Effects of Tillage on Water and Heat Movements in Japanese Andisols

HLM Archana[1], J Nishiwaki[2] and DAL Leelamanie[1*]
[1]Department of Soil Science, Faculty of Agriculture, University of Ruhuna, Kamburupitiya, Sri Lanka
[2]Department of Soil Science, College of Agriculture, Ibaraki University, Japan

Abstract
Soil water and heat are important physical aspects of soil. Their presence and transmission considerably impact on plant growth and performance as well as on soil organic matter decomposition. Both soil water and heat depend on soil pore geometry that can be altered by tillage application. The purpose of this study was to differentiate the effects of conventional tillage (CT) and no-tillage (NT) on water and heat movement in Japanese Andisols during November to January, which is the transitional period from autumn to winter. Water movement in the soil was analyzed through changes in moisture content and hydraulic conductivity. Heat movement was analyzed considering the temperature variability. Soil hardness and soil moisture characteristics were determined to identify the factors that contribute for tillage impacts on soil. Mini disk infiltrometer at three different suction heads (-0.5, -3, and -6 cm) was used to measure field infiltration and unsaturated hydraulic conductivity. Falling head method was used for saturated hydraulic conductivity determination, whereas hanging water column and pressure plate methods were used for determining soil moisture characteristics. Soil hardness was measured using cone penetrometer. Moisture sensors (Ech20 5TE and TDT sensors) buried at 2.5 cm (corresponding to surface soil), 7.5 cm, 20 cm and 40 cm depths were used to measure and record volumetric moisture content and soil temperature simultaneously. Two sample t-test ($p<0.05$) was used to determine statistical significance between the two sites. The soil hardness was significantly low in CT site up to the tillage depth (20-30 cm), and higher in CT than NT below that level. Possible formation of a hard pan below the tillage depth due to long-term migration and deposition of finer soil particles and the use of heavy machinery might be the reason for this result. Field unsaturated hydraulic conductivity was significantly higher in CT site than NT in November and January. Saturated hydraulic conductivity was also higher in CT than in NT up to tillage depth. Conversely, moisture retention and moisture content of surface soil (at 2.5 cm depth) were significantly lower in CT. Surface soil temperature was notably lower in CT than in NT as a result of enhanced soil surface area of CT, facilitating the dissipation of heat. These results emphasize that water and heat movement in soil were affected by tillage. Further investigations are needed to determine the most appropriate tillage system considering cropping systems.

Keywords: Hydraulic conductivity, Infiltration, Soil heat, Soil moisture, Soil temperature

***Corresponding author**: leelamaniee@yahoo.co.uk