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Effects of a bentonite–water mixture on soil-saturated hydraulic conductivity

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To reduce water loss in light-textured soils, hydraulic conductivity should be reduced by mixing the soils with some soil conditioners, e.g. sodium-bentonite. The objectives of this study were to investigate the effects of irrigation water with different bentonite concentrations (0, 0.05, 0.1, 0.15 and 0.2%) on hydraulic gradient (i) and relative saturated hydraulic conductivity (K_{rs}) in a laboratory soil column with a loamy sand soil. Addition of sodium-bentonite to the soil increased i throughout each experiment. Furthermore, addition of bentonite reduced K_{rs}, and a 0.2% bentonite–water concentration after infiltration of 48 mm of bentonite–water mixture (BWM), reduced the K_{rs} value to 56% of K_s. K_{rs} was reduced as the concentrations of bentonite increased and its value reached $\sim$0.5 to 0.6 as the infiltration of BWM increased. The lowest value of K_{rs} and the greatest reduction rate occurred at a bentonite concentration of 0.2%. It is concluded that BWM can be used as a channel liner. Using a 0.2% bentonite concentration resulted in a reduction in the seepage ratio from 1.0 to 0.08.

Keywords: seepage loss; seepage ratio; swelling forces; relative hydraulic conductivity

Introduction

One form of water loss in irrigation, especially in light-textured soil, is deep percolation. This usually occurs in long furrows as a result of high saturated hydraulic conductivity in the light-textured soil. Therefore, to decrease water loss, the hydraulic conductivity of a light-textured soil should be reduced by mixing the soil with a very impervious material such as bentonite (Chalermyanont and Arrykul 2005).

Bentonite is the name used for a range of clays that can swell and gel when dispersed in water (Grim 1968). The name 'bentonite' originates from the discovery of this type of clay near Fort Benton, USA, in the nineteenth century (Federation of Piling Specialists 2006). Komine and Ogata (1996) stated that 'Montmorillonite minerals in bentonite expand by absorbing water'. The montmorillonite mineral is a 2:1 layer consisting of an octahedral sheet sandwiched between two silica tetrahedral sheets. The octahedral sheet is composed of magnesium or aluminum coordinated octahedrally with oxygen atoms or hydroxyl groups. The silica tetrahedrons are interconnected in a silica sheet structure. Three of the four oxygen atoms in each tetrahedron are shared to form a hexagonal net. Interlayer water and exchangeable

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