Tropentag, September 10-12, 2025, hybrid conference

"Reconcile land system changes
with planetary health"

Effect of soil bulk density on saturated hydraulic conductivity

Fapailin Chaiwan[1], Jaranachai Chaihan[2], Kanita Ueangsawat[3], Choochard Santasup[4], Natchanon Santasup[5], nathitakarn phayakka[6]

[1]*Chiang Mai University, Faculty of Agriculture, Department of Plant and Soil Sciences, Thailand*
[2]*Faculty of Agriculture, Chiang Mai University, Plant and Soil Science,*
[3]*Faculty of Agriculture, Chiang Mai University, Plant and Soil Science,*
[4]*Chiang Mai University, Dept. of Plant and Soil Sciences, Thailand*
[5]*Chiang Mai University, Dept. of Plant and Soil Sciences, Thailand*
[6]*Faculty of Agriculture, Chiang Mai University, Department of Agricultural Economy and Development, Division of Agricultural Extension, Thailand*

Abstract

Soil compaction has become an increasing concern in agricultural areas, posing significant limitations on plant growth and overall crop productivity. This form of physical soil degradation commonly results from prolonged monoculture, inappropriate tillage practices, and the long-term lack of organic matter amendments. These conditions lead to increased soil bulk density, the breakdown of soil structure, and reduced water infiltration, resulting in surface waterlogging, limited aeration, and restricted root development, depending on the soil type, such as soil texture. This study aimed to investigate the effect of soil bulk density on the saturated hydraulic conductivity (Ks) of soil. The experiment was conducted using sandy loam soil collected from the experimental plot at the Faculty of Agriculture, Chiang Mai University, with an initial bulk density of 1.64 g cm-^{3}. Six levels of compaction were prepared: 1.30, 1.40, 1.50, 1.64, 1.70, and 1.80 g cm-^{3}. The water permeability of the soil was tested by varying the soil density to determine the saturated hydraulic conductivity at each density level. The results demonstrated an inverse, nonlinear relationship between soil bulk density and saturated hydraulic conductivity. The Ks value decreased significantly as the bulk density increased, indicating reduced pore connectivity and water flow pathways within the compacted soil matrix. At the highest compaction level (1.80 g cm-^{3}), the Ks dropped to its minimum value, highlighting the critical impact of soil compaction on infiltration capacity. These results highlight the necessity of appropriate soil management practices to preserve optimal soil physical properties. It is recommended that farmers avoid tillage operations on soils with excessive moisture content and apply organic matter consistently to enhance soil structure. Such practices are essential for mitigating compaction-related problems, enhancing water permeability, and increasing crop water use efficiency, thereby contributing to the long-term sustainable agricultural productivity.

Keywords: Soil compaction, Soil management, Soil porosity, Sustainable agriculture, Water permeability

Contact Address: Fapailin Chaiwan, Chiang Mai University, Faculty of Agriculture, Department of Plant and Soil Sciences, 239, Huay Kaew Road, Muang District, 50200 Chiang Mai, Thailand, e-mail: fapailin.c@cmu.ac.th