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Effect of Compost on Some Soil Physical Properties and Yield of Forage Sorghum (*Sorghum bicolor* L.) in Desert Soil of Northern State of Sudan

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ABSTRACT

A field study was conducted for two consecutive winter seasons; 2017/18 and 2018/19, at the Research Farm of the National Institute of Desert Studies, New Hamdab Scheme, Northern State of Sudan. The objective was to study the effect of compost manure (5 and 10 ton ha^{-1}), on fodder sorghum (*Sorghum bicolor* L.) yield and some physical properties in the area. The experimental design was randomized complete block design (RCBD) with four replicates. The results showed significant differences ($P \leq 0.05$) to due to the application of compost on increasing fodder sorghum yield or biomass, very highly significant differences ($P \leq 0.001$) in reducing bulk density and increasing total soil porosity, also result indicated that compost manure has highly significant differences ($P \leq 0.01$) in increasing soil moisture content. Application of 10tonne ha^{-1}compost manure produced the highest means values of sorghum biomass of (44.13 and 53.9 ton ha^{-1}) compare to the control of (20.9 and 25.4 ton ha^{-1}) season one and tworespectively, decrease soil bulk density from (1.7 and 1.8 gcm^{-3}) to (1.40 and 1.44gcm^{-3}), increased total porosity from (47.6 and 45.4) to (34.4 and 31.8) and increase moisture content from (19.0 and 18.7%) to (9.6 and 8.7%) for the controlseason one and two respectively.

Keywords: fodder sorghum, *Sorghum bicolor* L., compost, desert soil, yield, Sudan

1. Introduction

Compost use is one of the most important factors, which contribute to increased productivity and sustainable agriculture. In addition, compost can solve the problem faced on farmers with decreasing fertility of their soil. Due to soil fertility problems, crops returns often decrease and the crops are more susceptible to pest and disease because they are in bad condition (Madeleine *et al.,* 2005).

Compost consists of the relatively stable decomposed organic materials resulting from the accelerated biological degradation of organic materials under controlled, aerobic conditions (Paulin and Peter, 2008).

Compost fertilizer is made from plant and animals remains with the objectives of recycling plant and animals remains for crop production. The decomposition process converts potentially toxic or putrescible organic matter into a stabilized state that can improve soil for plant growth. Composted organics has other beneficial effects, including diverting landfills wastes to alternative uses, removal of pathogen inocula or weed seeds and decomposition of petroleum, herbicide or pesticide residues, erosion control and as a nutrient source for sustainable re- vegetation of degraded soils. Using compost can improve the capacity to produce safe „clean green" horticultural produce and importantly increase the potential for large-scale organic food (Paulin and O'Malley, 2008).

Sudan has a huge animal wealth that is estimated to be about 130 million heads of different animal classes. There is a feed gap to cope with this huge animal wealth as indicated by different studies (AOAD 2003). This necessitated expanding irrigated forages vertically and horizontally to bridge this feed gab. Fertilization of forage crops toincrease productivity and improve quality is of equal

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importance. With the rise in prices of chemical fertilizers beyond the capability of farmers, organic fertilizers seem to be more appealing (Abusuwar and El Zilal, 2010).

The objective of this study is to evaluate the effect of compost on fodder sorghum yield and some soil physical properties.

2. Materials and Methods

The experiment was carried out during two consecutive seasons 2017/18 and 2018/19 in summer season at the National Institute of Desert Studies Research Farm, New Hamdab Scheme, in the Northern State of Sudan. The study area lies at the intersection of latitude 17º 55' N, and longitude 31º 10' E in the desert climate.

The soil of the study area belongs to El Multaga soil series which is classified as Haplocambids, coarse loamy, mixed, hyperthermic. The soil structure is moderate subangular blocky. It is non-saline and non-sodic (see Table 1 below) (LWRC, 1999). Generally, the soil chemical fertility is low and mostly this soil is deficient in nitrogen, phosphorus and organic carbon for optimum yield production of different cultivated crops. The physical and chemical properties of the soil are shown in Table 1.

Table 1: Some soil properties of the experimental site

Soil properties	**Soil depth (cm)**				
	0 – 23	**23 – 65**	**65 - 80**	**80 - 105**	**105 - 125**
CS (%)	37	33	43	42	40
FS (%)	40	23	22	21	24
Silt (%)	15	25	11	19	8
Clay (%)	8	19	24	18	28
Texture	**LS**	**SL**	**SL**	**SL**	**SCL**
CEC	6	14	26	24	26
pH (paste)	7.5	7.3	8.1	7.8	7.5
ECe	0.35	0.37	0.42	1.1	3.2
ESP	3.0	3.0	4.0	5.0	8.0
$CaCO_3$ (%)	0.8	2.6	10.4	0.2	27.5
O.C (%)	0.052	0.066	0.078	0.061	0.052
C/N ratio	4	4	5	5	5

LS = Loamy sand, SL = Sandy loam, SCL= Sandy clay loam

Compost manure was manually broadcasted and incorporated on the designated experimental units (7x6 m) at the rates of 0, 5, and 10 ton ha^{-1}.

Seeds of Fodder Sorghum (*Sorghum bicolor* L.) were sown at the rate of 30 kg ha^{-1} on the 12th of July 2017/18 and 2018/19. Nitrogen and phosphorus were added as recommended (43 kg N ha-1 plus 43 kg P_2O_5 ha-1) by ARC. The irrigation was carried out every 7 days. During all experimental period observations on soil dry balk density, soil moisture content, soil total porosity and yield biomass of Fodder Sorghum were taken.

2.1. Methods of soil physical analyses

The core sample method as described by Black, (1965) and Landon, (1984) was used to determine the soil dry bulk density (ρd). Soil core was obtained from 0 -15 cm soil depth for each of experimental units at 60 days after sowing (DAS). The soil was oven dried at 105º C for 24 hours, and weighed. The soil dry bulk density (ρd) for all soil samples were calculated in the laboratory using the equation below:

$$\rho d = \frac{Ms}{Vt}$$

Where Ms is a dry soil mass and Vt is the total soil volume or the core volume.

Measurements of the soil moisture were done at 0 - 30 cm soil depths. Soil samples were taken by an auger. Readings were taken at the field, two days after irrigation at 60 DAS. Gravimetric method was used to determine the soil moisture percentage (ϴ) as described below:

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$$\Theta = \frac{(Mm - Md)}{Md}$$

Where Mm is the moist soil mass and Md is the oven dry soil mass.
The soil total porosity (T.P) was calculated by following the equation below:

$$T.P = 1 - \frac{\rho d}{\rho s}$$

T.P = Soil total porosity
ρd = Soil air dry bulk density
ρs = Soil particle density (taken as 2.65 g cm^{-3})

Data were statistically analyzed using MSTAT program. Duncan's Multiple Range Test (DMRT) was used to show the significance in the differences between means.

3. Result and Discussion

Tables 2 & 3 shows the effect of compost fertilizer on soil bulk density, soil total porosity, soil moisture content and sorghum biomass. Application of 5 and 10 $tonha^{-1}$ of compost manure showed significant ($P \leq 0.05$) increasing sorghum biomass from (44.13 season1 and 53.9 $tonha^{-1}$ season2) compared to control (20.9 season1 and 25.4$tonha^{-1}$ season2). This result confirm with that of (Mohammad *et al.,* 2004; Muhammad *et al.,* 2018; Chantigny *et al.,* 2002 and Steiner, 2008) who stated that compost fertilizer increase significantly sorghum forage.

Table 2: Effect of compost fertilizer on bulk density, total porosity, moisture content and sorghum biomass.

Parameters	Bulk Density (gcm^{-3})	Total Porosity (%)	Moisture Content (%)	Yield (ton ha^{-1})
Control	1.74a	34.4b	9.67b	20.93b
C5	1.47b	44.9a	17.00a	31.13a
C10	1.40b	47.5a	19.00a	44.13a
C.V	2.54	3.5	9.76	24.53
SE	0.023	0.030	0.839	4.56
Sig	***	***	**	*

Table 3: Effect of compost fertilizer on bulk density, total porosity, moisture content and sorghum biomass

Parameters	Bulk Density (gcm^{-3})	Total Porosity (%)	Moisture Content (%)	Yield (ton ha^{-1})
Control	1.80a	31.80b	8.66b	25.4b
C5	1.50b	43.00a	16.33a	50.6a
C10	1.44b	45.43a	18.66a	53.9a
C.V	3.30	4.78	2.45	17.79
SE	0.030	1052	1.79	3.94
Sig	***	***	**	*

Also result as shown Table 2&3 indicated thataddition of 5 and 10 $tonha^{-1}$ of compost fertilizershowed very highly significant ($P \leq 0.001$) in reducing bulk density from (1.4season1 and 1.44gcm^{-3} season2) compared to control (1.74 season1 and 1.80gcm^{-3} season2)and increasing porosity from (47.5season1 and 45.43gcm-3 season2) compared to control (35.4 season1 and 31.8gcm-3 season2).This result confirm with that of (Amlinger *et al.,* 2007; Brown and Cotton, 2011; Fageria, 2002; Moran and Schupp, 2003). who stated that compost application generally influences a beneficial way by lowering soil density, this passively effect has been detected in most cases and it is typically associated with an increase in porosity.

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As shown Table 2&3 moisture increase highly significant ($P \leq 0.01$) by adding compost fertilizer from (19.0 season 1 and 18.66% season 2) compare to the control to (9.6 season 1 and 8.7% season 2) and from observed result we can find a proportional relation between compost level and soil moisture content. This result is inconformity with that of Yüksek *et al., (*2009) who stated that compost manure increase significantly moisture content.

Conclusion

It can be concluded that in the high terrace soil of the Northern State of Sudan, the application of 10 tonne ha^{-1} compost manure produced the highest mean values of sorghum biomass and improved the physical soil condition by decreasing soil bulk density and increasing both total porosity and moisture content.

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