EFFECTS OF USING ORGANIC COMPOST ON WATER HOLDING CAPACITY OF DHAKA SOIL

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ABSTRACT

The climate of the world is facing a continuous change over time. As an effect of that the underground water level is decreasing. The field of agriculture is directly getting affected by it. Scarcity of water at the upper level of land soil causes various difficulties in cultivation. Researchers are seeking solutions using different ways to minimize this problem. Our aim is to use compost with agricultural soil to increase its water holding capacity. This process can be a suitable solution to our problem regarding the other needs at our country. In our study, compost was mixed with soil and sand samples placed in moulds of 20cm, which represented the upper layer of soil of an agricultural land. At the 1st stage, soil sample was prepared by mixing soil, sand and compost at different percentages. At the 2nd stage, sample was made by mixing sand and compost. Each type of mixture was placed in series of moulds made of PVC pipe and then kept under water for 24 hours in a tank for soaking water. These moulds were then placed on a dewatering bed. The dewatering bed was a plastic bowl containing a layer of sand and a layer of brick chips under it. Soil samples were collected in containers from different layers of soil of the mould at a regular time interval. Then the moisture content of those samples were measured. From the moisture content the water holding capacity of our samples were calculated. Elaborate analysis was done to compare the results for different types of mixtures. It is found that, the water holding capacity of both compost mixed soil and compost mixed sand are considerably high comparing to normal sandy soil and sand respectively which we find at land condition. Mixing of compost with soil and sand increased the water holding capacity of both the samples significantly. From our study we obtained the result that, proper use of compost with soil or sand can increase the water holding capacity of the soil of agricultural land and thus reduce the irrigation demand and also increase the organic value of soil as well.

Keywords: *Compost, sand, water, holding, moisture content.*

1. INTRODUCTION

The natural foundations of life are fresh water, fertile land and clean air. They are also the formation base of a safe, peaceful and prosperous society. It is the responsibility of every society that these basic elements remain secured. The recent periods of extreme drought and the associated depletion of water supplies have highlighted a critical disturbance on natural systems and brought about much discussion on water management. This problem of water management also causes irrigation water demand which is continuously increasing day by day with the increasing population. For controlling irrigation water demand agricultural soil has to be treated with different processes (Reza et. al. 2012) . The skin of the earth called soil is dynamic natural body capable of supporting agriculture cover. It contains chemical solution, gases, organic refuse, flora and fauna (Gabbler *et al*., 2009). According to Yusuf (2010) soil is the loose material that covers the land surfaces of the earth and supports the growth of plants. As agriculture is the single largest consumer of fresh water and accounts for about 75% of anthropogenic fresh water use. According to Wallace (2000) on average 63% of fresh water applied to agricultural lands is lost to evaporation and runoff. Rain water and irrigation water that is not absorbed by soils is capable of transporting fertilizers and pesticides into watersheds creating nonpoint pollution. Due to the increased use of chemical fertilizers and the highly inefficient use of water, there has been an increase in non-point pollution in agricultural areas around the world. With the world's population set to increase by 65% (i.e., 3.7 billion people) by 2050 (Adamu et. al 2012), the additional food required to feed future generations will put further pressure on irrigation system for which water holding capacity should increase.

The water holding capacity of a soil is a very important agronomic characteristic. Water-holding capacity is defined as the water retained between field capacity and wilting point. Permanent wilting point refers as the minimal point of soil moisture the plant requires not to wilt. If moisture decreases to this or any lower point a plant wilts and can no longer recover its turgidity when placed in a saturated atmosphere for 12 hours. The amount of soil moisture or water content held in the soil after excess water has drained away and the rate of downward movement has decreased denoted Field capacity. Available water holding capacity can be defined as the amount of water (moisture) the soil can hold for the use of plants root for certain period of time (Yusuf, 2010). Soil water holding capacity is controlled primarily by the soil texture and the soil organic matter content. The plants can only extract a certain portion up to Permanent wilting point and this portion is called available water (Madhu et. al. 2014). The soil water content that is strongly attached to soil particles and aggregates, and cannot be extracted by plants represent the unavailable water which held as films coating soil particles. For optimum plant growth, the generalized content of soil components by volume should be roughly 50% solids (45% mineral and 5% organic matter), and 50% voids of which half is occupied by water and half by gas (Vengadaramana et. al. 2012). Water holding capacity of soils is controlled primarily by the number of pores and pore-size distribution of soils. Because of increased aggregation, total pore space is also increased. From measurement of water holding capacity of any soil it can be decided if clay soil, sand, sandy soil or loamy soil which more effective for the irrigation process. With application of wastes for plant nutrient supply increases the moisture content of the soil. An increase in organic content of the soil increases aggregation; decreases bulk density, increases water holding capacity (Bari and Koenig 2006). Therefore, it is worthy to investigate the effect of adding organic compost to the agricultural soil collected from Dhaka.

2. MATERIALS AND METHODS

Three phases of works are conducted for this study, (i) Collection of materials: soil, sand and compost made from organic waste is collected from some specific areas (ii) Experimental setup: sample preparation in a number of cylinder moulds and drying bed is fabricated and (iii) Experimental runs: experiment is properly executed. All experiments of this study have been conducted in environmental engineering laboratory of AUST.

2.1 Collection of Maerials

The materials namely soil, sand and compost are primary component of the composite soil. To assemble the experiment the required amount of soil, sand, compost and brick chips were collected from different places of Dhaka city. The compost was collected from a horticulture centre at Agargaon, Dhaka. The sandy soil, which was collected from a river side located in Bosila, Keraniganj as shown in Figure 1. Sand was collected from a constructed site located in Banani.

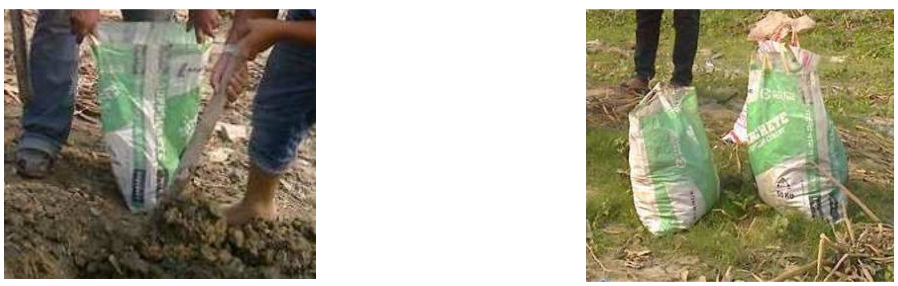


Figure 1: Sandy soil collection from the river bed

2.2 Mixing of soil, sand and compost

The components soil, sand and compost were used to make four types of soil mixture or composite soil as shown in Table 1. The first mixture contains 67% soil and 33% compost, the second mixer contains 100% soil, the third mixer contains 67% sand and 33% compost, the forth mixer contains 100% sand.

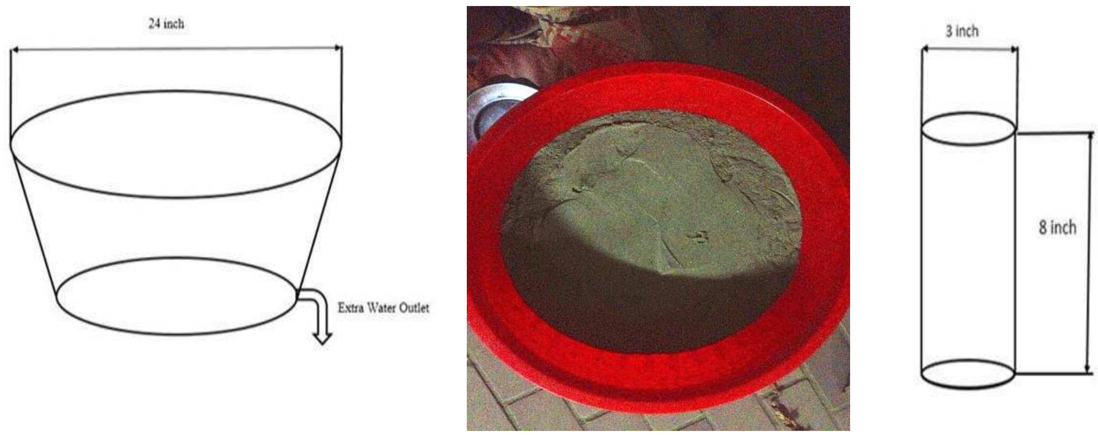
a) soil and compost b) sandy soil c) sand d) compost

Figure 2: Soil, Sand and Compost sample

For accurate data collection small brick particles, stones, poly-bags and other unnecessary particles were removed from collected soil, sand and compost. The large particles of soil, sand and composts were smashed into very fine sizes, so that the water can pass smoothly through the moulds containing different types of soil mixture after saturation for determining the water holding capacity

2.3 Experimental Setup

Experimental setup consists of dewatering bed and cylindrical moulds. The dewatering bed was prepared by a plastic bowl of diameter 24 inch and height 10 inch approximately. It is used to contain the materials of dewatering bed. At the bottom of the bed there was a 2.5 inch layer of brick chips and the upper portion contains 6 inch layer of sand. The detail of the drying bed is shown in Figure 3a and Figure 3b



a) Schematic of dewatering bed b) dewatering bed c) mould

Figure 3: Soil holding equipment

To remove all excess collected water from the bed a tap is inserted at the bottom of the dewatering bed as shown in Figure 3(a,b). The dimension of the cylindrical mould used in this experiment was 8 inch (20.32cm) in height and 3 inch (7.62cm) in diameter as shown in Figure 3(c). This was prepared from UPVC pipe according to the above mentioned dimensions. A 12.5 feet long UPVC pipe is collected and then cut them into proper dimension.

2.4 Other Accessories

Nets are used to cover the cylinder full of soil. A water tank is used to keep the moulds under water. The moulds containing soil mixture become saturated once immersed in water for 20 to 24 hours. The dimension of the water tank was 7 feet long, 3 feet wide and 3 feet of height. About 45 gallons of water were required to fill the tank up to the mark to swallow the moulds. After put off the moulds containing the soil mixture from the tank it is kept in the dewatering bed. In Laboratory drying oven was used to dry out the wet soil sample for calculating the moisture content of the samples collected from the pre select designated places of the moulds. Each of the soil samples were kept in oven for 18 hours. The temperature was maintained constantly 103-105.

a) Moulds swallow in water tank b) Mould of soil placing in dewatering bed

Figure 4: Placing of Moulds of soil.

3. EXPERIMENTAL PROGRAM

Four experimental run namely A, B, C and D was conducted for different duration of time as shown in Table 1. Four different types of sample mixture were used as indicated in Table 1. Numbers of mould used in each run are shown in the second column of Table 1. Duration of most of the runs was 1 week except run A, where the mould contains composite soil sample made with sandy soil and compost. Run B, C, D were done using only soil, sand-compost mixture and sand respectively to show a comparison among the difference of water retention of different soil mixtures.

Table 1: Experimental program of water holding capacity test.

Run	Number of Mould	Duration of runs, Days	Composition of soil mixture in %		
			Soil	**compost**	**sand**
A	18	20	67	33	-
B	6	7	100	-	-
C	6	7	-	33	67
D	6	7	-	-	100

4. RESULTS AND DISCUSSION

The moisture content calculations of samples collected from different moulds containing soil mixture was performed to determine the water holding capacity after specified time schedule. Run A with soil mixture with 67% soil and 33% compost provides elaborate results showing different stages of change in moisture content of the soil sample. The compost portion 33% is taken only for academic research interest. There are gradual decreases of moisture content of composite soil sample for run A as shown in Figure 5a. Figure 5(b) shows the gradual decrease of moisture content of 100% soil, for test run B. It is found that mixing of compost with soil provide increased water holding capacity as compared in Figure 6.

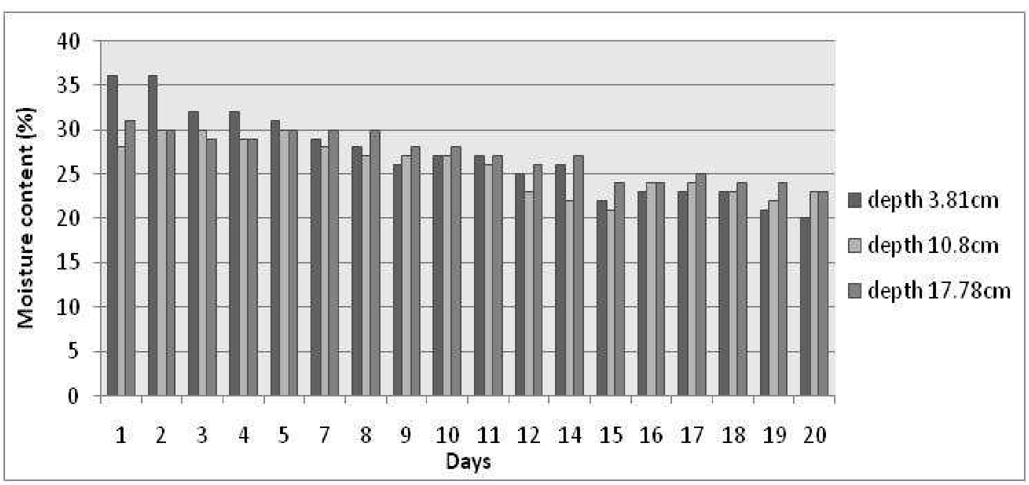


Figure 5(a): Decrease in water holding capacity in test Run A

Figure 7(a) shows the gradual decrease of moisture content of 100% sand sample, which is drawn using the results of test run D. Compost mixed soil sample gave 2-3 times increased moisture content in the course of time than both soil and sand as shown in Figure 6 and 8

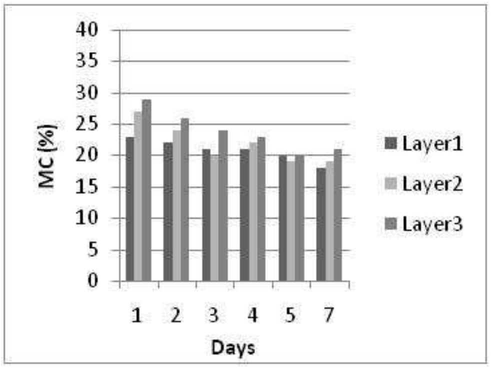


Figure 5b Test Run B

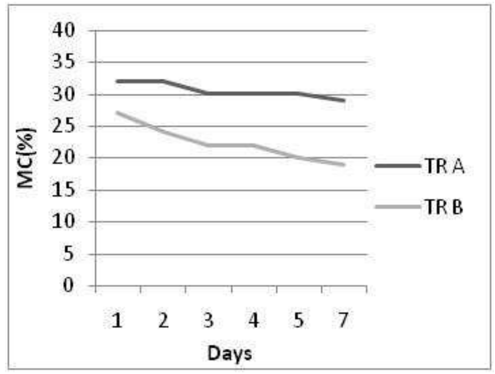


Figure 6 Comparison between test run A & B

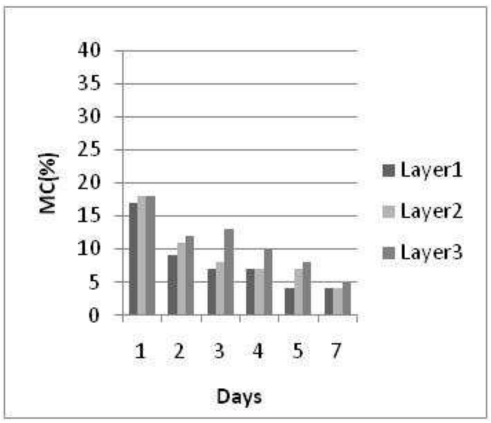


Figure 7a: Test Run D

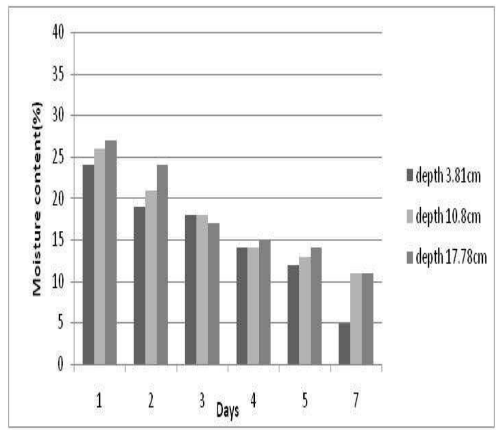


Figure 7b: Test Run C

Figure 7(b) represents percentage moisture contents of sand mixed with compost. Figure 9 shows the comparison of change in moisture content between run C and run D. The moisture content after 7 days was significantly reduced in only sand mixture. The sand dries up below 5% after only 7 days. The soil contains moisture up to 20% at the end of the run.

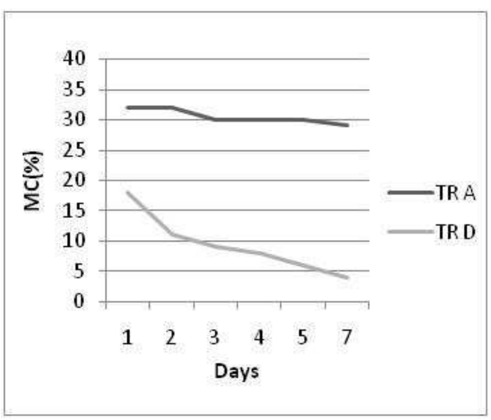


Figure 8: Comparison between run A & D

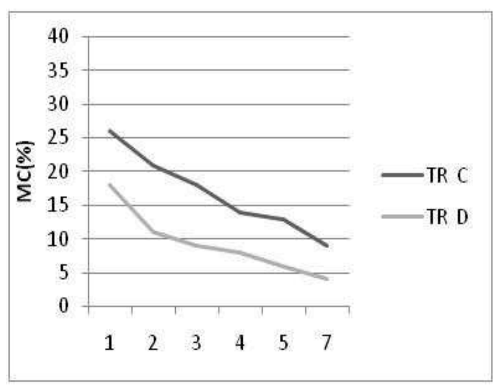


Figure 9: Comparison between run C & D

For another observation a graph was plotted using the moisture content data of the seventh day of 3 different layers of soil of the moulds. All 4 type sample's data were used in this graph. All the 4 curves showed the result that on the seventh day water retention was highest at the depth of about 16.5cm - 20.32cm.

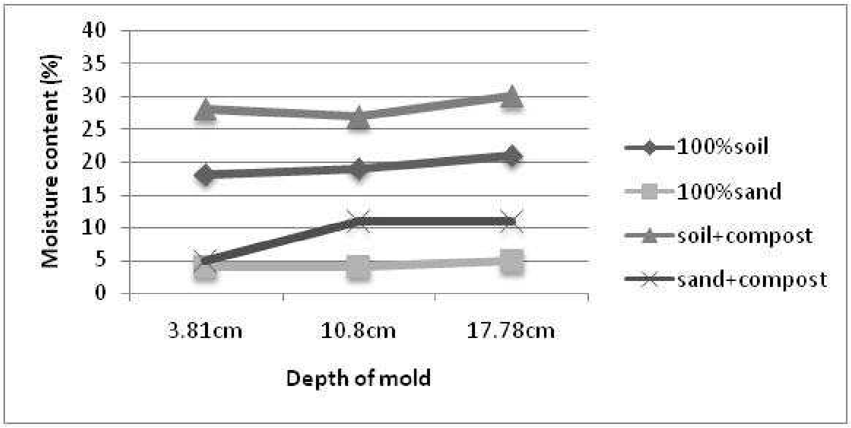


Figure 10: Depth of the mould vs moisture content of the 4 type of samples on the seventh day.

5. CONCLUSIONS

- It can be understood that the water holding capacity of agricultural soil can be highly increased by the usage of compost. Compost is a coarser absorbing material with more pore spaces to store water as illustrated by the tests. Therefore usage of optimum percentages of compost will increase water holding capacity.
- From the experiment it is found that both the soil mixture of run A and run C, that is soil mixture with 67% soil & 33% compost and 67% sand & 33% compost provides respectively 30% and 60% more water holding capacity than run B with soil and run D with sand.
- From this study we can consider another fact that, the water holding capacity can be increased by mixing compost with at the top 20cm to 25cm depth of soil of the land, depending on the availability, economy, and practical application facts.

In those areas like Dhaka and its neighbouring, where there is scarcity of water, like north region of our country, this procedure can be an effective solution to hold water long time in the agricultural land.

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