customarily used as a method for overcoming these drawbacks. Hitherto, the effects of one-time inversion tillage on soil physical properties have not been investigated. This study focuses on analysing whether the improved soil physical properties derived by long-term reduced tillage remain after one-time inversion tillage by mouldboard plough.

The study was carried out in a 5.5 ha field in the southern part of Lower Saxony, Germany. Since 1996, this field has been subdivided into three plots, one managed conventionally by using a mouldboard plough (CT), while in the others a chisel plough (RT1) and a disk harrow (RT2) were employed. In October 2014, the entire field was ploughed by mouldboard plough to a depth of 30 cm. During the following year, four field studies were conducted to analyse the effects of this one-time inversion tillage on volumetric soil water content, bulk density, saturated hydraulic conductivity and infiltration rate. Additionally, penetration resistance measurements taken across the entire field were interpolated by kriging to analyse the spatial distribution of soil characteristics. The surveys of RT1 and RT2 were compared with CT and with analyses conducted before the one-time inversion tillage.

This study shows that positive effects of long-term conservation tillage on several soil physical characteristics still remain after one-time mouldboard ploughing. Throughout the entire cropping season, the topsoil tilled under former conservation tillage practices revealed significantly higher ($p < 0.05$) values of saturated hydraulic conductivities and infiltration rates compared to the plot that experienced continuously conventional tillage. Moreover, field-wide measuring of penetration resistance indicated the removal of the compaction zone developed under conservation tillage in soil depths between 10 and 20 cm. After mouldboard ploughing, penetration resistance in the topsoil was significantly ($p < 0.05$) reduced in both plots, showing the same order of magnitude as measured in the conventionally managed plot.

The results of this study suggest that one-time inversion tillage with a mouldboard plough offers a suitable management option for overcoming some of the main disadvantages associated with long-term conservation tillage, while conserving the improved soil physical properties and functions.