Emir. J. Agric. Sci. (1992) 4: 92-100

A Comparative Study of Water Retention Among A Sandy Soil And Composts in Al Ain, U.A.E. (Short Communication).

Keiichiro Matsuda[1], Mahmoud Al-Afifi[2], Hiromi Yokota[1], Hiroyasu Onuma[3], Akira Koto[4], and Suhayl Itani[2]

[1]Prof. Emeritus and Senior Scientist, Shizuoka Univ., Japan.

[2]Assoc. Prof. of Soil Science, Faculty of Agric. Sci., United Arab Emirates University, UAE

[3] Kokusai Koshu Co., Ltd., Japan

[4] Sanyo Consultant Co., Ltd., Japan

ABSTRACT :

The distribution of available water at different matric potentials in two types of composts that are used locally was compared to that of a sandy soil using moisture characteristic curves. The two types of compost were Al Ain compost (recycled domestic refuse) and bark compost (extracted from barks of Tsuga heterophylla trees). Al Ain compost and bark compost showed higher field capacities than that of the sandy soil : 25% and 38%, respectively, to 70% of the soil. A similar trend was also observed in terms of available water capacity. The composts were observed to hold more water at lower matric potential than the soil.

Key words : Available water, Compost, Water potential, Sandy Soil, Al Ain, Tsuga heterophylla.

INTRODUCTION

Al Ain city, UAE, is a major agricultural area in the Emirates located at 55.5° longitude and 24.4° latitude near the Arabian desert. The city is surrounded by a linear aeolian

subsystem comprising of parallel and subparallel linear dunes and therefore its soils are primarily sandy in nature (Stevens, 1969, Matsuda et al., 1979).

Sandy soils are generally known to have both a low water-holding capacity and available water capacity because of their small surface areas and pore space volumes (Foth, 1984). Accordingly, it is necessary to increase the soil-water retention of the sandy soils of Al Ain region as part of the on-going agricultural development plans and production expansion projects.

Lal (1981) indicated that soil organic matter increases retained water at lower tensions, thereby increasing the available water capacity, i.e. water held between - 0.03 MPa and - 1.5 MPa. Soil organic matter, including both humus and plant residues, can absorb up to 90% of its weight as water. Such a characteristic substantially increases the water-holding capacity of mineral soil, i.e. water held at - 0.0001 MPa, and it may significantly improve the moisture retaining capacity of sandy soils (Smith and Elliott, 1990). Similarly the composted bark was reported to increase the water-holding capacity of the soil (Ito, 1974 and Wilson, 1981).

Accordingly, the present research was initiated with the main objective of comparing the water characteristic curves and the available water capacities between the sandy soils of Al Ain region, and two kinds of composts used for soil amendment, namely Al Ain compost and bark compost.

MATERIALS AND METHODS

An experiment was conducted at the University Farm of the United Arab Emirates University in Al Ain region to compare soil-water characteristics of the sandy soils of the region with that of two soil amendments. The two composts used to improve the water retention of the local soils were : Al Ain compost (recycled domestic refuse) and bark compost (extracted from barks of Tsuga heterophylla trees). Soil samples were collected from three random locations inside the farm. The soil samples were then mixed, dried and sieved to < 2mm and their respective mechanical compositions were analyzed using the method of Day (1965). In addition, the effect of hydrochloric acid treatment on the particle-size

distribution was examined by treating soil samples with continuous addition of 0.5 N HCl until the formation of carbon dioxide ceased. Fractionation of the silt and the clay from both HCl-treated and untreated samples was determined by the pipette method.

One hundred cm^3 metallic cylinders were filled with samples of the soil and composts. The cylinders were lightly agitated to prevent compaction in the course of filling. Each cylinder was then placed inside a small vessel filled with water to a height of 5 mm of that of the cylinder. The cylinders were left overnight to insure sample saturation with water by capillarity. Water content of the samples were determined by two methods at different levels of tension : 1 - Suction method at 1.0 to 2.7 pF, and 2 - Centrifuge method at 3.0 to 4.2 pF. Values of measured pF were converted into those of water matric potentials (MPa).

RESULTS AND DISCUSSION

Mechanical analysis of the soil samples revealed that the sand content was more than 90% with a higher fine sand fraction than coarse sand (Fig.1). Accordingly, the soil texture was classified as sand. The mean carbonate content of the soil was 17% with an average 11% decrease in the fine sand content with HCl treatment. This shows that the carbonate in the soil is mainly included in the fine sand fraction.

The respective water-holding capacities of the soil, Al Ain compost, and bark compost were 36%, 49%, and 66% on volume basis of water at saturation. The higher water-holding capacities of the composts compared to the soil may be due to their specific surface areas and smaller pores.

The moisture content of the soil at every matric potential was lower than those of the composts at the same potentials (Fig. 2). The order of available water capacities of the samples was : soil < Al Ain compost < bark compost (Table 1).

Available water capacity may be sub-divided into readily available water held between - 0.03 MPa and - 0.1 MPa

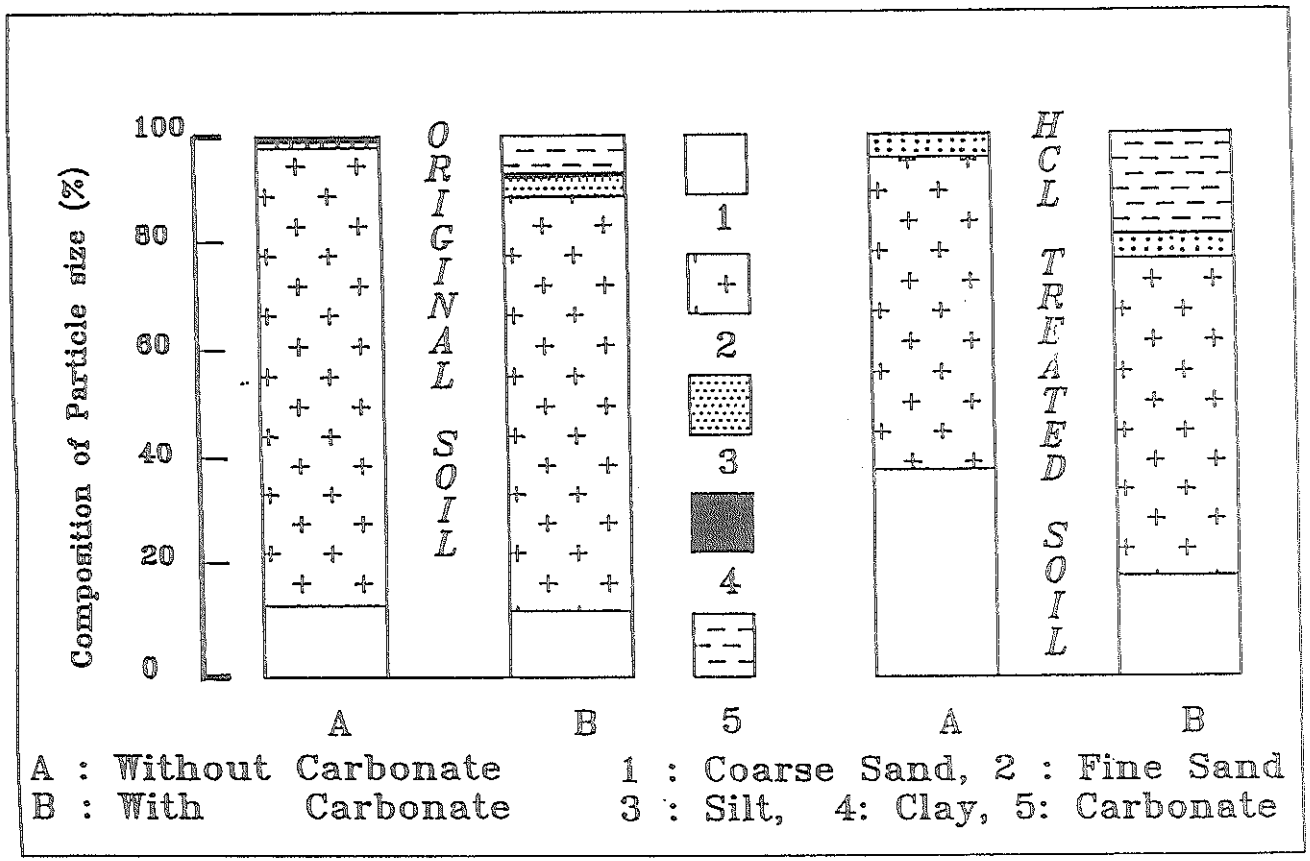

Figure 1. Mechanical composition of soil sample

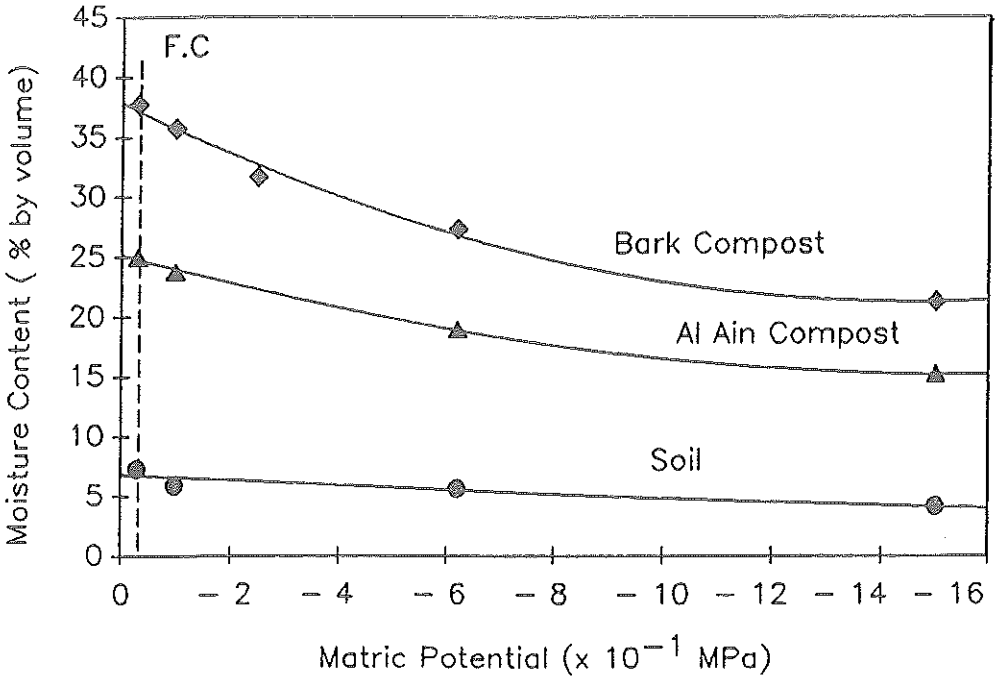

Figure 2. Soil and compost moisture characteristic curves

and non readily available water held between - 0.1 MPa and - 1.5 MPa.

Table 1. Field capacities and distribution of two types of available water of tested soil and composts.

Sample	Field[1] capacity	Available water capacity	Distribution of water[2] capacity %	
			Readily available	Non-readily available
Soil	7.3	3.2	44	56
Al Ain Compost	25.0	9.8	13	87
Bark Compost	37.7	16.5	12	88

1 cms per 100 cms of soil and compost depth

2 Readily Available (-0.3 to -1 x 10^{-1} MPa), Non-readily available (-1 x 10^{-1} to -15 x 10^{-1} MPa).

Table 1 shows values calculated from the moisture characteristic curves. In the distribution of the available water capacity, the soil was shown to have proportionally more readily available water than those of the composts, similar to the findings of Landon (1984). Accordingly, most of the available water in the soil can be rapidly used by the growing plants. However, the composts were found to hold greater quantities of the non-readily available water compared to that of the soil. Variations in available water capacities between both samples are due to the differences in the slope of the sample-moisture characteristic curves (Fig. 2). Composts had higher slopes in comparison with that of the soil at the water matric potential below - 0.5 MPa. Accordingly, the composts are considered to be similar in hydraulic behavior to fine-textured soils since those soils are known to hold more of the non-readily available water and have higher field capacities (Foth, 1984). Consequently, higher crop yields could be expected, similar to the findings

of Lehane and Staple (1965) who observed higher yields of wheat crops grown on a clay soil compared to those grown on a sandy soil.

CONCLUSIONS

Since more of the available water in composts is held at low matric potentials, water losses by deep perculation below the root zone due to gravity will be minimized and consequently more water for plant uptake will be available. Mixing these composts with the sandy soils of Al Ain region is expected to reduce water losses and increase water retention.

REFERENCES

Day, P. 1965. Particle fractionation and particle-size analysis. In : C. Black. (Eds). Methods of Soil Analysis. American Society of Agronomy. 545-567.

Foth, H. 1984. Fundamentals of Soil Science. 7th edition. John Wiley and Sons. N.Y. p 74-79.

Ito, M. 1974. Effects of continuous application of bark compost on Sugi nursery. Bull. Shizuoka Prefecture Forest Experiment Station. 6 : 1-14. (in Japanese).

Lal, R. 1981. Physical Properties. In : D. Greenland (Ed). Characterization of soils in relation to their classification and management for crop production : Examples from some areas of the humid tropics. Clarendon, Oxford. p 135-145.

Landon, J. 1984. Tropical Soil Management. Booker Agricultural International Limited. p 85-93.

Lehane, J. and W. Staple. 1965. Influence of soil texture, depth of soil moisture storage, and rainfall distribution on wheat yields in southwestern Saskatchewan. Can. J. Soil Sci. 45:207-219.

Matsuda, K., H. Yokota, Y. Zaitsu, and H. Onuma. 1979. Some characteristics of the soil of Al Ain, Abu Dhabi - UAE.

(Forecast). Sand Dune Research 25 : 1-7. (in Japanese).

Smith, J. and L. Elliot. 1990. Tillage and residue management effects on soil organic matter dynamics in semi-arid regions. In : R. Singh, J. Parr, and B. Stewart. (Eds) : Dryland Agriculture, Strategies for Sustainability. Advances in Soil Science 13 : 69-88.

Stevens, J. 1969. The Soil and Agriculture of Al Ain Oasis, Abu Dhabi. Report to the Department of Agriculture. Government of Abu Dhabi. Univ. of Durham. 36 pp.

Wilson, G. 1981. Bark compost for pot Chrysanthemums . Acta Horticulturae. 126:95-104.

دراسة مقارنة لقدرة الأرض الرملية والأسمدة العضوية الصناعية المستخدمة كمحسنات للتربة في مدينة العين على الإحتفاظ بالماء

ملخص :

أجريت هذه الدراسة لمقارنة نسب الماء الميسر في تربة رملية بمثيلتها في نوعين من الأسمدة العضوية الصناعية المنتجة محليا وذلك بإستخدام منحنى التوزيع الرطوبي .

وفي هذا البحث أستخدم سماد مدينة العين المصنع أساسا من القمامة وسماد لحاء الأشجار المتخلص من أشجار Tsuga heterophylla . ولقد أظهرت النتائج أن النسب المئوية للرطوبة لسماد مدينة العين وسماد لحاء الأشجار والأرض الرملية عند السعة الحقلية هي ٢٥٪ ، ٣٨٪ ، ٧٪ على التوالي .

كما لوحظ إرتفاع نسب الماء الميسر في عينتي سماد مدينة العين وسماد لحاء الأشجار عن مثيلتها في الأرض الرملية. وتشير النتائج الى أن إضافة السمادين المستخدمين في هذا البحث الى الترب الرملية يمكن أن يزيد من كفاءة إستخدام المياه وذلك لقدرة هذين السمادين على الإحتفاظ بكميات أكبر من المياه بالمقارنة بالترب الرملية .