



(RESEARCH ARTICLE)



## Examination of compost application on Some chemical Properties of Aridisols in Sudan

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### Abstract

The addition of compost to soil is a common soil management practice used by small farmers of Sudan to improve soil properties and growing media. Therefore, the aim of this study was to investigate the effects of different doses of compost (mesquite manure) on some soil characteristics. The preparation of composted mesquite was performed through aerobic fermentation for three months with periodic stirring (every two weeks) and moistening. The pot experiments were conducted in the Faculty of Agriculture, University of Khartoum over two seasons and treatments used were: Control (pure soil), 10 (T1), 20 (T2), 30 (T3) and 40 (T4) (ton.ha<sup>-1</sup>) of compost mesquite was applied on Aridisols (Shambat Soil) in a completely randomized design with four replicates. The experiment was repeated in the second season without further addition of compost. The soil was analyzed for: saturation percentage, soil pH, electrical conductivity of the saturation extract (EC<sub>e</sub>), calcium, magnesium, sodium, potassium, nitrogen, phosphorus and organic carbon percentages. Generally, the results showed significant differences between all treatments and the control. Mesquite manures (compost) treatments have lowered the soil pH, but have greatly improved its nutrient content. The results showed a significant superiority of the fourth treatment (40 ton/ha) in the concentration of all elements analyzed in the soil. Also, this study demonstrated that mesquite could be converted into useful product instead of constituting a menace to agricultural lands.

**Keywords:** Composted Mesquite; Aridisols; Soil and Chemical properties

### 1. Introduction

The recent global food crises attributed to rising human population and low yields call for production strategies that can stimulate increased and sustainable crop yields. Also, the scarcity and rising cost of mineral fertilizers and the negative impact of climate change further constitute bottlenecks to effort targeted at achieving increased crop yields. Unfortunately, problems of rapid solubility, high volatility and occasional pollution of ground-waters that accompanies use of mineral fertilizers, exacerbate ecosystem degradation (Foster and Chilton, 2003). Conservation agriculture systems using a low level of external inputs have become more important worldwide in the last few years since they promote the preservation of natural resources, reducing ecosystem degradation, both natural and agro ecosystems (Francis and Daniel 2004).

Mesquite, a common name for the genus *Prosopis* sp., is widely spread in the tropics (Pasicznik 2001 and Laxen 2007). *Prosopis* is a group of trees that stands out as having huge potential to help feed millions of people, especially the species *Prosopis chilensis*. It grows very fast and is invasive in nature and once established can be hardly eliminated, so it is classified as weed in many countries (Algama and Seneviratne, 2000 and Laxen 2007). This is now one of the most numerous and widespread trees in dry areas of Africa and Asia. *Prosopis* trees produce masses of nutritious beans even in the driest years. Where they are native in North and South America, *Prosopis* trees of various species have been, and

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still are, an important staple food for many indigenous peoples. But as a relatively recent arrival in Africa and Asia, people there have not yet learned of its valuable uses and some even think that the beans are poisonous. *Prosopis* also has the potential to become a source of food for very many poor people in the dry areas of Africa and Asia. The sooner it does, the fewer poor people will go hungry. *Prosopis* beans as a food are composed of hard seeds enclosed in a fibrous endocarp, surrounded by a sweet fleshy mesocarp, commonly 15 cm long, but up to 30 cm in some species. There is significant variation in nutritional values between species and even between trees of the same species. Many studies showed the positive effects of mesquite trees on soil properties and conditions, including; Desertification control and sand dune stabilization (Fredrickson et al., 2006; Herrera-Arreola et al., 2007; Laxen, 2007). However, beans generally contain 10–20 percent crude protein, 30–60 percent carbohydrate including up to 40% sugars in some varieties, acceptable amounts of minerals, and an acceptable amino acids profile. This makes the beans comparable or superior to most cereals, with no anti-nutritional factors detected (Pasicznik et al., 2001; Felker et al., 2012). However, mesquite as a multipurpose tree gives many products and renders several services (Pasicznik, 2001). In countries such as Argentina, Chile, Peru, Mexico, and the USA where *Prosopis* is native, the beans were an important staple food in times past (Beresford-Jones et al., 2009). These were traditionally ground into flour using stone mills, and mixed with maize or other flours to make bread, cakes, or a rich gruel. Alternatively, they were boiled into a molasses-like syrup for sweet drinks, and home-made products are still sold in local markets (Felker, 2005; Felker et al., 2012). *Prosopis* gum is similar to Arabic gum and can be used in cooking and all parts of the tree have traditional medicinal uses (Pasicznik et al., 2001). In the Sudan, mesquite was introduced in the early 20th century and now it is widely spread all over the country (Elamin, 1990; Vogt, 1995). The species was identified as *Prosopis juliflora* (Swartz) DC. (Elamin, 1990). It invaded some irrigated agricultural schemes and proved difficult to control and was condemned to eradication from all over the country by a Council of Ministers' Decree (No. 6/95, dated 16 February 1995).

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## 2. Materials and Methods

### 2.1. Experimental Site and Pots Layout

The experiment was carried out in the Faculty of Agriculture, University of Khartoum, Shambat, Sudan (latitude 15°:14' N and longitude 32°:32' E), during September to December 2012 and pot experiments were conducted over two seasons; 2012 and 2013. The treatments were laid out in a completely randomized design (CRD) with four replicates and the 5 different rates (treatments) of well-cured composted mesquite manure at 0 (Control), 10 (T1), 20 (T2), 30 (T3) and 40 (T4) (ton.ha<sup>-1</sup>). Maize (*Zea mays*) was used as an indicator-crop and the seed rate was 5 seeds/pot. Maize was sown in soil Aridisols (Shambat soil). The soil weight was 5 kg per pot and the same soil was used for the two seasons.

### 2.2. Preparation of compost

The manure was collected from mesquite trees sprouting abundantly along water canals around Alsilate area. Leaves and twigs were cut green, air dried and cut into small pieces manually and aerobically (heaps) composted. Water was sprinkled every seven days and the heap was turned over every 15 days. The decomposition process lasted for three months.

The seedlings, Irrigation and Weeding: Maize (*Zea mays*) seeds were sown directly in the pots and after germination the seedlings were thinned out to three stems per pot. The seedlings were irrigated every three days according to the soil field capacity (all pots were irrigated to 80% of the field capacity). The same soil was used for the second season. Weeds were regularly removed whenever appeared.

### 2.3. Soil analysis

The soil was first characterized for general properties and then analyzed for selected properties after termination of the experiment. Soil samples were air dried and passed through a 2mm sieve and the following parameters were determined: Soil pH was measured by a pH meter with glass electrode in a soil paste and Electrical conductivity of the saturation extract (EC<sub>e</sub>) was measured by EC-meter Model JENWAY 4510 date of Mani: Sep, 05 serial No 01892 (Page et al. 1982). Calcium and Magnesium were determined by titration with EDTA, Sodium and potassium were determined by flame photometer according to the method described by Richards (1969). Total nitrogen was determined by micro-Kjeldhal method, Available Phosphorus was measured spectrophotometrically after its extraction from the soil with a NaHCO<sub>3</sub> 0.5 M solution at pH 8.5 and Soil organic carbon (SOC) was determined by the humid oxidation method were described in AOAC (1990). Particle size distribution was obtained by the modified hydro-pipette method (Day, 1965).

**2.4. Statistical analysis**

The data were subjected to analyses of variance by a SAS program package (SAS 2004) and mean separations were obtained by Duncan's multiple range test ( $p \leq 0.05$ ).

**3. Results and Discussion**

**3.1. Characterization of the soils and mesquite manure:**

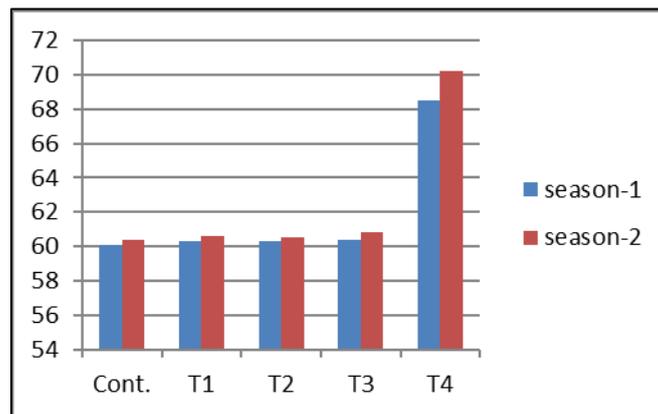
The soil used as growing media was clay soil. It was poor in nutrient content, including nitrogen and available phosphorus. The data presented in Table (1) showed some chemical analysis properties of Mesquite composted.

**Table 1** Some chemical properties of Soil and Mesquite composted

Type of material	SP	pH	Ece	Ca	Mg	Na	K	N	P
			(dS/m)	(mmol+/l)			%		
Soil	66.4	7.73	0.8	2.6	1.3	6.42	0.14	0.05	2.65
Mesquite manure (%)	-	-	-	2.1	1.8	0.2	0.10	1.4	0.87

*3.1.1. The Saturation Percentage (SP)*

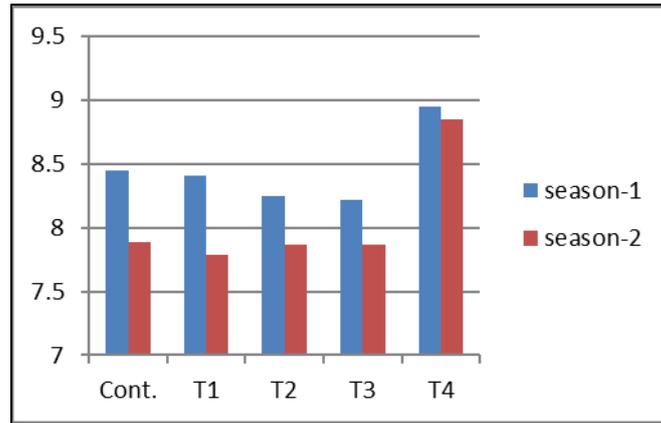
Significant differences were observed in the saturation percentage of soil in the two seasons. Treatment 4 (40 ton/ha) gave significant increase in the saturation percentage in the two seasons compared to other treatments. No significant differences were observed by the application of T1 (10 ton/ha), T2 (20 ton/ha) and T3 (30 ton/ha) in Shambat soil. The trend was the same in the second season (Figure 1). Similar results were obtained by Esawy et al. (2009) who showed that the saturation percentage was higher in treated soil with compost (plant residues).



**Figure 1** Effect of treatments on saturation percentage (first & second season)

*3.1.2. pH value*

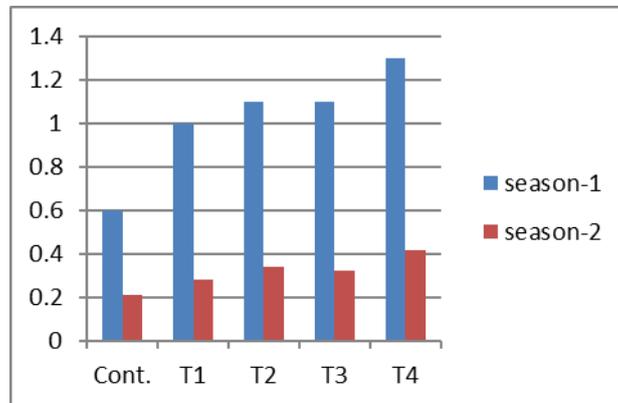
The results indicated that the treatments significantly affected the pH compared to the control in the first season. The control treatment was the highest and treatment 4 (40 ton/ha) was the lowest. That is because the decomposed mesquite released organic acids that lowered the pH. Similar findings were reported by Chang et al (1991) who reported that the soil pH decreased with increasing rate of manure application. There were no significant differences observed in the second season (Figure 2) this is because the effect of composting on soil pH has a temporary effect i.e. the pronounced effect will be in the first season or the buffering capacity of these soil is high. The soil pH was decreased with the application of manure, but soil pH was slightly increased or remained similar to the original soil level this is may be due to the buffering capacity of the soil. Similar results were obtained by Chang et al. (1991) who showed that the compost effect on soil pH depends on the initial soil pH level.



**Figure 2** Effect of treatments on soil pH (first & second season)

### 3.1.3. Electrical Conductivity of extract (ECe)

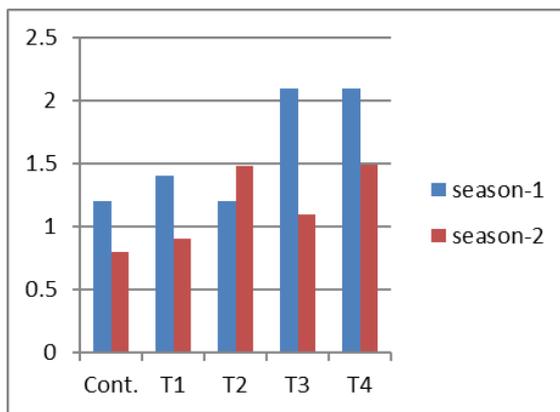
The electrical conductivity was significantly different in the first season. Treatment 4 (40 ton/ha) gave a high significant difference in the two seasons and the control treatment was lowest. No significant differences were observed by the other treatments on Shambat soil in first season. In the second season the same trend was observed (Figure 3). Application of composted organic manure will improve the physical condition of the soil that facilitate the water movement and hence salt leaching. Similar results were obtained by Chang et al. (1991) and Eghball (2002) who showed that the EC increased with increased manure/compost application rate. This is may be due to the concentrations of nutrients released after decomposition.



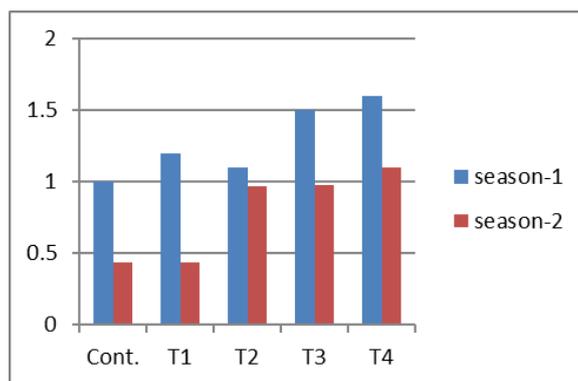
**Figure 3** Effect of treatments on electrical conductivity (first & second season)

### 3.1.4. Calcium and Magnesium

Significant differences were observed calcium and magnesium contents soil in the first season. Significant differences were observed by application of T 4 (40 ton/ha), T 3 (30 ton/ha) compared to other treatments. Similar trend was observed in the second season (Figures 4 to 5). Moreover, addition of organic compost increased the surface area, therefore increased soil cation exchange capacity (CEC) and that increased soluble cations in the soil solution. Similar results were obtained by Warman and Cooper (2000) who showed that the level of calcium and magnesium contents increased with addition of mature compost.



**Figure 4** Effect of treatments on calcium content (first & second season)



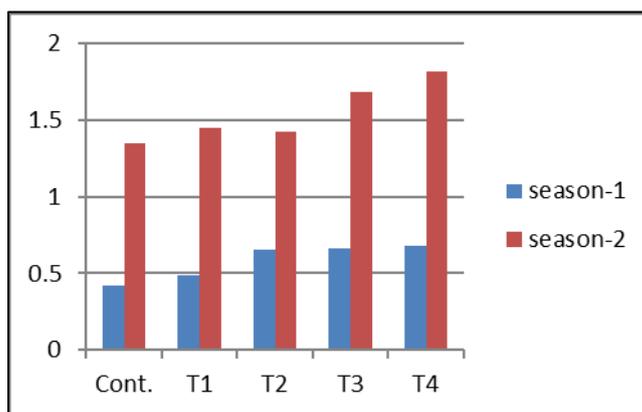
**Figure 5** Effect of treatments on magnesium content (first & second season)

**3.1.5. Sodium**

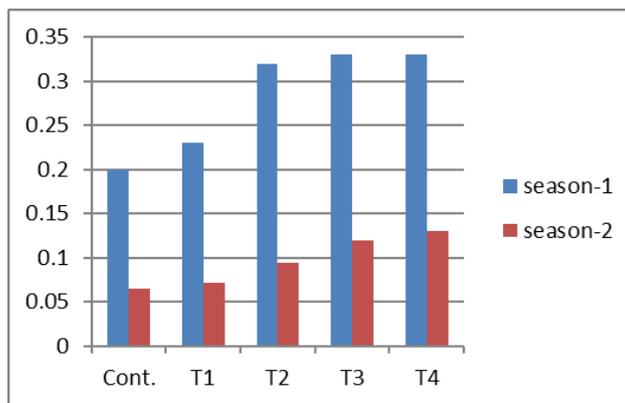
Significant differences were observed in the sodium content in the two seasons. Treatment 4 (40 ton/ha) gave significant increase in the sodium content in the two seasons. In the second season all treatments gave significant differences compared to the control (Figures 6). This may be due to increase in the total soluble solids.

**3.1.6. Potassium**

The application of compost treatments caused significant differences in potassium content of soil in the two seasons. The application of organic manure gave significant increase potassium content in the soil type examined for two seasons (Figures 7). The addition of manure compost increased the availability potassium content in soil and compost due the release of potassium upon organic matter decomposition. Similar results were obtained by Warman and Cooper (2000), who found that application of manure compost, increased the soil potassium.



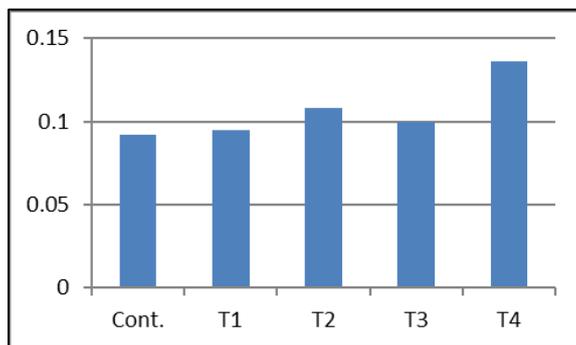
**Figure 6** Effect of treatments on sodium content (first & second season)



**Figure 7** Effect of treatments on potassium content (first & second season)

### 3.1.7. Nitrogen

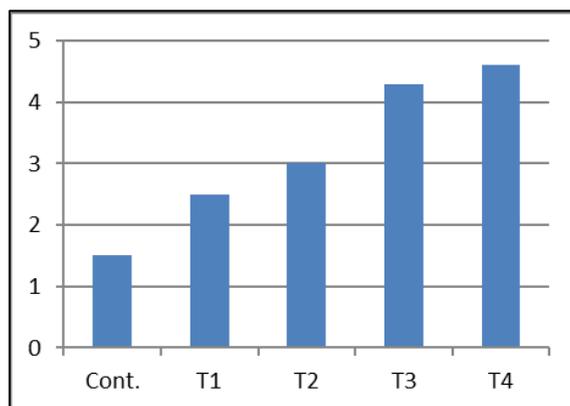
The nitrogen content showed significant increase by organic compost application in the soil examined (Figures 8). Treatment 4 (40 ton/ha) was the highest. This is natural because application of manure releases nitrogen and other nutrient upon decomposition. This result confirmed the finding of Eghball and Pwure (1999a), who found that application of manure or compost increased the soil nitrogen.



**Figure 8** Effect of treatments nitrogen content

### 3.1.8. Phosphorus

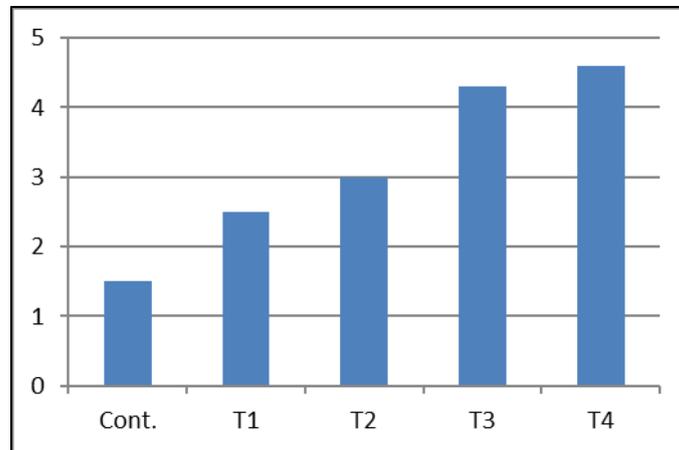
The phosphorus content was increased significantly by the treatments in both seasons. Treatment 4 (40 ton/ha) gave significant increase in the phosphorus content compared to the control (Figures 9). This was probably because of increased microbial activity and therefore, more release of phosphorus. Similar results were obtained by Sharpley and Rekolainen (1997), who showed that by application of composts and manure soil phosphorus levels were increased.



**Figure 9** Effect of treatments phosphorus content

### 3.1.9. Organic carbon

Organic carbon was increased significantly by the treatments in the examined soil in both seasons. Treatment 4 (40 ton/ha) gave significant increase in the organic carbon compared to the control, (Figures 10). That could be explained by the fact that compost is a source of organic carbon. Similar results were obtained by Zebarth *et al.* (1999) and Eghball (2002), who showed increase in soil organic carbon with increased manure/compost application. Similar results were obtained by Valtcho and Warman (2004) who showed that the level of sodium increased with addition of mature organic compost.



**Figure 10** Effect of treatments Organic carbon content

## 4. Conclusion

The results of this study showed that the application of composted mesquite has positive effects on soil properties such as increased soil organic matter and improve the availability of nutrient (i.e., N, P, and K). Also, it was decreased soil acidity. Thus, with confidence, it could be said that the mesquite trees could be converted into useful product as organic fertilizer (compost) instead of constituting a menace to agricultural lands.

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