Influence of Soil Water Content, Clay, Temperature, and Carbonate Minerals on Electrical Conductivity Readings Taken with an EM-38

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Introduction

There has been considerable interest in using bulk soil electrical conductivity (EC), as measured by electromagnetic induction using the Geonics EM-38 (Geonics Ltd., Mississauga, ON, Canada), as a soil survey tool in many parts of the American Midwest (e.g., Jaynes et al., 1993; Doolittle et al., 1995; Jaynes, 1996; Brevik et al., 2000). However, many of these studies have compared soil electrical conductivity (EC) patterns to Order 1 or 2 soil surveys, without investigating the factors controlling soil EC. If electromagnetic measurement (EM) techniques are to be used in soil mapping, it is important that various factors that may influence soil EC be evaluated.

Electromagnetic induction is a noninvasive technique that measures soil EC by inducing an electrical field in the soil. In the vertical dipole, the EM-38 integrates soil properties to a depth of about 1.5 m to obtain an apparent soil EC value, while in the horizontal dipole soil properties are integrated to a depth of about 0.75 m (McNeill, 1980b). The manufacturer of the EM-38 has reported that the EC of soil is determined by a combination of soluble salts, clay content and mineralogy, soil water content, and soil temperature (McNeill, 1980a). However, there is little research looking at these factors and their relative influence on soil EC in the soil science literature. Studies that are available typically look at only one of these factors, such as soil water content (e.g., Sheets and Hendrickx, 1995; Khakural et al., 1998) or soil salinity (e.g., Williams and Baker, 1982; Wollenhaupt et al., 1986; Nettleton et al., 1994; Lesch et al., 1998). Williams and Hoey (1987) looked at two factors, the salt and clay content of soil. In each case, these studies found good correlation between the factor being studied and soil EC readings, often reporting $r^2$ values of 0.7 or greater. However, if the EM-38 is to be used as a soil survey tool, we need to understand the relative importance of the influence of these four factors on soil EC. Therefore, this study was designed to investigate the influence of soil water content, clay content, temperature, and carbonate mineral content on bulk soil EC along a transect in central Iowa as determined with the Geonics EM-38.

Materials and Methods

A Mollisol catena located at the Iowa State University Agronomy Farm in Boone County, Iowa was chosen for this study. The soil properties of this catena have been studied in detail previously (Khan, 1991; Khan and Fenton, 1994). Soil