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Effect of Soil Amendments on Hydraulic Characteristics of Two Types of Soil

[1]M.A. AL-Samarrai, [2]M.M. AL-Lami and [2]H. Abdul-Majeed
[1]Department of Plant Production, Faculty of Agriculture, Mu`tah University, P.O. Box 7, Karak, Jordan
[2]Department of Soil Science, College of Agriculture and Forestry, Mosul University, Mosul, Iraq

Abstract: A laboratory experiment conducted to evaluate the action of some soil amendments on improving physical properties of two soil textures, Clay Loam and Sandy Clay Loam soils. Three soil amendments, with two doses each were applied. Aggregate stability and hydraulic conductivity values were found higher with Sandy Clay Loam soil (SCL) than Clay Loam soil (CL). For both soils all treatments gave significantly higher aggregate stability index than control treatment. For a given amendment used Wet Sieving Index as well as hydraulic conductivity were found increased with increasing dose level with both soils. On the other hand CL soil have, always higher moisture content than SCL soil with any treatment and moisture tension applied.

Key words: Aggregate stability, hydraulic conductivity, soil amendments

INTRODUCTION

Low stability and physical degradation of surface soil are problems affecting the agriculture of large areas in Nineveh province of Iraq which characterized as a heavy soil, compacted and poor soil structure and aggregation which resulting in a poor aeration and low water holding capacity[1]. It is common knowledge in soil science that organic matter helps to form and stabilize aggregates from mineral particles[2-4]. The influence of soil physical properties on plant growth is well known. Attempts for optimizing soil physical conditions by classical treatments such as using amendments with organic matter or salts have long been in vogue. The use of gypsum compounds as an amendment for improving soil aggregates is universally recognized. Moreover it is a common practice to apply gypsum for the improvement of poor structured qualities of alkali soils by replacing adsorbed sodium ion by calcium ion in the clay complex as well as helps flocculation of clay particles[5-7]. The use of gypsum as a source of calcium to increase the permeability of certain soil and to reclaim sodic soils has been thoroughly investigated[8]. Loveday and Scotter[9] have shown that gypsum treatment increase structural stability and hydraulic conductivity of the treated soil. Results from numerous studies have shown that various amounts of crop residues affect soil properties and crop yield[10,11]. Usually those studies showed that returning these amounts of crop residues to the soil increased soil organic matter content, microbial activities, nutrient availability, water infiltration and storage as well as crop yields[12].

This study was conducted to evaluate the action of some soil amendments on improving physical properties of two soil textures, Clay Loam and Study Clay Loam soils.

MATERIALS AND METHODS

A laboratory experiment was conducted on 1998, using 2 kg capacity pots, two types of soil textures Clay Loam (CL) and Sandy Clay Loam (SCL) soils (Table 1) as well as three soil amendments were used i.e., Roots of *Glycyrrhiza glabra* (Liquorice or sweet wood) plant with two doses, 10 and 20 g kg^{-1} (T_1 and T_2), Phosphogypsum with two doses, 1.25 and 2.50 g kg^{-1} (T_3 and T_4) and Poultry residues with two doses, 10 and 20 g kg^{-1} (T_5 and T_6). In all there were six treatment combinations beside control treatment for each soil type. Treatments were replicated three times in a Complete Randomize Design. Sweet wood roots as well as poultry residues were air dried and ground and sieved through 2 mm sieve.

Table 1: Different soil characteristics of the pretreated soils used

Soil characteristics	Clay loam soil	Sandy clay loam soil
Particle size distribution:		
Clay (%)	39.10	33.10
Silt (%)	29.10	21.50
Sand (%)	31.80	45.40
Permanent wilting point (%)	14.00	12.00
Field capacity (%)	24.00	20.00
Organic matter (%)	0.50	0.85
Bulk density (g cm^{-3})	1.40	1.55
Particle density (g cm^{-3})	2.66	2.68
pH	7.80	7.70

Corresponding Author: Dr. M.A. Al-Samarria, Department of Plant Production, Faculty of Agriculture, Mutah University, P.O. Box 7, Karak, Jordan

Different materials were prepared and mixed thoroughly with the soils before putting in the pots. All the treatments were kept at 75% of field capacity moisture content. The experiment was continued for six months under controlled temperature 25°C±1. At the end of the experiment different physical characteristics of the two soils have been calculated.

RESULTS AND DISCUSSION

Wet sieving index: The results revealed that Wet Sieving Index (WSI) was found higher with SCL soil than CL soil for any treatment, particularly T_1, T_2 and T_6 where the differences were significant (Fig. 1). For CL soil, T_4 gave the highest WSI value, next in range were in the order T_2, T_6, T_5, T1, T_3 and control treatment. This can be attributed to the fact that organic materials have a powerful effect upon aggregation process[5,13-16].

For both soils, all the treatments gave significantly higher WSI values than control treatment.

Organic amendments (T_1, T_2, T_5 and T_6) produced higher WSI values than chemical amendment (T_3 and T_4) particularly with SCL soil.

For any given amendment used WSI was found increased with increasing doses applied for both soils.

Hydraulic conductivity measurements: For SCL soil, all treatments except T_1 gave a significant excel over control treatment. Never the less T_4 and T_6 gave the highest values of hydraulic conductivity; next in range were T_3, T_2 and T_5 in sequence (Fig. 2).

For CL soil, T_2 and T_4 gave significantly the highest hydraulic conductivity values over the rest of treatments, next in range were in the order, T_1, T_6 and T_3 over control treatment, whereas T_5 gave the lowest value of hydraulic conductivity.

Hydraulic conductivity increased with increasing soil amendment doses applied, particularly with CL soil where the increases were significant[9,17]. In general treatments with SCL soil gave higher hydraulic conductivity values than CL soil.

Soil moisture characteristics: For any given treatment, CL soil retained more moisture content than SCL soil (Table 2). This can be attributed to the fact that clay particles in particular are able to adsorb and swelling can occur as a consequence. On the other hand sand particles are not so reactive and only limited surface adsorption can occur in a bed of sand. As a result more water would actively retained with clay loam soil than Sandy clay loam soil under specific moisture tension[18-20].

Table 2: Effect of different soil amendments and tension applied on moisture percentages retained by the two soils used

	0.33 bar		1bar		3 bar		8 bar	
Treatments	CL soil	SCL soil	CL soil	SCL soil	CL soil	SCL soil	CL soil	SCL soil
T_1	21.50	19.60	19.80	16.50	15.40	8.70	12.70	4.60
T_2	20.90	19.60	19.70	16.50	15.70	9.10	12.60	3.90
T_3	21.60	21.00	20.90	16.50	14.90	9.40	18.80	8.30
T_4	22.00	19.70	19.70	16.60	15.80	9.30	18.30	4.60
T_5	22.30	20.20	21.20	16.70	15.40	8.50	10.50	2.30
T_6	25.40	20.70	18.40	16.10	15.60	11.30	8.90	7.80
Control	25.20	20.50	18.00	15.50	15.20	11.70	9.30	9.10
LSD 0.05	1.880	1.194	1.722	0.851	0.401	2.827	4.828	3.862

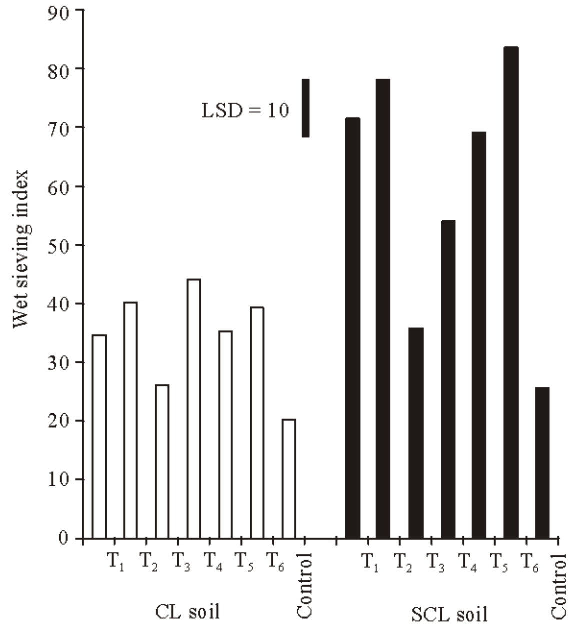

Fig. 1: Wet sieving index as affected by different treatments applied

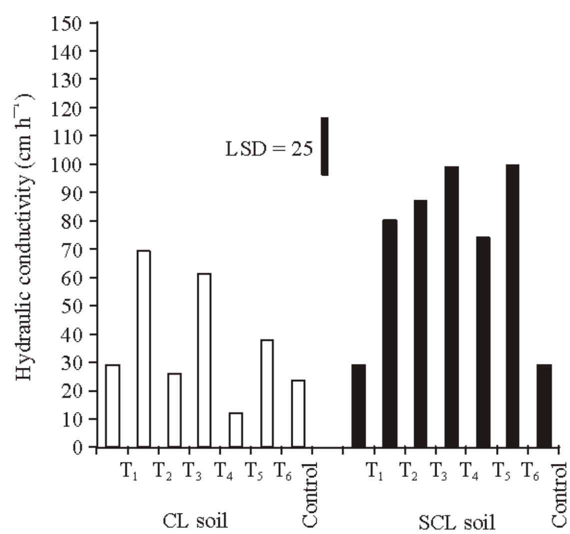

Fig. 2: Effect of different amendments on hydraulic conductivity measurements

For SCL soil, all treatments gave lower moisture content than control treatment but the differences were not significant except with 8 bars tension applied where the differences were significant particularly for the treatments T_1, T_2, T_4 and T_5. On the other hand, for CL soil, all treatments gave more moisture content than control treatment under 1, 3 and 8 bars tension applied in particular.

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