American Journal of Agricultural and Biological Sciences, 2012, 7 (4), 425-434
ISSN: 1557-4989

doi:10.3844/ajabssp.2012.425.434 Published Online 7 (4) 2012 (http://www.thescipub.com/ajabs.toc)

EMPLOYING ELECTROMAGNETIC INDUCTION TECHNIQUE FOR THE ASSESSMENT OF SOIL COMPACTION

Khalid A. Al-Gaadi

Depterment of Agricultural Engineering, Precision Agriculture Research Chair,
College of Food and Agriculture Sciences, King Saud University, P.O. Box 2460, Riyadh 11451, Saudi Arabia

Received 2012-09-09, Revised 2012-10-10; Accepted 2012-11-07

ABSTRACT

An experiment on a sandy soil field was conducted to investigate the potential of determining soil compaction from apparent soil Electrical Conductivity (EC_a) measured by Electromagnetic Induction (EMI) technique. A soil conductivity meter (EM38) was used to measure EC_a under four soil Moisture Contents (MC) (4.965.336.94 and 8.0%) and a range of Soil Compaction (SC) levels (on the average, from 220 to 2070 kPa). At each MC and SC level, EM38 measurements were recorded at three EM38 heights above the ground (0, 20 and 40 cm) and at vertical and horizontal device orientation. Except at the MC of 8.0%, results revealed that the measured EC_a was proportional to SC at all considered soil conditions and modes of measurement (EM38 orientation and height). For all soil conditions and modes of measurement, an overall mean of the coefficient of correlation (R^2) of 0.66 was observed between SC and EC_a at soil MC of up to 6.94%. Thus, EC_a measurement can be an indicator of soil compaction, given that the MC is below 7% in sandy soil. For both EM38 orientations, higher correlations between SC and soil EC_a (average R^2 of 0.90) were observed with the EM38 placed on the ground (0 cm height) compared to those achieved at 20 cm and 40 cm height, where the average R^2 values were 0.62 and 0.47, respectively. At 0 cm height and MC of up to 6.94%, higher correlations between SC and EC_a were obtained at vertical EM38 orientation (average R^2 of 0.98) compared to those at horizontal orientation (average R^2 of 0.81).

Keywords: Electromagnetic Induction, EM38, Soil Compaction, Soil Electrical Conductivity, Precision Agriculture, Moisture Content

1. INTRODUCTION

Soil Compaction (SC), which is one of the physical soil properties, refers to the increase in soil density and strength and the reduction in soil macro-pores. Extensive use of heavy agricultural machineries can greatly contribute into the increase of SC in agricultural fields (Alexandrou *et al*., 2002). Excessive SC exerts detrimental effects on crop production as it creates poor environment for root growth (poor aeration and excessive soil strength), reduces water infiltration and increases runoff, hence increases soil erosion. Krajco (2007) reported that soil was endangered by SC, as one of the various degradation processes that worked within the topsoil or subsoil layers. Compaction can restrict and interfere with root growth, reduce the amount and size of soil pores, decrease soil infiltration, cause water-logging and lead to run-off. This was emphasized by Hoefer *et al.* (2010) who stated that higher soil strength, accompanied with higher soil penetration resistances, was considered as a limiting factor for root growth as it resulted in a lack of water and nutrient supply and caused poorer plant growth and higher vulnerability of the crop to diseases. In a similar study, Kulkarni (2003) stated the negative effects of soil compaction, which included the prevention of root growth and development of plants, reduction of water infiltration as compacted soil offered smaller pores and fewer natural channels, increase of surface wetness, runoff and erosion.

Conventional methods used for SC assessment, such as cone penetrometers, can provide accurate measurements. However, these conventional procedures for compaction measurement are characterized as time consuming, labor intensive and costly. Alternatively, in-