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Effect of organic manures on yield and yield components of rain-fed sorghum in the Gedarif State.

Ibrahim Elsadig Ibrahim[1], Ali Eltoum Hassan[2], Elasha A. Elasha[2] and Salih Elagab[3]

[1]Gedarif Research Station
[2]Gezira Research Station, Wad Medani.
[3]El-Obei d Research Station

ABSTRACT: Field experiments were executed for two seasons (2007/08 and 2008/09), at northern and southern Gedarif state with an objective to study the impact of organic manures addition on yield of rain-fed sorghum. The organic fertilizers used were; farm yard manure (FYM) and chicken manure (CM) at levels of 5, 10, 15 and 20 tons/ha for each manure (manually soil incorporated) plus a control. The experiment was sown to Arfa-Gadamak and arranged in a randomized complete block design with three replications. The land was twice ploughed and the crop was sown in rows of 80 cm apart at 20 cm between plants, thinned to 1-2 and 2-3 plant/hole after three weeks at the northern and southern Gedarif respectively, and weeded thrice. Sowing was on the 23rd at Kilo-6 and 26th of July at Doka in the first season, and on the 31Ist at Kilo-6 and the 13th of July at Doka in the second season. The data recorded in both seasons were, plant height, number of heads, grain yield, 1000 grain weight and straw yield. Statistical analysis was carried using MSTATC package and treatment means were compared using the least significant difference at 5 %. Also, the data were economically evaluated to test the efficiency of organic manures on the productivity of rain-fed sorghum and to find the most economical and optimum at level of these manures through assessing their profitability. The results showed that the addition of organic manure resulted in significant differences among all the measured attributes. Irrespective of the first level of farm yard manure (5 tons/ha), other treatments significantly increased sorghum grain yield also. Generally, the application of chicken manure was superior to farm yard manure and the highest grain yield was obtained at 20 ton/ha (1975 kg/ha) followed by 15 tons/ha (1552 kg/ha), 10 tons/ha (1390 kg/ha) and then by 5 tons/ha (994 kg/ha). The economic analysis showed that the chicken manure had both the highest net return and marginal rate of return (584 %) compared to farm yard manure especially at 5 tons/ha and was found as the most economic and optimum level for sorghum production under Gedarif State. From both statistical and economic analysis, the study recommended the application of chicken manure at 5 tons/ha (i.e. 2.1 tons/ feddan) for sorghum production in the Gedarif state.

KEY WORDS:- *Fertilization , Dura*

INTRODACTION

Sorghum (*Sorghum bicolor* L. Moench) is the staple food crop of most people in the Sudan, and it is the largest grown crop in area wise. In Sudan the area under irrigated sorghum is about 8% while 92% is under rain-fed (Fadlelmula,

2009). Gedarif is the largest rain-fed sorghum producing state in the Sudan. Most soils of the Central Clay Plains of the Sudan within which Gedarif state is located, are characterized by low crop productivity as a result of low total nitrogen (0.03%), and organic carbon (0.4%) content. Only few measures have been taken to improve soil chemical and physical properties particularly in rain-fed farming. The extensive cropping and the continuous removal of crop residues either by burning or by domestic use coupled by the rapid decomposition due to high temperature lead to the decrease in both organic matter and fertility status (Ahlam, 2009). Accordingly, the grain yield of sorghum in these areas, particularly during the last two decades was only 200 kg/fed (Hassan, 2008). This yield gap can only be bridged by improvement of crop management practices such as proper fertilization or by addition of organic manures. The importance of soil organic matter is reported by many scientists. Chaney and Swift (1984) indicated that the soil organic matter plays an essential role in maintaining the stability of soil aggregates. Swift (1991) stated that the main constituents of soil organic matter are humic substances, which together with polysaccharides, are the active ingredients for soil aggregation. Decreasing of soil bulk density as a result of the addition of organic matter is reported by Hillel (2002). EIghball (2002) reported that usually crop yields will not depress when organic manures are applied at the correct rates. Hence, long–term application of manures will positively affect soil fertility. Ibrahim (2002) reported that application of FYM and urea to the Gezira soil significantly increased total nitrogen content of the top 30 cm of the soil. They also found that manure application increased the organic carbon, hydraulic conductivity and decreased the bulk density of the top 30 cm. The use of organic manure in new Hamdab conditions led to sustainable production of wheat, and enhanced the poor chemical soil fertility of the poor desert soil. The use of organic manures is known for its positive impact on soil organic matter which plays a significant role in the stability of the soil aggregates. Ali and Adam (2003) investigated the effects of three organic manures (FYM, filter-mud and bagasse) on some chemical and physical properties of Khashm Elgriba soil series and found that increasing the rate of each of the applied manure resulted in a highly significant reduction in the bulk density and consequently a highly significant increase in both porosity and soil moisture content. They also stated that the main constituents of soil organic matter are humic substances, which together with polysaccharides, are the active ingredients for soil aggregation. Moreover, the application of organic fertilizers such as livestock manure, bird, chicken and crop residue was found to bring a gradual improvement in soil productivity and crop performance through the enhanced root growth and nutrient up take (Toz-Chuan, 1994). The use of organic fertilizers recently acquired a great attention; European communities are among those who became aware of the hazards which may arise when they use crops and food stuffs made or grown by the use of chemical substances. British and German are the pioneers in this respect. They start to use crops grown by using what is known as organic farming. It is found that 25% of British and 30% of German are preferring food materials produced organically

(Taha, 2010). In Sudan, rain-fed Sorghum, Sesame, Pearl millet, Roselle and many other crops are grown organically without the use of fertilizers and chemicals. Recently, after the reduction in crop yields due to the soil deterioration, the use of chemical fertilizers and manures arises as one of the available alternatives for increasing crop yields. This will subject the value added to the Sudanese crops in the sense that they are mostly grown organically. Hence the objective of this study was to investigate the effect of organic manures on yield and some other attributes of rain-fed sorghum.

MATERIALS AND METHODS

Two experiments were carried out during 2007/08 and 2008/09 growing seasons at two different locations. The first site was at Gedarif Research Station Farm at Kilo-6 about 12 km west of Gedarif town (latitude 14° 03′N, longitude 32° 22′E, Elevation 539 m above sea level).The soil of this site is heavy cracking clay (Vertisols), with very low organic matter and low nitrogen contents (0.64 and 0.031% respectively). The second site was at Doka demonstration site 75 km south of Gedarif town (latitude 13° 44′ N, longitude 35° 77′ E, elevation 604 m above sea level). The soil of this site is heavy cracking clay (Vertisols), with very low organic matter and low nitrogen content (0.58 and 0.027%, respectively). Four levels of each manure (farm yard manure (FYM) and chicken manure (CM)), were applied in addition to the control. Level (1) is 5 tons/ha, level (2) is 10 tons/ha, level (3) is 15 tons/ha and level (4) is 20 tons/ha. The experimental units were arranged in a factorial trial in a randomized complete block design RCBD with three replications. The land was ploughed twice, then the crop was sown in rows 80 cm apart and 20 cm between plants. The variety sown in both sites was "Arfa-Gadamak" which was an early maturing variety. The applied manures were incorporated manually into the soil at sowing. The crop was sown on the 23rd of July at Kilo-6 and on 26th of July at Doka in the first season, whilst it was sown on the 13th of July at Doka and on the 31^{first} of July at Kilo-6 in the second season. Thinning was done three weeks after sowing together with weeding. The crop was weeded three times. At harvest the plant height, number of heads/m^2 was measured. The net area of one meter square was harvested and the grain yield was adjusted to Kg/ha. Replicated samples of 1000 seeds were taken and weighed to get the mean 1000 seeds weight. After drying, the straw was weighed to get the mean straw yield.

RESULTS and DISCUSSION

Soil physical and chemical characteristics in the experimental sites (i.e. Kilo-6 and Doka) are presented in Table 1. Seasonal rain fall data for both sites during 2007 and 2008 growing seasons are shown in table 2. Doka site had higher rain fall (714 and 815.4mm) during the two growing seasons of 2007 and 2008 compared to Kilo-6 with rain fall of 453 mm and 308.8mm for 2007 and 2008 seasons respectively. It was also observed that Doka site received rain fall amount of 152 mm and 27mm during June 2007 and 2008 growing seasons, respectively, while Kilo-6 site had no rain during this period. The rain fall of July for Doka site was higher (208 and 335mm) compared with that of Kilo-

6 (31mm and 81mm) (Table 2). August scored the highest rain fall during the two seasons for both sites(i.e. Kilo-6 and Doka). Rain fall in September was 191mm and 52 mm) for Kilo-6 during the first and second seasons respectively, while it was 110 mm and 155 mm for Doka during the first and second seasons respectively. During October 2007 no rains have been received at both sites, however 22 mm were received during October 2008 for Doka site.

Table 1: Chemical and Physical characteristics of the experimental sites

Character	Kilo-6	Doka
Clay content (%)	74	76
Silt content %	18	22
Fine sand content (%)	02	1.0
Coarse sand content (%)	06	1.0
Bulk density (g cm^3)	1.67	1.7
Porosity (%)	34	36
pH	8.1	7.4
Calcium carbonate (%)	8.2	7.4
Carbon/nitrogen C/N (%)	8.7	6.8
Total nitrogen (%)	0.031	0.021
Organic carbon (%)	0.64	0.58
Available Phosphorus (mg/kg soil)	3.0	4.0

Table 2: Monthly and seasonal rainfall values for the two locations during 2007and 2008 growing seasons.

	Rain fall in mm			
Month	2007			2008
	Kilo-6	Doka	Kilo-6	Doka
June	0.0	152	0.0	26.5
July	31	208	80.5	335.3
August	231	244	175.9	276.6
September	191	110	52.4	155.0
October	0.0	Nil	0.0	22.0
Total	453	714	308.8	815.4

In general, the addition of organic manures to rain-fed sorghum resulted in a significant increase in plant height compared to the control (Table 3). This increase could be justified by the fact that application of organic manures enhances the chemical and physical properties of the soil as reported by Chaney and Swift, 1984; Hillel, 2002; EIghball, 2002: and Ali and Adam,

2003. Accordingly, sorghum plant height had increased with the increase in the level of manures (Table 3). The difference in the environment also had a great impact on plant height, as the southern area (Doka) has attained more plant height compared to the northern area (Kilo-6) which could be attributed to the high rain fall. Abu Gideiri (1985) attributed the cereals stem elongation during the reproductive stage to surrounding available resources.

Table 3: Plant height (cm) of rain-fed sorghum during 2007 and 2008 seasons at Kilo-6 and Doka sites.

	Kilo-6	Doka	
Treatment	2007	2007	Combined
0 level	98.37	108.9	103.4
FYM1	99.83	113.1	106.5
FTM2	101.93	120.9	111.4
FYM3	109.07	124.8	116.9
FYM4	116.20	125.8	121.0
CM1	105.60	125.5	115.5
CM2	114.07	126.9	120.5
CM3	117.93	131.1	124.5
CM4	120.50	139.3	129.9
G mean	109.215	124.019	116.62
CV%	4.4	3.9	4.84
LSD	8.5	8.38	6.9

The analysis of variance indicated that there is a significant increase in the 1000 seed weight and number of heads/m^2 compared to the control (Table 4). The increase in the 1000 seed weight and number of heads/m^2 due to chicken manure and farm yard manure application follows the same trend as plant height. It was very clear from (Table 4) that the 1000 seed weight was heavier during 2007 season at both sites compared to 2008 season at Doka site, although Doka site has got higher rains compared to Kilo-6. The number of heads/m^2 was higher during 2007 at Kilo-6 compared to Doka site during 2008. The increase in number of heads/m^2 followed the increase in level and type of the fertilizer. High fertilizer levels scored more heads/m^2, and chicken manure produced more heads/m^2 (Table 4).

Table 4: 1000 seed weight in (g) and number of heads/m2 of rain-fed sorghum during 2007/08 and 2008/09 growing seasons.

Treatment	1000 seed weight (g)				No. of heads/ m^2		
	Kilo-6	Doka			Kilo-6	Doka site	
	2007	2007	2008	Combined	2007	2008	combined
0 level	36.66	35.57	31.06	34.43	9.8	5.39	7.6
FYM1	41.17	40.13	31.86	37.72	11.64	6.18	8.91
FTM2	42.00	40.63	32.43	38.37	12.52	6.81	9.67
FYM3	42.17	41.80	32.90	38.96	13.02	7.81	10.42
FYM4	42.57	43.87	34.63	40.67	12.52	7.26	9.89
CM1	40.43	39.80	34.13	38.12	12.63	7.94	10.29
CM2	42.30	41.70	34.90	39.63	13.32	7.54	10.43
CM3	44.70	42.20	36.36	41.10	14.92	8.23	11.58
CM4	46.80	43.93	37.40	42.71	16.92	7.37	12.15
mean	42.20	41.07	33.96	39.08	13.09	7.17	10.09
CV%	5.2	5.43	2.67	4.81	10.24	9.25	7.54
LSD	8.44	3.86	1.57	0.426	1.2453	3.63	1.3088

The straw yield of sorghum was also significantly increased during the two seasons due to the addition of the organic manures compared to the control (Table 5). Net and Dukhuis (1987) stated that dry matter production was increased by earlier nitrogen application, hence, in this case, the increase in the straw yield was due to the addition of organic fertilizers which resulted in increase of the soil nitrogen content (Table 2.) However, it was observed that the straw yield in 2008 season (Table 6) at Doka site (2599 kg/ha) was greater than that obtained during 2007 season at Kilo-6 and Doka (936 and 871, respectively). This could be attributed to high rain fall of 815 mm in Doka site (Table 2).

Table 5: Straw yield of rain fed sorghum during 2007 and 2008 seasons at Kilo-6 and Doka sites.

	Straw yield Kg/ha			
Treatment	Kilo-6	Doka site		
	2007	2007	2008	Combined
0 level	350	394	1190	645
FYM1	569	569	1750	963
FTM2	672.	734	2100	1169
FYM3	788	1096	2788	1557
FYM4	919	1168	3173	1754
CM1	963	726	2403	1364
CM2	1228	870	2858	1652
CM3	1315	1041	3383	2081
CM4	1620	1241	3746	2034
mean	936	871	2599	1468
CV%	12.95	15.35	11.63	13.82
LSD	209.97	231.6	523.65	192.9372

Analysis of variance indicated that the manure application had significantly increased the grain yield of sorghum compared to the control (Table 6). CM produced higher grain yield as compared with FYM. The highest combined grain yield (1975 kg/ha) was obtained at CM_4. Moreover, it was observed that for the year 2007 Doka site has scored highest mean grain yield (1466 Kg /ha) compared to Kilo-6 (1100 Kg/ha) which could be attributed to the high rain fall at Doka site (714 mm) with only 453mm for Kilo-6. On the other hand, it was observed that during 2008 at Doka site the grain yield of sorghum was the lowest among all sites and seasons, which could be attributed to the lower rain fall at grain filling stage (in October). Similer results were obtained by Hassan et al, (2008). Akhundov, (1981) stated that application of nitrogen to wheat resulted in higher yield and higher 1000-seed weight.

Table 6: Grain yield in (kg/ha) of rain-fed sorghum during 2007 and 2008 seasons at Kilo-6 and Doka sites.

	Grain yield Kg/ha			
	Kilo-6	**Doka**	**site**	
Treatment	**2007**	**2007**	**2008**	**Combined**
0 level	409	545	325	426
FYM1	486	732	383	534
FTM2	733	974	442	716
FYM3	857	1113	490	820
FYM4	989	1346	566	967
CM1	1318	1097	513	994
CM2	1494	2046	630	1390
CM3	1478	2348	828	1552
CM4	2134	2941	1179	1975
mean	1100.037	1460.33	595	1053
CV%	1.27	162.65	16.88	0.6270
LSD	184.23	192.9	174.03	144.3

The economic analysis showed that the chicken manure scored highest net return compared to farm yard manure especially at a level of 5 tons/ha and was found as the most economic and optimum level for producing sorghum under Gedarif conditions (table7) . This level is better than the higher levels of both chicken and farm yard manures and the investment at this level produced a marginal rate of return (MRR) of about 584%. This indicates that every monetary unit (SDG 1) invested in this organic manure would be returned back, plus an additional amount of SDG 5.85.

Table 7: Partial budget and marginal analysis on the effect of organic manures on yield of rain-fed sorghum in Gedarif State.

Treatment	Grain yield kg/ha	Gross return SDG/ha	Variable cost SDG/ha	Net return SDG/ha	Marginal cost SDG/ha	Marginal net benefit SDG/ha	Marginal rate of return (%)
0 level	426	347	96	251			
FM5 tons	534	528	346	182	250	69	28
FM 10tons	716	705	500	109	250	73	29
FM 15tons	820	806	750	-39	250	148	59
FM 20tons	967	948	1096	-148	250	187	75
CM 5 tons	994	974	246	728	150	876	584
CM 10 tons	1390	1358	396	962	150	234	156
CM 15 tons	1552	1515	546	969	150	7	5
CM 20 tons	1975	1926	696	1230	150	261	175

CONCLUSIONS:

From this study the following conclusions were draw:-

1-The addition of organic manures increased the yield of rain-fed sorghum.

2-Chicken manures showed higher grain yields as compared to FYM.

3. The chicken manure at 5 tons/ha is the most economic and optimum level for sorghum production under Gedarif conditions.

RECOMMENDATION:

From statistical and economical analysis it is recommended that chicken organic manure at 5 tons /ha (2.1 tons/ feddan) is the most feasible organic manure for rain-fed sorghum production at Gedarif state.

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