Effect Of Sugar Cane Bagasse, Cattle Manure And Sand Addition On Some Physical And Chemical Properties Of The Clay Soils And Sunflower Production In Central Of Sudan

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Abstract: The study was conducted at the experimental Farm of the Faculty of Agriculture and Natural Resources, Gezira University, Wad Medani, Sudan, during the winter of 2004 and autumn 2005, to investigate the effects of adding bagasse, cattle manure and sand 5n some physical and chemical properties of the soil and production of Sunflower. Each of the treatment was applied at a rate of 0, 30, 45 and 75 t/ha in a RCBD with three replications. The study showed that increasing the rate of the bagasse and cattle manure resulted in a highly significant reduction in soil bulk density, but the addition of sand resulted in increasing the bulk density. Also it was found that porosity was increased highly significant when adding bagasse and cattle manure, and a highly significant reduction in porosity when adding sand to the soil. Bagasse was most effective in reducing bulk density followed by cattle manure and sand. The study showed that increasing the rates of addition of each treatment resulted in small increment in exchangeable potassium, total soil nitrogen and phosphorous. The highest production of sunflower (3.25 and 3.74 t/ha) was obtained by addition of 45 t/ha of cattle manure to the soil, which increased the production by 34.6% and 37% when compared to the control in the first and second season, respectively. Also the production increased by 21.6% and 29.3% when adding 45 t/ha of bagasse to the soil in the first and second season, respectively, and the addition of 45 t/ha of sand to the soil increased the production of sunflower by 19.3% and 24% for the first and second season, respectively.

1 INTRODUCTION

Over the years, soil degradation has become one of the most important problems in agriculture. Erosion, salinization, compaction and loss of organic matter are main form of soil degradation. Addition of organic matter could be a way to improve soil structure and aeration, creating a better environment for plants growth. The organic matter content of soils can be increased by growing and plowing under green manure crops, or by plowing under organic residues such as manure, crop residues and composts of different origin. Farmers need to manage tillage systems, as a practice of soil conservation, to reduce nutrient losses due to erosion and oxidation of organic matter, which is important as a source of nutrients and in improvement of soil physical and biological properties, all in order to obtain optimal crop growth (Maiorana et al., 2003). Cambardella and Elliott (1993) indicated that traditional tillage can reduce soil organic C and N and disrupt soil aggregates, while no tillage or minimum tillage are more efficient in conserving moisture, controlling soil erosion and increasing C and N storage in soil (Franzluebbers et al., 1995).

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Soil organic matter directly affects soil chemical, physical and biological properties, plays an important role in enhancing crop production (Stevenson and Cole, 1999), and is the most frequently reported indicator of soil quality and agronomic sustainability (Reeves, 1997). Maintaining and increasing soil organic matter content will ensure the sustainable development of agriculture. Soil aeration is an important aspect of soil physical quality. This is because the great majority of biological activity in soil requires a continual supply of oxygen to organisms. For this reason, biological activity is often used as an indicator of overall soil quality or soil health (Warkentin, 1995 and Wilson and Maliszewska-kordybach, 2000). Aeration is one of the most important physical factors which may limit the development of plant root systems and growth and yield of crops on compacted soils (Boone and veen, 1994, Czyz and Kukier, 1997). Sunflower grown in a compacted soil produced smaller plants and maximum area of individual leaves, due to compaction effects on water relations, N nutrition and photosynthesis (Andrade et al., 1993). The primary aims of proper tillage include control of weeds, incorporation of organic matter into the soil and improving soil structure (Hillel, 1969). Furthermore, Buckingham (1976) evaluated tillage on the basis of its contribution to achieve one or more of the following goals: management of crop residues and moisture, soil aeration and provision of good tilth, and control of erosion, weeds and insect. It has been shown that addition of organic matter improved soil properties such as aggregation, water-holding capacity, hydraulic conductivity, bulk density, the degree of compaction, fertility and resistance to water and wind erosion (Zebarth et al., 1999 and Franzluebbers.2002). One soil management technique considered to be promising (Palm et al., 1997) is organic resource input management. Swift et al. (1979) indicated that soil organic matter and hence soil fertility can be managed in three ways: (1) changing the growth environment by tillage, irrigation, mulching and fertilization, (2) timing and placement of manure and (3) manipulating soil fauna via tillage and fertilization. Manure application is

very important in influencing soil fertility and productivity, especially in the Sudano-Sahelian region where nutrient-poor and weathered soils are typically managed with little external input (Feller and Beare, 1997 and Ouedraogo et al., 2001). Another important technique that helps improve water and air circulation in the soil and benefits crop growth is tillage (Hoogmoed, 1999 and Barro, 1997). No more terature about the effect of adding sand to the soil, therefor this study aimed to investigate its effects in soil physics and production of sunflower. The present study was undertaken to evaluate the effect of adding different levels of bagasse, cattle manure and sand to the soil, on some physical and chemical properties of the soil and Sunflower production.

2 MATERIALS AND METHODS

Field experiments were conducted for two seasons during the winter of 2004 and autumn 2005, later called first and second seasons, respectively. To evaluate the effect of 4 levels of baggase (0. 15, 45 and 75 t/ha), 4 levels of cattle manure (0. 15, 45 and 75 t/ha) and 4 level of sand (0. 15, 45 and 75 t/ha) on the physical and chemical of the soils and sunflower performance. To investigate the response and performance of the crop according to the addition of bagasse, cattle manure and sand, sunflower (*Helianthus annuus* L.) Pan 7355 was chosen for this study. The experiment was laid out in randomized complete block design with three replications at the experimental farm of the faculty of Agriculture and Natural Resources, Abu Haraz (latitude 14˚ 29° N and longitude 33˚ 30° E), University of Gezira, Wad Medani, Sudan. The field has a cracking clay soil. The experimental area was disc-ploughed, disc harrowed and leveled and divided into 36 plot, each one equal 3 x 3 m^2 . The applied of organic manure and the sand were incorporated into the soil using hand tools. Three seeds/hill were sown on 23 of November and 16 July 2005 (Winter and autumn, respectively). The plant-to-plant distance was maintained at 30 x 80 cm by thinning at four leaves stage and nitrogen was broadcast before the second irrigation in the same doses for all the plots of the experiments. The general protocol of the experiment (plant protection measures, cultural practices and irrigation) was carried out as and when needed up to harvest. Soil bulk density (0 – 20 cm) was determined using the core method (Landon, 1984). The soil cores were weighed, oven dried at 105° C for 24 hours and reweigh. Chemical properties of the soil before sowing and after harvesting were recorded. The analysis was performed according to Richards (1954) and includes exchangeable potassium, organic carbon, and total nitrogen. Five plants from each plot were randomly selected at maturity to get the data, and the heads were covered with plastic mesh to reduce bird's damage.

The following parameters were measured:

1- Depth of root (cm): measured from the soil surface to the end of the main root.
2- Plant height (cm): measured from the soil surface to the base of the head at maturity.
3- Head diameter (cm): measured at maturity across the main head, including the area of the disk flowers.
4- Seed number/head: the total number of unfilled and filled seeds/head.
5- Percentage of empty seeds (%): (No, of unfilled seeds per head/Total no. of seeds per head)x 100.
6- 1000-seed weight (g): three samples of 1000 sound filled seed from heads harvested/plot were taken and weighted.
7- Seed yield: based on seed yield/plot (kg/m), and converted to ton/ha.

The standard statistical analysis of variance procedures were used for data of each season, the combined analysis of variance for the two seasons was carried out after testing the homogeneity of the error variance for each season. MSTATC computer program was used for the analysis of variance and mean separation was done according to Duncan's Multiple Range Test.

3 RESULTS AND DISCCUSION

The results indicated that for the two seasons and for different rates of adding bagasse, cattle manure and sand, the highest soil bulk density was reported for sand treatments followed by those of the cattle manure treatment and lastly those of bagasse treatment (Table 1.). The results showed the superiority of bagasse in reducing the soil bulk density. Reduction in soil bulk density in response to manure application had been documented by many researchers (Girma and Endale, 1995; Sommerfield *et al.*, 1988). However, Zaheeruddin and Adam (2003) reported that bagasse was the most effective in reducing the soil bulk density followed by farmyard manure. Total soil porosity was calculated for each of the three treatments and their respective levels of application (Table 1.). The data revealed that total soil porosity increased with decreasing soil bulk density which was in turn decreased with increasing rates of application of bagasse and cattle manure, and increased with increasing rates of sand application. It was observed that total soil porosity was highest for the bagasse treatment followed by those of cattle manure treatment and lowest percent was found when sand treatment applied. Maximum mean concentration of K in the soil was observed after application of cattle manure (1.92 and 1.95 K c mole (+) kg^{-1} soil) followed by bagasse application (1.91 and 1.94 K c mole (+) kg^{-1} soil) in first and second seasons, respectively, they did not show significant differences. Application of sand resulted in values of K in the soil. The data indicated that addition of cattle manure and bagasse to the soil has little affects in adding K to the soil. The results also showed that the amount of total soil nitrogen reported in both seasons after the termination of the experiments were very small (0.034 and 0.045 %), which were in agreement with the amount of the total soil nitrogen prior to the application of these treatments. Sommerfield and Makay (1987) had reported that significant increments in soil nitrogen in manure plots could only be obtained after several years of continuous application. The higher values of phosphorus (21.32 and 22.50 ppm) were found when adding 75 t/ha of bagasse to the soils in the first and second season, respectively. Also addition of 75 t/ha of cattle manure to the soil recorded high values of phosphorus (21.20 and 18.72 ppm) in first and second season, respectively. But addition of sand to the soil showed less values of phosphorus.

Table 1. Some physical and chemical properties of the studied soil at the end of the first season (composite soil samples (0 – 15 cm)).

	First season					Second season				
Treat-ment	Soil bulk density (g cm^{-3})	Poro-sity %	K C mole (+) kg^{-1} soil	N %	P ppm	Soil bulk density (g cm^{-3})	Poro-sity %	K Cmole (+) kg^{-1} soil	N %	P Ppm
Bag.0	1.71	35.5	1.14	0.028	11.32	1.74	34.3	1.17	0.030	10.65
Bag.1	1.58	40.4	1.82	0.036	15.51	1.60	39.6	1.83	0.042	20.21
Bag.2	1.52	42.6	1.91	0.049	19.50	1.64	38.1	1.94	0.056	22.54
Bag.3	1.45	45.3	1.88	0.052	21.32	1.48	44.2	1.91	0.068	22.50
Man0	1.72	35.1	1.12	0.039	11.31	1.73	34.7	1.16	0.041	09.11
Man1	1.67	37.0	1.82	0.047	16.41	1.69	36.2	1.84	0.061	16.42
Man.2	1.56	41.1	1.88	0.038	19.34	1.58	40.4	1.90	0.070	17.82
Man.3	1.51	43.0	1.92	0.028	21.20	1.55	41.5	1.95	0.074	18.72
Sand 0	1.70	35.8	1.14	0.033	12.48	1.69	36.2	1.12	0.027	11.12
Sand 1	1.74	34.3	1.25	0.036	09.16	1.77	33.2	1.28	0.038	6.41
Sand 2	1.80	32.1	1.20	0.036	07.40	1.82	31.3	1.31	0.034	6.64
Sand 3	1.88	29.1	1.14	0.035	06.43	1.90	28.3	1.27	0.030	6.10

The depth of roots, plant height and head diameter were significantly affected by addition of bagasse, cattle manure and sand to the soil throughout the two seasons (Table 2 and 4). When comparing the means of the three levels of the addition of bagasse to the soils (30, 45 and 75 t/ha), using Duncan's Multiple Range Test (DMRT). It was found that addition of 45 t/ha of bagasse to the soil gave longer roots (32.2 and 23.05 cm), the increasing percent is equal 32.9 and 20.2 % when compared to the control for the first and second season, respectively. The addition of manure increased the depth of roots although the three levels, but when using DMRT, it was noticed that addition of 45 t/ha gave taller depth of roots (28.97 and 19.33 cm), which represent 26.5% and 28.2% increasing percent, in first and second season, respectively. The results indicated that, the depth of roots increased in soils, which had been improved by addition of bagasse and manure. The reasons of increasing the depth of roots retain mainly to good aeration, porosity and improvement of the fertility of the soils. The present findings are in accord with those of Boone and veen, (1994), Czyz and Kukier, (1997). Also, the results showed that, addition of sand to the soil increases the depth of roots in the three levels mentioned and the deepest roots found (28.63 and 21.01 cm) when adding 75 t/ha of sand to the soil in the first and second season, respectively. The reasons may returned to less of cohesion and adhesion of the soil, increased of infiltration rate of the soil and less of nutrient around the roots, which enguaradge roots to search about nutrient. All levels of additions of bagasse, manure and sand increased the plant height in first and second season, when compared to the control (Table 2 and 5). Tallest plants (144.9, 164.64 cm) were obtained by the addition of 45t/ha of manure to soils, in the first and second season, respectively. Also, addition of 45t/ha of bagasse to the soil gave relatively taller plants (135.4, 155.33 cm) in first and second season, respectively. Addition of sand (45 t/ha) to the soil improved the height of plants (124.0, 149.33 cm) in first and second seasons, respectively. Head diameter was significantly increased by addition of bagasse, manure and sand to the soil in both seasons (Table 2 and 4). The biggest head diameters (18.7, 21.1 cm) were found when adding 45 t/ha of manure to the soil in first and second season, respectively. The positive effect could be due to the rapid expanding of manure nutrient.

Table 2. Means of depth of roots (cm), plant height (cm) and head diameter (cm) for different levels of the addition of bagasse, manure and sand in first season.

Treatment	Depth of roots (cm	Plant height (cm)	Head diameter (cm)
Bag.0	23.10 CD	114.5 EF	14.53 EFG
Bag.1	29.37 AB	133.5 B	16.47 BC
Bag.2	32.20 A	135.4 AB	17.37 AB
Bag.3	29.20 AB	130.6 BCD	16.13 CD
Man.0	20.77 D	115.2 EF	13.47 GH
Man.1	27.67 B	121.4 DE	15.50 DE
Man.2	28.97 AB	144.9 A	18.70 A
Man.3	28.47 AB	133.6 B	17.87 AB
Sand 0	20.00 D	108.5 F	12.40 H
Sand 1	25.63 BC	118.2 E	14.03 FG
Sand 2	28.50 AB	124.0 CDE	14.90 DEF
Sand 3	28.63 AB	117.7 EF	13.50 FGH

Means followed by same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

Table 3. Means of seed number, 1000-seed weight (g), empty seed %, and seed yield (t/ton) for different levels of the addition of bagasse, manure and sand in first season.

Treatment	Seed number/ head	1000-seed weight (g)	Empty seeds (%)	Seed yield (t/ha)
Bag.0	1125 DE	40.23 CD	17.37 C	2.057 H
Bag.1	1239 CD	46.33 BC	13.03 E	2.423 F
Bag.2	1351 ABC	53.73 AB	14.60 D	2.713CD
Bag.3	1257 BCD	49.667 B	16.40 C	2.557 DE
Man.0	1014 EF	35.07 DE	19.33 B	2.207 G
Man.1	1237 CD	45.73 BC	12.10 EF	2.770 C
Man.2	1482 A	56.90 A	10.87 F	3.253 A
Man.3	1398 ABC	53.20 AB	11.67 F	2.967 B
Sand 0	879.2 F	31.13 E	19.33 B	2.117 GH
Sand 1	1175 DE	39.57 CD	20.37 B	2.453 EF
Sand 2	1118 DE	43.17 C	20.57 B	2.657 CD
Sand 3	997.3 EF	35.50 DE	21.83 A	2.537 DEF

Means followed by same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

The seed number/head, 1000 seed weight, empty seed percent and seed yield were significantly affected by addition of bagasse, manure and sand in both seasons (Table 3 and 5). The higher values of seed number per head (1482 and 1834.43), were found when adding 45 t/ha of manure to the soils in season one and two, respectively. Manure application is very important in influencing soil fertility and productivity, because it was contain nutrient elements that can support crop production and enhance the chemical and physical properties of soil (Feller and Beare, 1997 and Ouedraogo et al., 2001). Also, the seed number/head increased significantly when adding bagasse and sand throughout the two seasons, when compared by the plants grown on untreated soils (control). Bagasse is an organic matter, which improved water-holding capacity, hydraulic conductivity, bulk density, the degree of compaction, fertility and resistance to water and wind erosion (Zebarth et al., 1999 and Franzluebbers.2002). No more literature about the effect of adding sand to the soils, but according to the research carried in this paper, it appeared clearly that there are direct effect of adding sand to the soils. Additions of sand increased the aeration, porosity and infiltration rate of the soils, therefore, enhanced the penetration of the roots, which increased the absorption of valuable nutrients. One thousand seed weight was significantly affected by the addition of bagasse, manure and sand through all the levels of addition in both seasons (Table 3 and 5). Heavier seeds with overall mean 56.90 and 69.93 g (first and second season, respectively) was produced by addition of 45 t/ha manure to the soil. Addition of 45 t/ha of bagasse to the soil gave relatively heavier seeds 53.73 and 66.53 g in first and second

seasons, respectively. Addition of sand to the soils increased the one thousand weights of seed when compared to the control, and gave less weight when compared to manure and bagasse. The justification had been retained to the manure and bagasse which they improved soil physics and fertility, while the addition of sand to the soil increases only soil physics. The percentage of empty seeds was significantly affected by the addition of different levels of bagasse, manure and sand in both seasons (Table 3 and 5). Addition of 45 t/ha manure gave the lowest mean percentage of empty seed (11.67, 8.43 %) in first and second season, respectively. While the addition of 75 t/ha of sand to the soil increased the percentage of empty seeds (21.83, 21.17 %) in first and second season, respectively. The results in Table 3. and 5. showed that, there was a significant difference in seed yield between the treatment and the control. Also DMRT indicated the differences between the means in the same treatment. It was noticed that highest values of seed yield (3.253 and 3.74 t/ha) were obtained when adding 45 t/ha of manure to the soils, with increasing percent 34.6% and 37.8% in first and second seasons, respectively. Addition of bagasse to the soil (45 t/ha) increasing the yield by 21.6% and 29.3% in first and second seasons, respectively. On the other hand, addition of sand to the soil (45 t/ha) improved the productivity by 19.3% and 24% in the first and second season, respectively.

Table.4 Means of depth of roots (cm), plant height (cm) and head diameter (cm) for different levels of the addition of bagasse, manure and sand in a second season.

Treatment	Depth of roots (cm)	Plant height (cm)	Head diameter (cm)
Bag.0	18.01 E	134.60 DE	15.80 D
Bag.1	21.52 C	142.03 CD	18.33 BC
Bag.2	23.05 B	155.33 AB	20.17 A
Bag.3	22.94 B	150.73 BC	18.17 BC
Man.0	18.32 E	128.27 E	14.90 D
Man.1	21.95 C	148.20 BC	18.83 B
Man.2	25.63 A	164.67 A	21.10 A
Man.3	23.53 B	153.87 B	20.03 A
Sand 0	18.88 E	131.40 DE	14.93 D
Sand 1	20.42 D	141.53 CD	17.51C
Sand 2	20.31 D	149.33 BC	18.67 B
Sand 3	21.97 C	147.40 BC	17.83 BC

Means followed by same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

Table 5. Means of seed number, 1000-seed weight (g), empty seed %, and seed yield (t/ton) for different levels of the addition of bagasse, manure and sand in a second season.

Treatment	Seed number/ head	1000-seed weight (g)	Empty seeds (%)	Seed yield (t/ha)
Bag.0	1172.23 E	44.30 D	16.37 E	2.45 EF
Bag.1	1479.43 CD	58.10 C	11.20 H	3.17 BCD
Bag.2	1530.43 CD	66.53 A	13.23 G	3.29 ABCD
Bag.3	1514.67 CD	56.63 C	15.30 F	3.25 BCD
Man.0	1145.97 E	42.13 D	17.67 D	2.26 F
Man.1	1605.13 BC	60.27 BC	10.37 I	3.45 ABC
Man.2	1834.43 A	69.93 A	9.60 J	3.74 A
Man.3	1739.80 AB	65.63 AB	8.43 K	3.58 AB
Sand 0	1163.13 E	44.83 D	17.33 D	2.73 F
Sand 1	1372.63 D	56.97 C	18.30 C	2.91 D
Sand 2	1492.90 CD	57.27 C	19.63 B	3.06 CD
Sand 3	1310.23 D	55.90 C	21.17 A	2.84 DE

Means followed by same letter(s) within columns are not significantly different at 0.05 probability level according to Duncan's Multiple Range Test (DMRT).

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