Effect of three organic manures on some physical and chemical properties of Khashm Elgirba soil series

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ABSTRACT

The effect of farmyard manure (FYM), filtermud (FM), and bagasse on some physical and chemical properties of Khashm Elgirda soil series was studied in 1999-2000. Each of the organic manures was applied at a rate of 0,15,30,45,60, and 75 t ha^{-1} in a RCBD with four replications. The organic manures were incorporated into the soil using hand tools. The study showed that increasing the rate of each of the applied manures resulted in a highly significant reduction in the soil bulk density and consequently a highly significant increase in both total soil porosity and soil moisture. Bagasse was the most effective in reducing the soil bulk density followed by FYM and lastly FM. The study also indicated that increasing rates of application of each of the tested manures resulted in small increments of both exchangeable potassium and organic carbon. However, the investigation did not show any noticeable increase in total soil nitrogen.

INTRODUCTION

Kashm Elgirba soil series lies in the central clay plain of the Sudan. It is part of the semi-arid region and hence is characterized by its low content of organic matter (0.2 to 0.3 %) and nitrogen (0.02 to 0.03 %) (Blokhuis, 1993). It is also characterized by its high percentage of smectitic clays (>65%) and a relatively high bulk density. The high values of the clay content and soil bulk density create great difficulty in land preparation of the scheme of New Halfa Agricultural Corporation. In addition, the high soil bulk density results in a low total soil porosity, which is very much associated with low infiltration rate and soil permeability. It is then perceived that Khashm Elgirba soil series, like any other Vertisols, requires appropriate cultural management.

The soil is classified as moderately fertile. It has been under the rotation of cotton, groundnuts, sorghum, and wheat for the last 40 years. The dry cotton stalks are either burnt to avoid the blackarm disease or hauled to nearby villages to be used as fuel or other domestic purposes, whereas the residues of other crops of the rotation are mainly used as animal feeds. Therefore, the crop residues are not used to any significant scale for manuring purposes. Addition of organic manures to these soils is envisaged as beneficial in improving both the physical and chemical properties that may be reflected on soil productivity.

The present study was carried out to assess the effect of the addition of filtermud, FYM and bagasse on some physical and chemical properties of Khashm Elgirba soil series.

MATERIALS AND METHODS

The studied soil belongs to Khashm Elgirba soil series, which occupies about 75% of the total area under the rotation of the scheme of New Halfa. The soil is nonsaline, nonsodic, alkaline in reaction, and has a high percentage of smectitic clays. It classifies as Typic Haplusterts, very fine, smectitic, isohyperthermic (Soil Survey Staff, 1999).

Three organic manures viz: FYM, FM, and bagasse, each at a rate of 0 (control), 15, 30, 45, 60 and 75 tonnes per hectare, were applied in a randomized complete block design (RCBD) with four replications. The experimental units were 6m x 7m. The organic manures were hand broadcast two weeks prior to sowing the chosen test crop (wheat). The applied organic manures were then incorporated into the soil using hand tools. The experiment was carried out during 1998/1999 and 1999/2000 seasons in a farm adjacent to New Halfa town.

Soil bulk density was determined using the core method (Landon, 1984). Two soil cores were obtained from 0 – 15 cm and 15 – 30 cm soil depth from each of the experimental units at 84 days after sowing (DAS) of the test crop but just before the subsequent irrigation. The soil cores were weighed, oven dried at 105°C for 24 hours and reweighed. The soil bulk density and the corresponding moisture percentage were calculated for all soil samples.

Immediately after harvesting of the wheat crop, other composite surface soil samples (0–15cm) were collected from each experimental unit for chemical analysis. The analysis was performed according to Richards (1954) and included: exchangeable potassium, organic carbon, and total nitrogen.

RESULTS AND DISCUSSION

The data indicated that for each of the organic manures examined, the highest soil bulk density was obtained for the control treatment, then the bulk density invariably decreased with increasing rates of application of each manure; suggesting that each of the tested manures was effective in reducing the soil bulk density (Table 1).

Table 1. Soil bulk density (g cm) of 0 -15 cm at 84 DAS as influenced by FYM, FM and Bagasse manures.

Season		Levels(t/ha)						Mean
		0	15	30	45	60	75	
1998/99	FYM	1.56	1.36	1.29	1.26	1.21	1.21	1.32b
	Bag	1.52	1.29	1.21	1.14	1.10	1.14	1.23c
	FM	1.50	1.42	1.37	1.28	1.30	1.26	1.36a
1999/00	FYM	1.56	1.36	1.30	1.25	1.21	1.21	1.32b
	Bag	1.53	1.28	1.121	1.14	1.11	1.13	1.23c
	FM	1.50	1.42	1.36	1.28	1.29	1.27	1.35a
	Mean	1.53a	1.36b	1.29c	1.23d	1.20e	1.20e	

Means followed by the same letter(s) within each column or row are not significantly different according to Duncan's Multiple Range Test (DMRT).

The data also indicated that for the two consecutive seasons and for the different rates of application of each of the studied manures, the highest soil bulk density was reported for FM treatments followed by those of the FYM treatments and lastly those of the bagasse treatments, showing the superiority of bagasse in reducing the soil bulk density.

The three organic manures under study could be ranked according to their coarseness in the following order: baggase being the most coarse material followed by FYM and then the FM . It was perceived that the degree of reduction in soil bulk density resulted from the application of these organic manures followed the same order viz: bagasse treatments followed by FYM and lastly the FM. It was perceived that the degree of reduction in soil bulk density that resulted from the application of these organic manures followed the same order. Reduction in soil bulk density in response to manure application had already been documented by many workers (Girma and

Endale, 1995; Sommerfield *et al*., 1988). However, Campbell et al. (1986) reported the inability of organic manures to reduce soil bulk density significantly unless high and frequent rates were applied to the soil.

When total soil porosity was calculated for each of the three sources of organic manures and their respective levels of application, the data revealed that total soil porosity increased with decreasing soil bulk density which was in turn decreased with increasing rates of application of each of the studied manures. At any specific rate of manure application, the total soil porosity was invariably highest for the bagasse treatments followed by those of the FYM treatments and lastly those of the FM treatment, and this was true for the two seasons (data not given).

It was observed that the percentage of soil moisture increased with increasing total soil porosity; and that for each of the three organic manures, the lower percentages of soil moisture were reported for the control then it invariably increased with increasing rates of manure application (Table 2).

Table 2. Soil moisture % (0 -15cm) at 84 DAS as affected by FYM, FM and bagasse manures.

Season		Levels(t/ha)						Mean
		0	15	30	45	60	75	
1998/99	FYM	20.58	22.68	24.15	25.10	25.98	27.35	24.31b
	Bag	21.40	24.65	26.43	27.35	28.60	27.93	26.06a
	FM	20.25	22.78	24.20	25.65	24.58	23.55	23.50b
1999/00	FYM	21.65	22.18	24.38	24.85	25.10	26.75	24.15b
	Bag	21.45	25.83	27.15	28.03	27.68	29.68	26.64a
	FM	21.83	23.90	24.28	25.45	24.75	24.15	24.06
	Mean	21.19a	23.76c	25.10b	26.07a	26.12a	26.57a	

Means followed by the same letter (s) within each column or row are not significantly different according to Duncan's Multiple Range Test (DMRT).

The results showed significant differences in soil moisture content of the bagasse treatment compared to those of the other two manures, with no significant difference in percentage of moisture between them.

Considering the levels of manure application, the DMRT at (0.05) indicated that 45, 60 and 75 t ha- doses gave the statistically significant values of soil moisture compared to those of lower rates and that the difference between these doses was statistically insignificant.

Increments in soil moisture with increasing rates of organic manures application were reported by many researchers (Murali *et al*., (1979; Khateel *et al*, 1981). However, Gupta et al. (1977) did not find any significant increase in (he percentage of soil moisture even at highest rates of manure application.

The results showed that there were no significant differences between soil bulk density or soil moisture percentage of the different sources of organic manures at different levels of application and their interactions (Table 3). This result was understandable because these manures were incorporated into the soil using hand tools which would not enable thorough mixing of the added manures with the soil even in the top 15cm and therefore the effect of the applied manure on either soil depth. This suggested that in order to have the beneficial effects of organic manures down to lower soil depths, machines that could pulverize the soil to the required depth should be used.

The results revealed that amount of exchangeable K resulting from application of different doses of each of the three tested organic manures are not very different from chat reported for the control (l .12 c mole (+) kg $^{-1}$ soil) suggesting that the three organic manures may be considered as equally ineffective in supplying exchangeable K to the soil (Table 4). It was perhaps pertinent to mention that many workers reported that the amounts of exchangeable K in the soil of the central clay plain of Sudan was adequate for plant growth (Fink, 1962; Ageeb and Abdalla, 1988).

For the two seasons, the percentage of soil organic carbon reported at the end of the experiment for each of the three tested manures at different levels, is very small (0.319 to 0.510%) and is not very different from that reported for the control treatment (0.310 0). Despite the high content of organic carbon of each of the added manures, the present result is not surprising because Khashm Elgirba soil series is inherently low in organic carbon (0.31 %). The result also revealed that both the F YM (23.2% O.C.) and the bagasse (25.7% O.C.) have relative advantage over filtermud (18.9% O.C.) in increasing soil organic carbon, particularly at high levels of application, (60 and 75t ha^{-1}). This was understandable because these two manures have a relatively higher content of organic carbon. The role of organic manures in increasing the soil organic carbon has been documented by many researchers (Christeen, 1988; Dawelbeit, 1996). However, Nagaya (1993) reported the inefficiency of organic manures to increase the soil organic carbon; particularly under arid and semi—arid climates where the rate of organic matter decomposition is quite high.

Table 3. Soil bulk densities (g cm-3) and their corresponding soil moisture percentages of the (15-30cm) at 84 DAS as affected by F Y M, FM and bagasse manures.

Treatment	Season 1998/1999		Season1992/2000	
	Soil bulk density (g cm^{-3})	Soil moisture %	Soil bulk Density (g cm^{-3})	Soil Moisture %
0 t ha^{-1} FYM	1.52	27.33	1.52	26.55
15	1.53	25.93	1.50	25.78
30	1.49	26.50	1.50	26.50
45	1.54	26.18	1.50	27.03
60	1.52	27.30	1.52	26.78
75	1.52	27.75	1.50	27.35
0 t ha^{-1} Bag	1.50	26.98	1.50	27.48
15	1.49	26.05	1.52	27.18
30	1.51	26.33	1.52	26.50
45	1.51	27.25	1.50	26.13
60	1.53	27.50	1.51	27.03
75	1.54	28.03	1.51	28.00
0 t ha^{-1} FM	1.53	26.90	1.52	26.75
15	1.51	25.78	1.52	26.90
30	1.48	27.03	1.50	25.48
45	1.52	26.25	1.51	27.05
60	1.53	26.00	1.51	26.98
75	1.51	26.33	1.5	27.10

Table 4. Some chemical properties of the studied soil after the termination of the experiment {composite soil samples (0-15cm)}.

Treatment	Season 1998/99				Season 1999/00			
	K C Mole(+) Kg^{-1} Soil	% 0.C.	%N	C:N Ratio c	K Mole(+) Kg^{1} Soil	% 0.C	%N	C:N Ratio
Control	1.10	0.31	0.03	10	1.14	0.31	0.03	10
15 t/ha FYM	1.10	0.34	0.03	11	1.18	0.35	0.03	12
30	1.23	0.34	0.03	11	1.22	0.37	0.03	12
45	1.20	0.38	0.03	12	1.20	0.39	0.04	10
60	1.25	0.48	0.04	12	1.23	0.48	0.04	12
75	1.25	0.51	0.04	13	1.20	0.48	0.04	12
15 t/ha Baggasse	1.21	0.32	0.04	11	1.25	0 .34	0.03	11
30 "	1.22	0.35	0.03	12	1.23	0.35	0.03	12
45 "	1.25	0.35	0.03	13	1.21	0.93	0.03	12
60 "	1.22	0 .46	0.03	15	1.20	0.39	0.03	13
75 "	1.25	O .46	0.03	15	1.21	0.44	0.03	15
15 t/ ha FM	I .25	0.32	0.03	11	1.18	0.33	0.04	8
30 "	1.23	0.33	0.03	11	1.22	0.32	0.03	11
45 "	1.21	0.32	0.03	11	1.25	0.34	0.03	11
60 "	1.25	0.32	0.03	11	1.12	0.34	0.03	11
75 "	1.25	0.34	0.03	11	1.20	0.34	0.03	11

The results also showed that the amount of total soil nitrogen reported in both seasons after the termination of the experiment were very small (0.03 t 0.04%) which were in agreement with the amount of the total soil nitrogen prior to the application of these organic manures (%0.03)This information suggests that the amount of mineralized nitrogen from these organic sources was either too small to be detected by the somewhat insensitive Kjeldahl procedure or that the harvested wheat plants had consumed such mineralized nitrogen. In either case, the application of the tested organic manures failed to substantially increase total soil nitrogen as they did with organic carbon. However, it was thought that there was a probability that the role of these organic manures in increasing the percentage of soil nitrogen might be observed if the soil samples were taken during the first few weeks after the application. The role of organic manures in supplying nitrogen to the soil had been documented (Gibbered, 1995; Mann and Ashraf, 2000). However, Summerfield and Makay (1987) had reported that significant increments in total soil nitrogen in manured plots could only be obtained after several years of continuous application.

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