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Effect of different soil conditioners application on some soil characteristics and plant growth.II-Soil evaporation and dry-wet cycles

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Abstract : Soil conditioners are used to improve soil hydrophysical properties for alleviate some of poor physical properties of sandy soils such as low water retention and inefficient water use, especially under new reclaimed soil in Egypt. The present study aims to assess the influence of bentonite application rates as natural deposits on intermittent evaporation from sandy soil.The evaporation experiment was conducted during August to December 2014 in the greenhouse of Water Relations and Field Irrigation Dept. NRC, Egypt. Sandy soil was mixed with bentonite (of 0, 2, 4, 6 ; 8 %wb) and farm yard manure (FYM) at 2 %wb and packed in transparent PVC columns to depth of 30 cm. Cumulative evaporation against time was measured daily. The soil moisture distribution at the end of the experiment was determined gravimetrically for each 5.0 cm interval.

The obtained results showed that increasing application rate of bentonite restricted the wetting front movement and need more time to reach 30 cm depth. Application of bentonite to sandy soil significantly reduced the cumulative evaporation throughout the three evaporation cycles and the reduction significantly increased with increasing the application rates, except for the higher rate (8%), which increased the cumulative evaporation under the present conditions. The decreasing in the amount of moisture lost by evaporation attributed mainly to the role of clay deposit in increasing the soil aggregation that decreased the pore space. The relation between residual moisture content as percentage from water holding capacity is linear, positively and highly significant at 1% level, which means that application of bentonite to sandy soils (coarse textured soils) meets a progressive increase of the soil water characteristics.
Keywords: Sandy loam, bentonite, farm yard manure, sandy soil, cumulative evaporation, dry-wet cycles.

Introduction

Efficient management of soil moisture is important issue for agricultural production in the light of scarce water resources. The coincidence of drought, water shortage and soil and water loss is the greatest limiting factor for socially and economically sustainable development under semiarid condition. Coarse textured soils in new reclaimed area usually recognized by poor properties i.e., surface area, water retention, organic matter content, fertility and high infiltration rate, that cause inefficient water use under previous conditions (Abd El-Hady[1]).The addition of different natural conditioners, such as natural deposits could been overcome (Al-Omran et al[2]). Soil conditioners improves the physical properties of soil (Wallace and Terry[3]) and include both synthetic and natural products and also include many kinds of organic materials, gypsum, lime, natural deposits (Wahab et al.[4]). Affifi[5]mentionedthat the application clay deposits (bentonite) to the sandy soil improved downward water movement and restricted the water loss by deep percolation and keep the nutrients from leaching out. Also, De Boodt[6]stated that water is subjected not only to gravity by promoting vertical downward movement, but also to lateral suction leading to reduction in irrigation. Abd El-Hady[1]mentionedthatsoilfine particles such as clay and silt fraction play an important role in water flow in coarse soil.Abd El-Hady andEbtisamEldardiry[7] found that application of shale deposits (bentonite) to sandy soil at different rates improved the physico-chemical properties and in particular soil moisture characteristics and cation exchange capacity. Abou-Gabalet al. [8]found that the addition of local Tafla (67 % silt+clay), dominated by bentonite) to the sandy soil in Egypt improved the soil texture and consequently soil-water plant relationships.

Soil conditioners whether natural or synthetic contributed significantly to provide a reservoir of soil water to plants on demand in the upper layers of the soil where the root systems normally develop(De Boodt[6]), improving soil physical properties, also serve as buffers against temporary drought stress and reduce the risk of plant failure during establishment This is achieved by means of reduction of evaporation through bounded movement of water from the sub-surface to the surface layer (Ouchiet al. [9]).

The aim of the present study is to assess the effect of bentonite application rates as natural amendments on intermittent evaporation in sandy soil.

Materials and Methods

Greenhouse experiment was carried out in Water Relations and Field Irrigation Dept., National Research Centre, Egypton a sandy loam soil(23% silt; 8% clay).The experimental design was completely randomized in three replicates. Some physical and chemical characteristics of the examined soil are outlined in $CaCO_3$(2.5 %), organic matter content (0.36%), ECe (1.24 dSm^{-1} in soil paste extract), pH (8.12 in soil : water 1:2.5) [Blake and Hartge[10],Carter[11], Rebecca[12]], respectively.

In brief, the bentonite was ground to pass through a 1mm sieve. After the soil and the bentonites had been mixed, bentonite used in current work is characterized by clay in texture, 4.8 dSm^{-1} (soil paste extraction), 7.88 , 4.6 % and 1.8 % for ECe, pH, $CaCO_3$ and organic matter content, respectively.

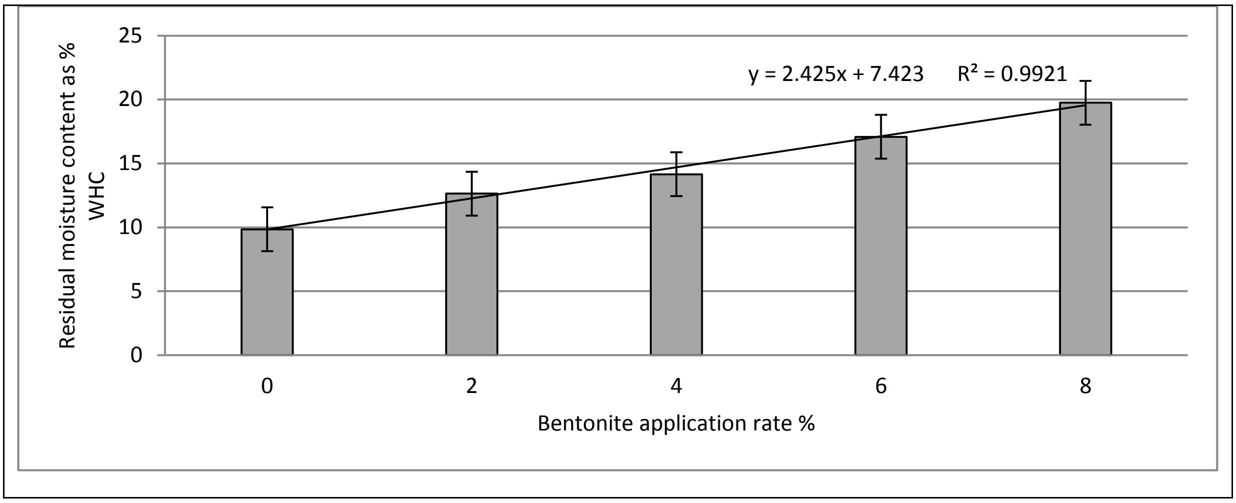
Evaporation experiment was conducted in pot size 20 cm filled by 2 kg soil and treated by bentonite application rates 0, 2, 4, 6 and 8 % on weight base and well mixed and compacted to near BD in field (1.65g cm^{-3}). The exposed area of the treated and untreated pots was 175 cm^2, they watered to water holding capacity and left under greenhouse conditions for 10 days then soil moisture in pot raised to WHC % on weight basis and left to another cycles.

The data were subjected to the analysis of variance (ANOVA) appropriate to the completely randomized design applied after testing the homogeneity of error variances according to the procedure out-lined by Snedecor and Cochran[13]. The significant differences (LSD) between treatments were compared with the critical difference at 5% probability level.

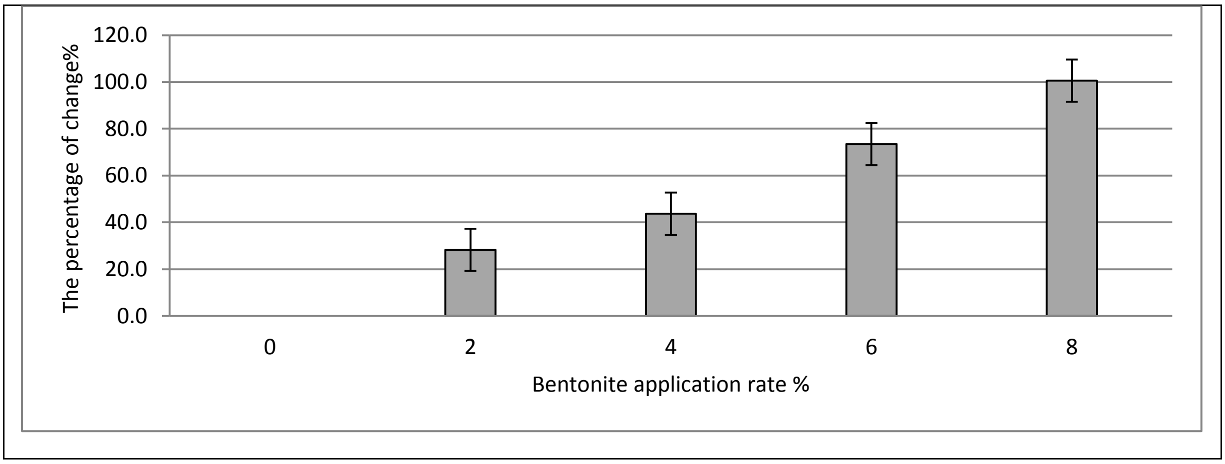
Results and Dissuasion

Effect of bentonite application rate to sandy soil on the evaporation from soil surface.

Water is considering the vital factor in life which determine from our ability to increase cultivated area in Egypt. Water loss factors which does not used in agricultural production and that should be controlled. The obtained results showed that the residual moisture in pots consistently increased in treated ones by increase bentonite application rates. The value of the increase was 9.85% in control pot and 19.57 % in pot treated by 8% bentonite. While the increase in moisture content is relatively low, where it is ranged between 2 to 3 % regarding to the increase application unite of bentonite (2%).



Fig, (1) Effect of Bentonite application rate on the residual moisture content as percentage from water holding capacity.



Fig, (2) Effect of Bentonite application rate on the percentage of change from water holding capacity

The obtained results could attribute of the remained moisture due to one or more of the followings: i) increases bentonite application rates to sandy soil led to increase fine particles which led to relatively decrease water matrix retained in soil and consequently need to more energy to los through evaporation, ii) when different bentonite rates added to sandy soil we found the effect of bentonite application to increase micro pores in treated soil than in untreated one. It is known that water flow under unsaturated condition is faster in heavy soil than in fine one which caused soil surface to quick dry that help as a protected layer for the followed layers from quick dry, and iii) form stable soil aggregation which help in quick mulch process.While treated pots by 6 and 8 % bentonite application rates led to clear change in soil HC. These results and somewhat the induces interpretation agreed with Satje and Nelson[14]**.**

The relation between residual moisture content as percentage from water holding capacity (**WHC**) is expressed in the following regression equation:

Y=2.425x+7.423R² = 0.9921**

Where Y is residual moisture content as % WHC and x is the bentonite application rate. It could notice the regression is linear, positive and highly significant at 1% level, which means that application of bentonite to sandy soils (coarse textured soils) meets a progressive increase of the soil water characteristics.

Effect of dry-wet cycles on the bentonite treated soil on evaporation process.

Fig. (3;4) showed the relation between both wet dry cycles and bentonite application rate and residual moisture content in soil. One can noticed that soil treated by bentonite at rate 8 % increased their ability to retain water as compared by 6 % bentonite application rate. The small difference in soil moisture remained in treated soil among wet-dry cycles caused by the change in different evaporation factors such as air temperature, direct sun rays, relative humidity …etc) during period of determination which extend to 10 days for each cycle.

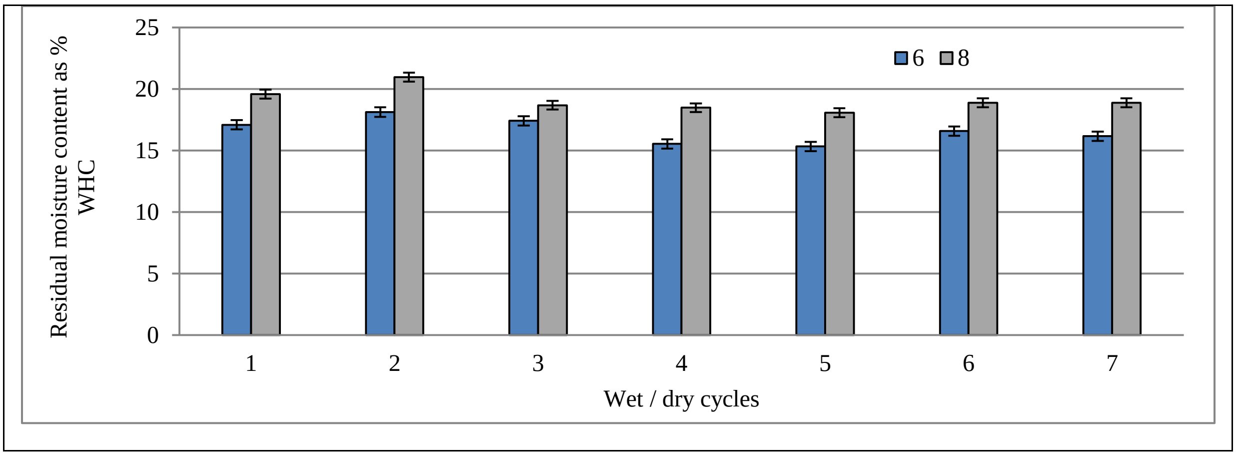


Fig. (3) Effect of followed wet and dry cycles on the evaporation from sandy soil treated by bentonite at different application rates (Each cycle is 10 days then the moisture raised to WHC)

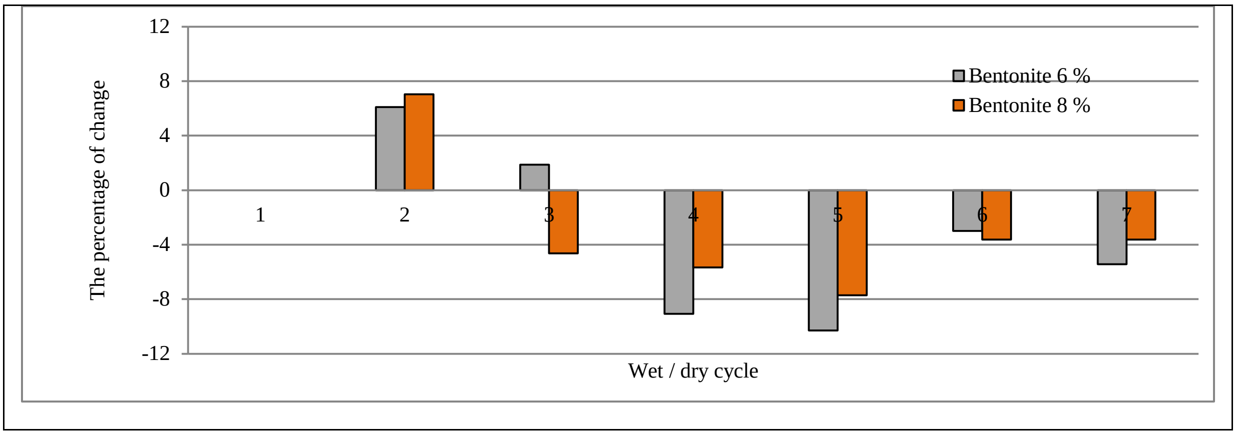


Fig. (4) Effect of followed wet and dry cycles on the evaporation from sandy soil treated by bentonite at different application rates

It is worthy to mentioned that the changeless in water quantity that kept in bentonite treated soil after followed wet-dry cycles, Confirms the stability of the childin the soil and do not need to repeat addition.The variation in residual moisture % in soil is mainly resulted from bentonite application rate and therefore could be explained in line with the physical nature of soil and its propertiesHillel[15]. The obtained results is in agreement with that obtained by Hassan and Abdel Wahab[16]whomentioned that enhancement of soil textural class from sandy to loamy sand was made with the increase in fine particles. Where Bulk density, macro-pores and saturated hydraulic conductivity led to dramatically decreased from side and from the other side total porosity, water holding capacity, field capacity and available moisture were progressively increased**(**Satje and Nelson[14]**;** Tayelet al. [17]).Decreasing the amount of moisture that lost by evaporation attributed mainly to the role of clay deposit in increasing the soil aggregation and then decreased the pore space and to its ability to absorbs water not only on their large surface area but also inside their geometric structure (Abdel-Nasser[18]**;** Al-Omranet al., [2]).

Conclusions

The obtained results recommended that the application of natural conditioners (rich in clay) enhancement soil water characteristics such as water holding capacity, stored and reduced cumulative evaporation, then improved the water conserved at rates up to 8 %. Also, addition natural conditioners up to 8 % bounded the water intake in sandy soil. The beneficial effects may be due to the increase clay content in treated soil. Developed of soil hydro-physical properties through reduced water infiltration and cumulative evaporation are good practices for plant growth under limited irrigation water.

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