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RESEARCH ARTICLE

EFFECT OF TILLAGE AND FARM YARD MANURE ON YIELD AND YIELDS COMPONENTS OF GRAIN SORGHUM (*Sorghum bicolor* L.monech) IN RAIN-FED

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ABSTRACT

Afield experiment conducted in North Kordofan state of Sudan for two successive rainy seasons (2007/08- 2008/09) to investigate the effect of tillage and farm yard manure on yield components growth and yield of sorghum (*Sorghum bicolor* L.monech) in gardoud soil (Red and black). The treatments consisted of three tillage depth (0, 15 and 25 cm) and five concentrations of manure (0,6,12,18 and 24 t/ha). Split plot design with four replications was used. Character studied were number of panicles/m^2 , number of grains per panicle, 100-seed weight and final grain yield (t/ha). The results showed that, the tillage and manure had significant effect on yield and yields attributes measured. Tillage depth (15 cm) was highest in highest in number of panicles/m^2, number of grains per panicle and final grain yield (t/ha). Concentration manure of 24 t/ha were superior in grain yield. Tillage and manure had no significant different in 100- grain weight. Black gardoud soil had higher grain yield (1.96 t/ha) than red soil (1.75 t/ha).

INTRODUCTION

Grain Sorghum (*Sorghum bicolor* (L.) Moench) is the main staple food crop of a large section of population in Africa and India. Sorghum crop adapted to drought areas is a crop of hot, semi – arid tropical environment with 400 – 600 mm rain fall areas. The crop thrives well in the temperature range of 16-40°C. Its performance is good with a mean temperature of 27°C (ICRISAT, 1986). Sorghum can be cultivated successfully on nearly all soils, but fertile loamy Soils are considered to be the best (EARS, 1999). In Sudan the flour from the grain can be used to make kisra, porridge, gruel, local beer and snack meals like Balleela (Awad, 2000). Tillage is an important crop production practices which may affect crop performance differently. Tillage creates an ideal seedbed condition for plant emergence, plant development and unimpeded root growth (Licht and Al-Kaisi, 2005.). Tillage practices are critical components of soil management systems (Mosaddeghi *et al*. 2009). Inappropriate tillage practices could inhibit crop growth and yield. The selection of an appropriate tillage practice for the production of crops is very important for optimum growth and yield. A good soil management programme protects the soil from water and wind erosion, provides a good, weed-free seedbed for planting, destroys hardpans or compacted layers that may limit root development and allows maintenance or even an increase of organic matter (Wright *et al*., 2008). The objectives of tillage are to develop a desirable soil structure or suitable tilth for a seedbed (Srivastava *et al*, 2006) for the tillage optimum growth and yield of the crop. Different tillage practices may influence the growth and yield of grain sorghum. Chemical fertilizer, herbicide and pesticide used in agriculture for increasing yield and controlling weeds and pests can contaminate the water, air and food, decrease soil fertility, inhibit growth of soil microorganisms and hazard human health (Erisman *et al.,* 2001). In addition, chemicals may destroy many species of plants, insects, fishes and soil microorganisms. Therefore, utilization of farmyard manure in agriculture is recommended for retaining productivity of problem soils, reducing the usages of chemical fertilizer, improving economy in agriculture and minimizing environmental problems. The fertilizers derived from animals, plants and microorganisms, are usually called organic fertilizer or farmyard manure. Many kinds of farmyard

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manure are locally produced based on available natural resources. Chicken manure, goat manure and cow manure are commercially available in Sudan. Information is needed in selecting appropriate tillage practice and farm yard manure for the production of grain sorghum in gardoud soil of North Kordofan of Sudan. The objective of the study was to investigate the effect of three different tillage depth and different concentrations of farm yard manure on yield and yields components of grain sorghum

MATERIALS AND METHODS

A field experiment was conducted during two successive seasons (2007/08- 2008/09) under rain fed, at two locations in two type gardoud soil(Red and black) in North Kordofan State, Sudan, latitude (11˚ 15 and 16˚ 30 N) and longitude (27˚ and 32˚ E).. The climate of the area is arid and semiarid zone. The soil is sandy with low fertility. Annual rainfall ranges between 350 – 500 mm. Average maximum daily temperatures varied between 30˚ and 35˚C throughout the year (El Naim *et al*. 2011). Physio-chemical properties of garduod soils (red and black) are shown in Table 1The experiment was laid out in Split plot design with four replications. The plot size was 4m × 2.4m. The treatments consisted of three tillage depth (0, 15 and 25 cm) and five concentrations of cow manure fertilizer (0, 6, 12, 18 and 24t/ha). Fertilizer have been distributed among the lines using a plow plowing at a depth of 0, 15 and 25 cm. Chemical analysis of farm yard manure is presented in Table 2. Sowing dates were on the July 19th, 2006 for first season, and 20th of July for second season. Seeds were sown on rows 50 cm apart; in intra-row spacing of 50 cm. Three seeds were placed in each hole. After two weeks from sowing, seedlings were thinned to two plants per hole. Manual weeding was practiced twice in the two location

Table 1.Physio-chemical properties of garduod soils (red and black)

Properties	Red Garduod	Black Garduod
Depth(cm)	30-0	30-0
Sand%	68.8	59
Silt %	8.0	2.0
Clay %	23.2	39
PH(paste)	7.30	7.56
Ece (ds/m)	0.34	0.22
Potassium (ppm)	12.82	9.14
Sodium (ppm)	13.79	9.63
Calcium (ppm)	10.79	7.06
Magnesium (ppm)	34.25	21.90
Phosphorus (mg/kg)	4.07	3.04
Nitrogen (%)	0.041	0.024

Table 2. Chemical analysis of farm yard manure

Element	Concentrate
Ca%	3.70
Mg%	4.30
K%	0.44
Na%	0.09
P%	0.12
N%	0.44
O.C%	21.0
Fe%	0.06
Mn%	0.03
Zn%	0.39
Cu%	0.43
C\N	47.7
PHpaste	6.5
Ece(ds\m)	11.30

(Ibrahim, 2003)

Characters studied

1 Number of panicles per plot: obtained by counting the total number of heads in each plot.
2 Number of grains per panicle
3 100-grain weight (g): based on random sample of 100 - seeds taken four times from the bulked seeds of each experimental unit.
4 Grain yield (kg/ha): panicles from each plot were harvested, sun dried, threshed, weighed and converted to kg/ha.

Statistical Analysis: Data were analyzed statistically using analysis of variance according to Gomez and Gomez (1984) procedure for a randomized complete block design. The differences of means were identified by least significant differences (L.S.D) at $P \geq 0.05$

RESULTS AND DISCUSSION

The influence of the three different tillage practices on the sorghum yield and yields components is shown in Table 3, 4, 5 and 6. Number of panicles per m^2 and number of seeds per panicle significantly influenced by the tillage depths. Among the different tillage depth, 15 followed by 25cm gave the highest number of panicles per plot, greatest number of grains per panicle and highest grain yield. The no tillage treatment gave the lowest number of panicles per plot, number of seeds per panicle and grain yield. The superiority of tillage depth (15cm) in producing the largest number of panicles per plot, greatest number of seeds per panicle and highest grain yield was associated with increased soil loosening. These results agree with that of (Aikins and Afuakwa, 2010) who reported that tilled plots gave higher number of seeds than that of untilled plots. They attributed their findings to tillage operation which improved soil aeration. Similar results have been reported by Rashidi and Keshavrzpour (2007) who evaluated the effects of seven tillage methods on grain yield and yield components of maize (*Zea mays* L.) under clay-loam soil and observed significantly greater maize grain yield and yield components under tilled treatments compared with that of the no tillage treatment. In contrast, Olaoye (2002) reported significantly higher cowpea number of pods per plant in no tillage plots compared with ploughing followed by harrowing plots under Ferrisols Ferruginous soils in the derived savannah agro-ecological zone of Nigeria while Agbede *et al*. (2008) also observed greater sorghum grain yield in the no tillage treatment in comparison with the ploughing followed by harrowing treatment. The effect of the four different concentrations of manure on the sorghum yield and yields components are shown in Table 3, 4, 5 and 6. Number of panicles per m^2 and number of seeds per panicle significantly influenced by the farm yard manure. Among the different concentration, 25t/ha gave the highest number of panicles per plot, greatest number of grains per panicle and highest grain yield. The no manure treatment gave the lowest number of panicles per plot, number of seeds per panicle and grain yield. The superiority of concentration of 25t/ha in producing the largest number of panicles per plot, greatest number of seeds per panicle and highest grain yield was associated with increased soil fertility. The manure provided nutrients to the plants and may improved edaphic factors, which resulted in higher vegetative growth parameters.. Similarly, other studies reported that organic

Table 3. Effect of farm yard manure and tillage depth on number of panicles per m^2 of sorghum

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	2.75	5.50	6.50	4.92	6.00	5.25	6.00	5.75
6	5.00	7.00	6.00	6.00	5.75	5.75	5.00	5.50
12	6.00	6.00	7.50	6.50	6.25	6.00	5.25	5.83
18	7.75	7.25	7.50	7.50	6.25	8.00	7.00	7.08
24	7.75	9.00	7.75	8.17	7.25	7.00	5.25	6.50
Means	5.85	6.95	7.05		6.30	6.40	5.70	
Red Garduod								
	Season1				Season2			
0	6.25	6.25	5.75	6.08	5.50	5.00	4.75	5.08
6	8.00	7.75	6.50	7.42	4.00	5.50	5.75	5.08
12	8.50	6.50	6.50	7.17	5.50	6.50	5.00	5.67
18	7.50	7.00	7.50	7.33	6.00	8.00	7.00	7.00
24	9.00	8.50	7.25	8.25	6.00	7.00	5.50	6.17
Means	7.85	7.20	6.70		5.40	6.40	5.60	

	Black Garduod		Red Garduod	
LSD5%	Season1	Season2	Season1	Season2
Manure	0.25	0.21	0.22	0.24
Tillage	0.41	0.34	0.36	0.40
Interaction	1.22	1.03	1.08	1.20

Table 4. Effect of farm yard manure and tillage depth on 100- seed weight of sorghum

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	2.60	2.69	2.75	2.68	2.26	2.58	2.57	2.57
6	2.83	2.24	2.41	2.49	2.14	2.44	2.10	2.20
12	2.78	2.00	2.63	2.47	2.27	2.60	2.33	2.40
18	2.51	2.31	2.50	2.44	2.46	2.64	2.78	2. 63
24	2.68	2.41	2.60	2.56	2.12	2.80	2.64	2.52
Means	2.68	2.33	2.58		2.31	2.61	2.47	
Red Garduod								
	Season1				Season2			
0	2.98	3.33	2.75	3.02	2.56	2.84	2.95	2.78
6	3.09	3.19	2.61	2.96	2.78	2.92	2.75	2.82
12	3.08	3.17	2.97	3.07	2.67	2.42	2.70	2.60
18	3.40	3.17	2.74	3.10	2.64	2.13	2.38	2.38
24	2.92	2.81	2.87	2.87	2.46	2.50	2.71	2.56
Means	3.09	3.13	2.79		2.62	2.56	2.70	

	Black Garduod		Red Garduod	
LSD5%	Season1	Season2	Season1	Season2
Manure	0.05	0.07	0.06	0.08
Tillage	0.08	0.12	0.9	0.13
Interaction	0.25	0.35	0.27	0.39

Table 5. Effect of farm yard manure and tillage depth on number of seeds per panicle of sorghum

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	1946	2922	2333	2411.1	2761	2612	2346	2371.6
6	1994	4499	2814	2952.2	3529	2618	3007	2653.7
12	3186	5881	2710	2660.6	1698	2476	2773	2346.6
18	3257	4722	3560	3805.7	1484.5	1406	2135	1688.9
24	3188	6383	3513	4258.5	3134	2313	2123	2468.5
Means	2706.3	4771.6	2970.1		2318.1	2280.0	2462.7	
Red Garduod								
	Season1				Season2			
0	2477	3213	3282	3135.4	1510	1748	1298	1522.6
6	3615	4068	4605	1148.3	2184	2070	1805	1708.1
12	3612	3316	4095	3668.4	1360	2625	2154	2181.9
18	2712	2952	3989	3155.4	1312	4132	2330	2418.4
24	4333	3979	4097	4132.7	2007	3792	2811	2637.1
Means	3332.6	3564.8	4008.9		1467.1	2830.4	1924.4	

	Black Garduod		Red Garduod	
LSD5%	Season1	Season2	Season1	Season2
Manure	121.60	148.04	100.01	126.29
Tillage	202.66	246.73	166.69	210.49
Interaction	607.98	704.19	500.03	631.45

Table 6. Effect of farm yard manure and tillage depth on grain yield (kg/ha) of sorghum

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	1315.5	2115.00	1765.00	1731.83	1410.50	1739.00	1550.00	1566.50
6	1598.33	2257.50	1635.00	1830.28	1616.25	1559.00	1326.25	1500.50
12	2462.50	2352.50	1875.00	2233.33	875.00	1674.00	1505.75	1351.58
18	2052.50	2520.00	2225.00	2265.83	873.75	980.00	1650.75	1168.17
24	2290.00	3707.50	2375.00	2790.83	1409.00	1814.25	1480.00	1567.75
Means	1943.77	2590.50	1977.00		1236.90	1553.25	1502.55	
Red Garduod								
	Season1				Season2			
0	2200.00	3896.50	2482.50	2859.67	990.00	1410.00	1130.00	1176.67
6	3452.50	4140.00	3137.50	3576.67	945.00	1765.00	1365.00	1358.33
12	3427.50	3332.50	3612.50	3457.50	970.00	1855.00	1600.00	1475.00
18	3135.00	2967.50	2995.00	3032.50	915.00	1875.00	1320.00	1370.00
24	3695.00	3142.50	3375.00	3404.17	1215.00	2370.00	1600.00	1728.33
Means	3182.00	3492.40	3120.50		1007.00	1855.00	1403.00	

	Black Garduod		Red Garduod	
LSD5%	Season1	Season2	Season1	Season2
Manure	121.60	148.04	100.01	126.29
Tillage	202.66	246.73	166.69	210.49
Interaction	607.98	704.19	500.03	631.45

fertilizer improved soil productivity and fertility, which improved yield and quality of crops (Aikins and Afuakwa, 2010). The soil treated with manure was found to be loose, which probably provided adequate aeration into the soil and improved soil microbial activities (Aikins and Afuakwa, 2010). Higher soil microbial activities may release nutrients from the farmyard manure as well as soil for better plant growth. The soil without manure showed a water logging condition for some time and dried earlier as compared with the soil treated with manure, indicating that the soil without manure has lower porosity and farmyard manure improves water holding capacity of soil. Aikins and Afuakwa (2010) revealed that organic manure increases pH and water-holding capacity, and decreases bulk density in soil. The loose soil was probably favorable for root growth and expansion, which ultimately promoted vegetative growth. Generally Black gardoud soil had higher grain yield (1.96 t/ha) than red soil (1.75 t/ha).

Conclusion

Tillage depth of 15cm and cow manure of 24 t/ha are effective and recommended to improved yield of grain sorhum in gardoud soil of North Kordofan of Sudan under rain-fed

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