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RESEARCH ARTICLE

INFLUENCE OF TILLAGE AND FARM YARD MANURE ON VEGETATIVE GROWTH INDICES OF GRAIN SORGHUM (*Sorghum bicolor* L. Monech) IN GARDOUD SOIL OF SUDAN IN RAIN-FED

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ABSTRACT

A field 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 vegetative growth indices 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 plant height, stem diameter, number of nodes per plant, plant density. The results showed that, the tillage and manure had significant effect on most growth measured. Tillage depth (15 cm) was highest in stem diameter, number of nodes per plant and plant density. Concentration manure of 6 and 24 (t/ha) were superior in growth indices of stem diameter and number of nodes per plant. Tillage and manure had no significant different in number of tillers and. Generally black gardoud soil had higher vegetative growth than red soil.

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.

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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 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 compare the effect of three different tillage depth and different concentrations of farm yard manure on growth and yield 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 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). The 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. 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 locations.

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 analaysis 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)

Data Collection

A sample of five plants was taken at random from each experimental plot to measure the following growth character.

Plant height (cm): The height of the main stem from ground level to the tip of the plant at 30 and 60 days after sowing (DAS). Stem diameter (cm): measured by using a vernier (caliper) at the third node at 30 and 60 DAS. Number of nodes per plant: was determined by counting the number of nodes of main stem

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

Plant height is an important growth character directly linked with the productive potential of plant in terms of fodder and grain yield (Saeed *et al*. 2001). The effect of tillage depth and farm yard manure on sorghum plant height after 30 and 60 days after sowing are presented in Table 3 and 4. The results showed that the manure and tillage increased the plant height at both sites during both seasons, because the tillage led to increase the rate of leakage of water into the soil and which led to increased soil moisture content (Agabawi, 1975). Tillage and manure had an effective impact on the growth of plants, especially plant height (Abdalla, 2006). Farm yard manure had significant effect on plant height. Increased concentration of manure increased plant height. No manure treatment had a lesser plant height. Hossain and Ishimine (2007) in field experiment found that growth parameters and yield increased with all types of manure, and the plants grown with goat manure or cow manure showed the highest vegetative growth parameters and yield except plant height, leaf number and tiller number. However, leaf number and tiller number increased slightly with the goat manure and cow manure than those with die chicken manure.

The effect of tillage depth and farm yard manure on *sorghum* stem diameter at 30 and 60 days after sowing are presented in Table 5 and 6. Farm yard manure and different depths of tillage had significantly effect on stem diameter in all sites and seasons. Tillage depth of 15 cm was superior in stem diameter. This results in agree of results obtained by Abdalla (2006). The concentration of cow manures of 24 t/ha had highest stem diameter compare to others. Agbede *et al*. (2008) reported bigger sorghum (*Sorghum bicolor* L.) stem girth in the no tillage plots compared with that in the disc ploughing plots under alfisols in the forest-savanna transition zone of Nigeria. They reported that there was no significant difference in stem girth between the no tillage and disc ploughing followed by disc harrowing treatments. Number of leaves per plant produced by a plant is directly proportional to the photosynthate produced. Table 7 show the effect of tillage and farm yard manure treatments on sorghum number of nodes per plant. Deep tillage resulted in positive results in the number of nodes per plant in both seasons at the two sites, respectively has been found that there is a direct relationship between the number of nodes and productivity (Radwa, 1971). Farm yard manure had no significant effect on number of nodes per plant. The manure provided nutrients to the plants and may improved edaphic factors, which resulted in higher vegetative growth

Table 3. Effect of farm yard manure and tillage depth on plant height (cm) of sorghum at 30 DAS

Black Garduod								
	Season1				Season2			
Depth/cm Manure t \ ha	0	15	25	Means	0	15	25	Means
0	19.60	26.48	20.70	22.26	26.98	31.05	30.13	29.39
6	16.05	31.38	24.23	23.89	27.05	30.63	31.70	29.79
12	19. 38	36.88	30.18	28.81	29.50	33.28	31.50	31.43
18	22.05	33. 55	30.13	2851	28.10	33.90	31.15	31.05
24	25.30	37.23	37.40	32.64	28.40	32.53	30.93	30.62
Means	20.48	33.10	28.53		28.01	32.28	31.08	
Red Garduod								
	Season1				Season2			
0	18.73	23.15	22.88	21.59	24.65	27.65	25.78	26.03
6	19.55	24.73	24.45	22.91	28.48	33.33	36.95	32.92
12	23.05	23.20	22.23	22.83	27.30	33.48	38.90	33.23
18	20.53	26.23	25.05	23.94	28.83	34.38	34.78	32.66
24	23.05	28.48	25.85	25.79	28.55	32.25	36.65	32.48
Means	20.98	25.16	24.09		27.65	32.22	34.61	
	Black Garduod				Red Garduod			
LSD5%	Season1		Season2		Season1		Season2	
Manure	0.62		0.71		0.61		0.54	
Tillage	1.04		1.19		1.02		0.89	
Interaction	3.12		3.56		3.05		2.68	

Table 4. Effect of farm yard manure and tillage depth on plant height (cm) at 60 DAS

Black Garduod								
Depth/c	Season1				Season2			
Manure t\ ha	0	15	25	Means	0	15	25	Means
0	66.23	9648	100.15	87.62	75.43	74.15	76.80	75.46
6	63.95	106.23	93.20	87.79	72.70	76.30	72.05	73.68
12	84. 88	99.63	67.05	93.85	71.55	75.98	74.53	74.2
18	92.48	98. 73	103.05	98.09	74.35	73.48	69.80	72.54
24	88.88	103.98	102.83	98.56	75.03	77.73	79.73	77.50
Means	79.28	101.01	99.26		73.81	75.53	74.58	
Red Garduod								
	Season1				Season2			
0	90.70	93.30	88.72	90.91	64.70	73.63	68.13	68.82
6	90.05	88.05	90.95	89.68	62.38	80.05	80.73	74.39
12	88.48	66.45	86.55	80.49	68.48	78.30	81.62	76.13
18	89.95	89.98	80.05	86.66	64.73	80.30	73.08	72.70
24	94.63	90.95	90.23	91.94	74.48	78.48	82.63	78.53
Means	90.76	85.75	87.30		66.95	78.15	77.24	
	Black Garduod				Red Garduod			
LSD5%	Season1		Season2		Season1		Season2	
Manure	1.15		0.82		1.97		1.57	
Tillage	1.91		1.37		3.28		2.61	
Interaction	5.73		4.10		9.84		7.82	

Table 5. Effect of farm yard manure and tillage depth on stem diameter (cm) of sorghum at 30 DAS

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	0.78	1.40	1.13	1.10	1.30	1.43	1.43	1.39
6	0.75	1.58	1.40	1.24	1.28	1.40	1.40	1.36
12	0. 95	1.63	1.55	1.38	1.30	1.53	1.45	1.43
18	0.10	1.65	1.58	1.44	1.23	1.43	1.43	1.36
24	1.25	1.72	1.75	1.57	1.30	1.48	1.38	1.39
Means	0.97	1.60	1.48		1.28	1.45	1.42	
Red Garduod								
	Season1				Season2			
0	1.08	1.30	1.38	1.25	1.28	1.20	1.15	1.21
6	1.10	1.43	1.40	1.31	1.28	1.53	1.68	1.50
12	1.40	1.33	1.33	1.35	1.30	1.48	1.68	1.49
18	1.20	1.53	1.35	1.36	1.38	1.60	1.50	1.49
24	1.23	1.60	1.53	1.45	1.33	1.50	1.63	1.49
Means	1.20	1.44	1.40		1.31	1.46	1.53	
	Black Garduod				Red Garduod			
LSD5%	Season1		Season2		Season1		Season2	
Manure	0.04		0.02		0.03		0.02	
Tillage	0.06		0.03		0.05		0.04	
Interaction	0.18		0.08		0.15		0.11	

Table 6. Effect of farm yard manure and tillage depth on stem diameter (cm) of sorghum at 60 DAS

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	1.40	2.23	2.00	1.88	1.55	1.75	2.00	1.78
6	1.38	2.13	2.18	1.90	1.55	1.65	1.93	1.71
12	1.70	2.20	2.15	2.02	1.45	1.60	1.78	1.61
18	1.95	2.15	2.15	2.08	1.53	1.60	1.20	1.78
24	1.93	2.30	2.28	2.17	1.58	1.55	1.78	1.64
Means	1.67	2.20	2.15		1.53	1.63	1.94	
Red Garduod								
	Season1				Season2			
0	1.90	2.15	1.38	1.81	1.40	1.58	1.55	1.51
6	1.98	2.20	2.15	2.11	1.55	1.75	1.75	1.63
12	2.13	2.10	2.18	2.14	1.58	1.83	1.70	1.70
18	2.00	2.25	2.13	2.13	1.50	1.78	1.73	1.67
24	1.83	2.15	2.23	2.07	1.43	1.80	1.80	1.68
Means	1.97	2.17	2.01		1.49	1.75	1.71	

	Black Garduod		Red Garduod	
LSD5%	Season1	Season2	Season1	Season2
Manure	0.38	0.29	0.04	0.02
Tillage	0.64	0.48	0.07	0.03
Interaction	1.92	1.43	0.20	0.09

Table 7. Effect of farm yard manure and tillage depth on number of nodes per plant of sorghum

Black Garduod								
Depth/cm	Season1				Season2			
Manure t \ ha	0	15	25	Means	0	15	25	Means
0	6.85	9.75	8.75	8.45	7.75	7.75	8.00	7.83
6	6.00	10.00	9.50	8.50	7.75	8.25	7.25	7.75
12	7.75	10.25	9.50	9.17	7.25	7.50	8.00	7.58
18	8.75	10.00	10.00	9.58	7.50	7.75	8.25	7.83
24	9.00	10.50	10.25	9.92	7.75	8.25	7.25	7.75
Means	7.67	10.10	9.60		7.50	7.80	7.75	
Red Garduod								
	Season1				Season2			
0	9.00	9.25	9.50	9.25	8.00	8.75	8.00	8.25
6	9.00	9.50	9.75	9.42	8.25	9.00	8.50	8.58
12	9.25	9.00	9.50	9.25	8.25	9.00	9.25	8.83
18	8.75	9.50	9.25	9.17	8.00	8.75	7.50	8.08
24	8.75	9.50	9.25	9.17	7.50	9.00	8.75	8.42
Means	8.95	9.35	9.45		8.00	8.90	8.40	

	Black Garduod		Red Garduod	
LSD5%	Season1	Season2	Season1	Season2
Manure	0.11	0.14	0.18	0.12
Tillage	0.18	0.23	0.31	0.20
Interaction	0.54	0.69	0.92	0.60

parameters. Similarly, other studies reported that organic fertilizer improved soil productivity and fertility, which improved yield and quality of crops. 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). Highersoil 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.

Conclusion

Tillage depth of 15cm and cow manure of 24 t/ha are effective and recommended to improved vegetative growth of grain sorhum in gardoud soil of North Kordofan of Sudan.

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