Effect of Soil Compaction and Palm Oil Application on Soil Infiltration Rate

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Abstract: Water-saving technologies have been gaining interest as a way of saving water while minimizing crop production losses. This study aims to introduce a new technique for reducing the vertical infiltration rate through clay and sandy loam soil surfaces by using soil compaction and oil-based liquid (palm oil) treatment. A two-factorial experiment of a randomized complete block design with three replications was conducted for each soil type. The compaction factor had levels of zero-, three-, and five-time compaction passes performed by a plate compactor. The oil factor had two levels, namely, 0 and 1.0 $\mathrm{L/m^2}$ palm oil, which was applied to the soil surface prior to compaction. The soil infiltration rate, bulk density, moisture content, and penetration resistance were recorded. The results showed that the soil bulk density for both soils increased with increasing compaction as well as the application of palm oil. The maximum bulk densities reached for clayey and sandy loam soils were 1.7 and 1.8 $\mathrm{g/cm^3}$, respectively. Additionally, increasing compaction and treating the soil with palm oil resulted in decreasing the infiltration rate generally. The infiltration depth versus time nonlinear curves fitted well based on the Kostiakov infiltration model. The infiltration dynamics profile of the noncompacted surface was higher than that of the compacted soil for all compaction treatments. On average, compaction had a reduced infiltration rate of 86% and 73% in sandy loam and clayey soil, respectively. The associated reductions by palm oil treatment on respective soils were 22% and 25%. This finding suggests that the oil factor provided an additional effect on compaction when reducing the vertical infiltration rate through the soil surface, and thus could be exploited in constructing the bottom of the furrow for selected crop productions under a raised bed system. The reduced vertical infiltration forces the water to move laterally into the plowed and noncompacted beds of the furrow. The increased lateral water movement physically increases the amount of water stored within the root zone, thereby improving the irrigation efficiency and crop productivity of the raised bed furrow crop system. The raised bed is generally good in controlling the soil moisture content for the growth of aerobic paddy and the majority of vegetables. **DOI: 10.1061/(ASCE)IR.1943-4774.0001534.** *© 2020 American Society of Civil Engineers.*

Author keywords: Compacted soil; Infiltration; Bulk density; Palm oil; Kostiakov infiltration equation; Soil penetration resistance.

Introduction

The infiltration rate is the amount of water entering the soil per unit surface area per unit time (Muhamad et al. 2008). During infiltration, water penetrates the soil from the surface due to the resultant combination of gravity and capillary forces that vertically induce percolation downward. The behavioral changes of air and water that penetrate the soil can affect the infiltration. Agricultural engineers and soil scientists study and understand the infiltration behavior of the soil. Inherent factors, such as the soil texture on a large scale, cannot be changed and could affect water infiltration into the soil. Soil texture, as determined by the percentage of sand, silt, and clay contents, is an important factor in studying the dynamics of infiltration (Haghnazari et al. 2015).

Applying more water than the soil's capacity results in water loss due to deep percolation and runoff. The deep percolation aspect causes water to be lost beyond the crop root zone depth, resulting in reducing irrigation efficiency (Wickham and Singh 1978). These water losses through deep percolation have been reported in the range of 0.1 to several hundred mm/day and directly affect the irrigation efficiency (Kukal and Aggarwal 2002). Soil compaction is an agricultural activity problem that should be addressed. However, this phenomenon can be a solution to some issues, such as reducing deep percolation, especially in the construction of the furrow irrigation system. In a growing field condition, soil compaction can occur as a result of vehicle traffic passing and, consequently, increases soil bulk density, decreases porosity and total pore volume, and alters pore size distribution,

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Note. This manuscript was submitted on April 6, 2020; approved on September 16, 2020; published online on December 23, 2020. Discussion period open until May 23, 2021; separate discussions must be submitted for individual papers. This paper is part of the ***Journal of Irrigation and Drainage Engineering***, © ASCE, ISSN 0733-9437.