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Effect of Chisel Plough and Chicken Manure on growth and Yield of Sorghum (*Sorghum bicolor* (L.) Moench).

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ABSTRACT

The recent demand for poultry meat products in Sudan has led to tremendous expansion in the poultry industry. There is a need to assess the potential impacts of chicken manure on crop yield and in particular evaluating the critical application levels. Field experiments were conducted on Hard, Non-Cracking Sandy Clay (Gardud) soil of North Kordofan State, Sudan, to study the effects of tillage (chisel) and chicken manure on the yield of sorghum (*Sorghum bicolor* (L.) Moench) variety Arfaagadamuk, at two locations, HaiSeka and ELAinELSafia for two successive seasons (2007\08 – 2008\09). Split plot designed with three replications was used. The results showed that tillage (15cm depth) and chicken manure (8ton/ha) treatment significantly increased the plant height (cm), 100-seed weight, panicle weight and grain yield (ton/ha) as compared with other treatments in two locations at all seasons. The interaction effect of tillage and application of chicken manure improved all growth and yield parameters particularly at 15cm depth and 8 ton/ha, and the deviations from the control were found to be statistically significant at ($p \leq 0.01$).

Keywords: Chisel plough, chicken, manure, *Sorghum bicolor*

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INTRODUCTION

Sorghum (*Sorghum bicolor* (L.) Moench). It is the main staple food crop in South Kordofan and second in importance in North Kordofan State, coming after millet [1]. The common names of sorghum in the Sudan are Aish, Thura (defaced to dura) and Mareig in Kordofan. The sorghum uses in Kordofan are diverse. The flour from grain can be used to make Kisra, gruel, local beer and snack meals. The grains and straw are good feed for animals [2]. Chicken manure is known to increase proliferation of the indigenous microorganisms, and contains as much nitrogen as farmyard manure but richer in potassium and phosphorus [3]. The effectiveness of poultry manure depends on its composition and the environmental conditions. The organic matter content in the soil increased by the application of organic fertilizers [4]. Soil organic matter significantly affected soil fertility in addition to its influence on soil physical properties, particularly aggregation, reaction and water holding capacity [5]. Organic management practices promote soil water conservation and can reverse environment degradation. Livestock on their farm could provide a variety of animal products, to the local economy and manure for improving soil fertility [6]. Adding of organic matter to the soil significantly increased the organic carbon content, stored nutrients and maintained the soil fertility for long term [7,8].

Tillage operation in any soil is useful to prepare the soil structure for seed or root bed so as to increase the infiltration and moisture content of the soil, improve soil aeration, weeds control, get rid of the plant debris, improve soil moisture content by reducing surface water runoff, loosening the surface soil for better seed bed, minimizing soil surface compaction, preparing the soil for irrigation, reducing soil erosion, pest control, and mixing chemical in the soil [2]. Soil exhaustion is the main factor for the deterioration of agricultural production in sandy Goz soils in North Kordofan State of Sudan. The only alternative for crop production is the Gardoud soil. Its characterized by hard surface crust which decrease the infiltration rate, and increase surface run off. Consequently, low field capacity will be resulted; moreover, Hard, Non-Cracking Sandy Clay (Gardoud) soil is low in fertility, so the soil could not be cultivated unless some treatments were applied to improve its physical and chemical characteristics. The recommendation of the researches to improve the physical properties of the Hard, Non-Cracking Sandy Clay (Gardud) soil is to use the chisel plough for crop production. Improving the quality of the soil through organic practices can encourage the soil to hold moisture more efficiently than conventionally managed soil. The higher content of organic matter also makes organic soil less compact so that the root system can penetrate more deeply to extract moisture. These results highlight the importance of organic farming and their potential to future crop failures [8]. The objective of this study the effect of chiseling tillage depth and manure on growth and yield of sorghum in Hard, Non-Cracking Sandy Clay (Gardud) soil.

MATERIALS AND METHODS

Seed test

Sorghum seeds (*Sorghum bicolor*) Arfaagadamuk variety were supplied by Ministry of Agriculture, North Kordofan State. Laboratory test was carried out to check the germination percentage of the seeds. It was found that the seed germination about 90%.

Soil test

Soil samples were taken from two locations, HayELseka and Elian ELsafia village each of Hard,Non-Cracking Sandy Clay(Gardud) soil. The samples were taken at from 0 -30cm depth. Mechanical and chemical tests were carried out according to [9]. method and the results are shown in Table (1). The Chemical analysis of chicken manure used in the experiment is presented in Table 2.

Table 1: Some Physical and Chemical properties of the soil.

Eliau Elsafia	HayElseka	Locations
0 – 30	0 – 30	Depth(cm)
80	68.8	Sand %
2.0	8.0	Silt %
18	23.2	Clay %
7.56	7.30	PH (paste)
0.22	0.34	Ece (dS/m)
9.14	12.82	Potassium (ppm)
9.63	13.79	Sodium (ppm)
7.06	10.79	Calcium (ppm)
21.90	34.25	Magnesium (ppm)
3.04	4.07	Phosphorus (mg/kg)
0.024	0.041	Nitrogen (%)

Table 2. Chemical analysis of chicken manure.

3.40	Ca (%)
4.30	Mg (%)
1.90	K (%)
0.07	Na (%)
0.001	P (%)
1.80	N (%)
27.00	O.C (%)
0.03	Fe (%)
0.05	Mn (%)
0.38	Zn (%)
0.50	Cu (%)
15.00	C/N
6.15	PH (paste)
16.20	Ece (dS/m)

Field Experiments

A field experiment was conducted during two successive seasons (2007/08- 2008/09) under rain fed, at two locations (HayELseka and Elian ELsafia village) in North Kordofan State, Sudan, to study the effect of chisel plough and chicken manure on yield of sorghum (*Sorghum bicolor*) variety Arfaagadamuk supplied by Ministry of Agriculture, North Kordofan State. Mechanical and chemical tests for soils at depth of 0-30cm were carried out according to [9]. method and the results were shown in Table 1.

In each location total area of 16 m×72 m was used to conduct the experimental work. The area was divided to four replications, each replicate was divided to three split

units while each unit was subdivided into four subunits each of 6 m×4 m. The unit composed five rows each of 6 m long. The area in each location was ploughed using chisel plough at two depth, 15cm and 30cm while 0cm was regarded as control. Four concentrations of chicken manure fertilizer (0 ton/ha, 4 t/ha, 8 t/ha, and 12 t/ha) were combined with depths of ploughing, therefore there was twelve treatments as follow

1. $D_0 \times M_0$ = depth 0 cm, manure 0 ton/ha.
2. $D_0 \times M_4$ = depth 0 cm, manure 4 ton/ha.
3. $D_0 \times M_8$ = depth 0 cm, manure 8 ton/ha.
4. $D_0 \times M_{12}$ = depth 0 cm, manure 12 ton/ha.
5. $D_{15} \times M_0$ = depth 15 cm, manure 0 ton/ha.
6. $D_{15} \times M_4$ = depth 15 cm, manure 4 ton/ha.
7. $D_{15} \times M_8$ = depth 15 cm, manure 8 ton/ha.
8. $D_{15} \times M_{12}$ = depth 15 cm, manure 12 ton/ha.
9. $D_{30} \times M_0$ = depth 30 cm, manure 0 ton/ha.
10. $D_{30} \times M_4$ = depth 30 cm, manure 4 ton/ha.
11. $D_{30} \times M_8$ = depth 30 cm, manure 8 ton/ha.
12. $D_{30} \times M_{12}$ = depth 30 cm, manure 12 ton/ha.

Sowing operation was conducted using hand tools with seed rate of 5-7seeds/hole at 5-7cm depth. The seedlings were then thinned to three plants per hole after three weeks from sowing.

Character Studies

All measurements were taken from the three central rows in each plot. The following traits were measured

50% flowering (days)

The numbers of days from sowing to the time that 50% of heads in the plot had extruded anthers halfway down the head were determined.

Plant height (cm)

Measured from ground surface to the tip of the main panicle for a random sample of ten plants per plot and averages were calculated.

Stem diameter (cm)

Measured at maturity on the stalk at 10cm from the soil surface roots on the basal side (by fernier).

Panicle weight (g)

Random five heads of each plot weighed and divided by five

100- Seed weight (g)

Based on random sample of 100 -seeds taken four times from the bulked seeds of each experimental unit.

Grain yield per plant (g)

The average weight of grains produced by main stem in addition to that of tillers from a sample of ten randomly selected plants was determined.

Grain yield (t/ha)

It was estimated after air drying and then threshing the bulk harvested heads from each plot using the formula

$$\text{Grains yield (t/ha)} = \text{Grain weight (g/plot)} \times 10^4 \div (\text{plot area (m)} \times 10^6)$$

Statistical analysis

The data obtained from the trials were analyzed statistically using sigma stat program to get ANOVA table and to detect the differences between means.

RESULTS AND DISCUSSION

Plant height

Table 3: Effect of chicken manure and Tillage on plant height (cm) of Sorghum grown for two seasons in two locations.

treatments	ELAinELsafia		Hay ELsika	
	2007/08	2008/09	2007/08	2008/09
D ₀ M ₀	52.20	46.29	21.37	45.45
D ₀ M ₄	56.42	83.90	37.76	56.42
D ₀ M ₈	107.30	122.18	50.89	104.10
D ₀ M ₁₂	107.10	102.89	54.98	86.10
D ₁₅ M ₀	67.33	86.05	28.403	60.70
D ₁₅ M ₄	101.20	71.14	32.00	101.20
D ₁₅ M ₈	112.65	135.31	78.70	107.30
D ₁₅ M ₁₂	102.86	152.09	81.30	107.10
D ₃₀ M ₀	44.09	74.51	33.53	83.54
D ₃₀ M ₄	99.00	101.2	39.02	99.00
D ₃₀ M ₈	104.1	78.40	65.52	112.65
D ₃₀ M ₁₂	86.00	161.54	78.40	102.86

Key:

D₀= no tillage, D₁₅= tillage at 15cm depth, D₃₀= tillage at 30cm depth

M₀= no manure application, M₄= 4t/ha manure application, M₈= 8t/ha manure application, M₁₂= 12t/ha manure application.

The results of plant height are shown in Table 3. Interaction between treatments significantly increased the plant height (cm). plants tend to be taller in early sowing and

this was attributed to the effect of day length of flowering [1,10].Tillage treatment gave higher plant heights than control [10,11].This is attributed to the increased of the interaction rate .The effect of treatment on plant height showed (112.65,135.21,7870 and 107.30cm)at season1 and seasons 11, local 1and and local2 respectively. Similar results were obtained by [10]. Chicken manure application at 8 & 12t\ha dose and zero tillage increased the plant height of 107cm.This may be attributed to the fact that chicken manure application improved the water holding capacity of soils [5,3]. Significantly increased the plant height per plant by 30%, 63.2% and 2.42%whereas tillage treatment styling 35.1% and 8.85% respectively

Stem diameter (cm)

Table 4, show the effect of chicken manure and Tillage on stem diameter. The stem diameter was significantly increased the stem diameter per plant by 1.53, 1.8 and 1.83 and 1.8 whereas tillage treatment styling Interaction treatments showed the largest diameter. These results similar to the finding of [10,2]. on comparing the mean stem diameter of two locations, it was observed that local₁ was larger than local₂. This may be attributed to higher amount of rains in that area.

Table 4: Effect of chicken manure and Tillage on stem diameter (cm) of Sorghum grown for two seasons at two locations.

Local1	ELainELSafia		Hay ELSika	
treatments	2007/08	2008/09	2007/08	2008/09
D ₀ M ₄	1.60	1.25	1.88	1.43
D ₀ M ₈	1.48	1.30	1.28	1.30
D ₀ M ₁₂	1.11	1.26	1.30	1.26
D ₁₅ M ₀	1.09	1.35	1.33	1.35
D ₁₅ M ₄	1.63	1.28	1.60	1.28
D ₁₅ M ₈	1.53	1.80	1.83	1.80
D ₁₅ M ₁₂	1.59	1.29	1.80	1.29
D ₃₀ M ₀	1.13	1.18	1.25	1.13
D ₃₀ M ₄	1.35	1.43	1.40	1.25
D ₃₀ M ₈	1.53	1.48	1.90	1.48
D ₃₀ M ₁₂	1.43	1.84	1.45	1.84

Key:

D₀= no tillage, D₁₅= tillage at 15cm depth, D₃₀= tillage at 30cm depth

M₀ = no manure application, M₄= 4t/ha manure application, M₈= 8t/ha manure application, M₁₂= 12t/ha manure application

Flowering

Table 5, show the effect of chicken manure and Tillage on days to 50% flowering. Highly significant differences were detected among the two locations for this character in both seasons. The result showed slightly similar percent in that finding by [1]. The higher 50% flowering (day) was observed at the treatment of zero tillage and zero chicken manure application. This is may be attributed to the water stress that suspected to the plants.

Table 5: Effect of chicken manure and Tillage on 50% flowering (day) of Sorghum grown for two seasons in two Locations.

treatments	ELAiNELsafia		Hay ELSika	
	2007/08	2008/09	2007/08	2008/09
D ₀ M ₀	64.00	69.00	83.00	77.50
D ₀ M ₄	50.00	62.25	70.25	50.00
D ₀ M ₈	36.75	67.25	67.25	36.75
D ₀ M ₁₂	48.00	45.00	39.50	48.00
D ₁₅ M ₀	53.00	66.250	70.00	62.8
D ₁₅ M ₄	39.00	59.50	61.25	44.25
D ₁₅ M ₈	53.50	40.00	40.00	42.50
D ₁₅ M ₁₂	49.00	56.00	45.00	44.50
D ₃₀ M ₀	63.00	66.00	67.75	66.8
D ₃₀ M ₄	44.25	56.00	46.50	39.00
D ₃₀ M ₈	42.50	48.00	48.00	53.50
D ₃₀ M ₁₂	44.50	72.75	72.75	49.00

Key:

D₀= no tillage, D₁₅= tillage at 15cm depth, D₃₀= tillage at 30cm depth

M₀ = no manure application, M₄= 4t/ha manure application, M₈= 8t/ha manure application, M₁₂= 12t/ha manure application

Panicle weight

Table 6 show the effect of chicken manure and Tillage on head weight (g). The maximum weight of heads at the plants reached the physiological maturity were obtained at tillage depth of 30cm and by used chicken manure 12t/ha. This is supported by [12]. Also [13]. reported that the grain yield was positively and significantly correlated with head weight, this result confirmed the results found by [10].

Table 6: Effect of chicken manure and Tillage on panicle weight (g) of Sorghum grown for two seasons in two Locations.

treatments	ELAiNELsafia		Hay ELSika	
	2007/08	2008/09	2007/08	2008/09
D ₀ M ₀	10.00	11.30	5.25	14.2 3
D ₀ M ₄	15.00	12.75	6.50	15.00
D ₀ M ₈	20.53	20.50	11.35	23.00
D ₀ M ₁₂	18.25	14.25	13.50	22.25
D ₁₅ M ₀	13.50	22.75	7.50	18.50
D ₁₅ M ₄	26.50	26.80	12.90	27.90
D ₁₅ M ₈	29.50	42.75	15.75	35.50
D ₁₅ M ₁₂	25.50	25.00	20.75	39.50
D ₃₀ M ₀	12.75	13.50	6.25	19.73
D ₃₀ M ₄	20.00	14.00	10.00	25.23
D ₃₀ M ₈	22.80	16.00	13.75	32.33
D ₃₀ M ₁₂	20.75	17.75	19.75	18.00

Key:

D₀= no tillage, D₁₅= tillage at 15cm depth, D₃₀= tillage at 30cm depth

M₀ = no manure application, M₄= 4t/ha manure application, M₈= 8t/ha manure application, M₁₂= 12t/ha manure application

100-seed weight (g)

Table 7 show the effect of chicken manure and Tillage on 100 seed (g). All application of treatments showed non –significant difference among the treatment at all location and in all seasons.[8]. and [3].

Table 7: Effect of chicken manure and Tillage on 100 seed (g) of Sorghum grown for two seasons in two Locations.

Treatments	ELAinELSafia		Hay ELSika	
	2007/08	2008/09	2007/08	2008/09
D ₀ M ₀	20.19	23.45	12.12	18.15
D ₀ M ₄	22.41	30.65	14.18	22.41
D ₀ M ₈	25.70	39.89	22.78	28.09
D ₀ M ₁₂	20.74	31.95	22.40	27.81
D ₁₅ M ₀	25.19	29.40	15.13	20.60
D ₁₅ M ₄	35.00	35.20	25.70	26.81
D ₁₅ M ₈	39.81	45.69	39.60	35.69
D ₁₅ M ₁₂	35.81	35.60	35.00	32.74
D ₃₀ M ₀	22.19	25.00	13.91	19.21
D ₃₀ M ₄	24.81	33.00	22.44	24.45
D ₃₀ M ₈	35.98	43.68	38.15	33.89
D ₃₀ M ₁₂	30.81	33.40	33.60	30.72

Key:

D₀= no tillage, D₁₅= tillage at 15cm depth, D₃₀= tillage at 30cm depth

M₀ = no manure application, M₄= 4t/ha manure application, M₈= 8t/ha manure application, M₁₂= 12t/ha manure application

Grain yield

Table 8: Effect of chicken manure and Tillage on Yield (kg \ ha) of Sorghum grown for two seasons in tow Locations.

treatments	ELAinELSafia		Hay ELSika	
	2007/08	2008/09	2007/08	2008/09
D ₀ M ₀	100.20	145.80	99.16	113.38
D ₀ M ₄	110.70	148.99	116.60	122.19
D ₀ M ₈	150.20	180.15	119.90	145.82
D ₀ M ₁₂	135.70	165.62	115.77	130.57
D ₁₅ M ₀	195.50	180.80	121.66	118.22
D ₁₅ M ₄	291.00	190.80	133.33	135.53
D ₁₅ M ₈	269.99	226.20	165.83	159.38
D ₁₅ M ₁₂	230.70	213.70	139.82	140.99
D ₃₀ M ₀	159.00	150.90	111.60	120.82
D ₃₀ M ₄	111.64	188.33	120.80	143.2 0
D ₃₀ M ₈	250.67	219.15	155.78	158. 89
D ₃₀ M ₁₂	199.87	192.70	145.98	135.2 9

Table 8 show the effect of chicken manure and tillage on yield (kg \ ha) Grain yield at two locations in both seasons, showed significant difference. The average of grain yield was greater due to higher number of grain per head and increased yield of sorghum. The similar

results, were reported by [1,2] and [14]. The treatment, increased the sorghum grain yield compared with the control [15].

As shown in the results revealed a highly significant difference between treatments in affecting sorghum yield by range of 269.99, 226.20, 165.83 and 159.38 ton/ha. This might be attributed to the improved soil physical condition obtained by manure and tillage. This result was in agreement with the findings of [16]; [17],[18],[15] and [11].

CONCLUSIONS

Chisel plough and chicken application has positively enhanced the growth and yield of sorghum (arffaagadamuk) in Hard, Non-Cracking Sandy Clay (Gardud) soil. The highest results of yield and yield components were associated with the additions of 8t/ha chicken manure and at tillage depth of 15cm

Chicken manure and chisel ploughing were recommended to maximize the yield of sorghum in the Hard, Non-Cracking Sandy Clay (Gardud) soil of Sudan. Further research on dose of chicken manure and depth of tillage are important to achieve good results

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