Journal of Novel Applied Sciences
Available online at www.jnasci.org
©2012 JNAS Journal-2012-1-3/68-73
ISSN 0000-0000 ©2012 JNAS

Effect of Tillage Depth and Pattern on Growth and Yield of Grain Sorghum (*Sorghum bicolor* L. Moench) under Rain-fed

Ahmed M. E l Naim [*], Mkarem A. M. Baldu and Moayad M.B. Zaied

Department of Crop Sciences, Faculty of Natural Resources and Environmental Studies, University of Kordofan, Elobeid, Sudan

Corresponding author Email : naim17amn@yahoo.com

ABSTRACT: A field experiment was carried out under rainy season (2010/11),at two locations (Khorelabeid and Kaba) in Sheikan locality, North Kordofan State, Sudan to investigate the effects of the tillage on growth and yield of grain sorghum(*Sorghum bicolor* L.Moench).The tillage practices treatments consist of no tillage,tillage at depth 15 and 25 cm and two tillage patterns namely:headland and continuous patterns,using chisel plough.Treatments were randomly arranged in a randomized complete block design (RBCD) with three replications. The results showed that tillage treatments had significant effect on most of the parameters measured in this study.In this respect, it was observed that increased tillage depth increased plant height, length of internode.Length of flag leaf, panicle length, number of seeds per panicle,panicle seed weight, grain yield (Kg/ha) and harvest index.The tillage depth of 25cm with head land pattern had the highest number of grains per panicle, panicle grain weight and grain yield (t/ha), while the no tillage treatment had a lesser grain yield and yield s components.

***Keywords*:** Chisel plough, Food crop, Tillage depth, Tillage pattern.

INTRODUCTION

Grain Sorghum (*Sorghum bicolor* L. Moench) is the main staple food crop of a large section of population in Sudan. 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 (El Naim *et al.,* 2012). 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. 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 sorghum is very important for optimum productivity.A good soil management protects the soil from water and wind erosion, destroys hardpans or compacted layers that may limit root development. 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. Sandy clay soils locally known as gardud are less arable despite their better production potential than other infertile and exhausted sand soil in western Sudan due to surface physical constraints such as low infiltration and workability. The scarcity of water resources is one of the main challenges in the world and it is considering as a limiting factor for economic development especially for agriculture. Also, the demand on water resources is increasing with time for both agriculture and non-agricultural purposes. The climate of Kordofan is generally arid and semi-arid, with more than 90% of the total area receiving

less than 200 mm rainfall per year (Raddad, 2005). In addition, the pattern of rainfall is characterized by uneven distribution over various regions and there is a strong fluctuation from year to year in terms of quantity and timing. Information is needed in selecting appropriate tillage practice and pattern 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 two pattern methods on growth and yield of grain sorghum.

MATERIALS AND METHODS

Site of experiment

A field experiment was conducted during season (2010/11) under rain fed, at two locations in North Kordofan State, latitude (11˚ 15 and 16˚ 30 N) and longitude (27˚ and 32˚ E). The first location is Khorelbeid Farm and the second location Kaba (about 15kms south Elobied). Which it is characterized as semiarid, with rainy and hot dry summer with annual mean rainfall of 300 mm, as most of it occurs from July to October. The soil used was sandy clay (gardod) with the following characteristics: pH 7.78, electrical conductivity (EC) 1.28 ds/m, organic matter 1.63% (El Naim and Ahmed, 2010).

Experiment layout

The Tillage practices treatments consist of no tillage, tillage at depth 15 and 25 cm and two tillage pattern (Head and Continuous) with the help of traditional (disc harrow plough).Treatments were randomly distributed in a randomized complete block design (RCBD) with three replications. Each plot consisted of 6 rows of 10 m length. Inter- and intra- row spacing was 80 cm x 60 cm. The experimental beds were manually prepared with traditional hoes.

Sowing

Sowing was done in the first location (Elkhor Elabiad) on July, 19th and on 22nd of July, 2010 in the second location (Kaba). Seeds were sown in holes at spacing of 60×80 cm. Five seeds were placed in each hole. Seedlings were thinned to two plants per hole, two weeks later.

Characters Studied

Growth attributes

In each plot, four plants were selected at random from the middle row to measure the following characters:

1- Plant height (cm): measured from soil surface to the tip of the main head, just before harvesting.
2- Stem diameter (cm): measured by using a vernier (caliper) at the third node.
3- Length of internode (cm)
4- Number of leaves per plant
5- Length of flag leaf (cm)

Yield attributes

1- Panicle length (cm): Mean length of the panicle measured on a sample of four head measured from the base to the tip of the head.
2- Panicle width (cm): Mean width of the panicle measured on a sample of four head measured at maximum width of the panicle.
3- Number of grains per panicle:
4- 100- seeds weight (g): 100 seeds will be counted (four times) from each sample and weighed.
5- Grain yield per plant (g)
6- Grain yield (kg/ha) heads from each plot were harvested, sun dried, threshed, weighed and converted to kg/ha

$$\text{Grain Yield (t/ha)} = \frac{\text{grain weight (ton) of 7 plants X 10000(m2)}}{\text{Harvested plot area (m2)}}$$

Statistical Analysis

Data were analyzed statistically using analysis of variance according to Gomez and Gomez (1984) procedure for a randomized complete block design and the computer package MSTAT-C. . The differences of means were identified by Duncan's Multiple Range Test (DMRT) at $P \geq 0.05$.

RESULTS AND DISCUSSION

Vegetative Growth Attributes

Table 1 shows the effect of tillage depth and pattern on plant height and stem diameter and length of inter-node of sorghum. Tillage treatments had significant effect on the most growth attributes measured: plant height, stem diameter, length of internode, number of leaves per plant and length of flag leaf (the results of the number of leaves per plant and length of flag leaves are shown in Table 2).These parameters increased with increased tillage depth. Tillage depth of 25 cm was superior in stem diameter.

The results showed that the 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 (T 25cm H) had an effective impact on the growth of plants, especially plant height (Abdalla, 2006). This results in agree of results obtained by Abdalla (2006). 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 photosynthetic produced. Deep tillage resulted in positive results in the number of nodes per plant in the two sites, has been found that there is a direct relationship between the number of nodes and productivity. This is might be due to the an increase in plant available water capacity of the soil under different tillage treatments and due to the breaking down of larger soil particle aggregates to smaller ones, it is difficult for water to drain out of the soils because of the greater force of adhesion between the micropores and soil water. However decrease the total porosity and to increase the percentage of smaller pores as some of the originally larger pores have been squeezed into smaller ones by compaction (Hamdeh, 2004). Lal (1983) found that tillage optimized the soil and environmental conditions for germination, seedling establishment and crop growth.

Ohiri and Ezumah (1991) found that tillage operations loosen, granulate, crush or compact soil structure, changing soil properties such as bulk density, pore size distribution and composition of the soil atmosphere that affect plant growth. Mohammed et al. (2011a) study the effect of three tillage depth (0,15 and 25cm) on vegetative growth of grain sorhum in gardoud soil of North Kordofan. They found that Tillage depth (15 cm) was highest in stem diameter, number of nodes per plant and plant density. Mohammed et al. (2011b) found that tillage depth of 15cm was effective and recommended to improved vegetative growth and productivity of grain sorghum.

Aikins and Afuakwa (2010) found that no tillage treatment produced the shortest plant, smallest stem girth and smallest number of leaves. Conventional tillage practices modify soil structure by changing its physical properties such as soil bulk density, soil penetration resistance and soil moisture content (Rashidi and Keshavarzpour, 2008). This difference results in change number, shape, continuity and size distribution of the pores network, which controls the ability of soil to store and transmit air, water and agricultural chemicals. This also improves porosity and water holding capacity of the soil. This all leads to a favorable environment for crop growth and nutrient use (Khan et al., 2001; Khurshid et al., 2006).

Table 1. Effect of Tillage depth and pattern on plant height and stem Diameter and length of inter-node of sorghum

	Location 1			Location 11		
Treatments	Plant height (cm)	Stem diameter (cm)	Length of internode (cm)	Plant height (cm)	Stem diameter (cm)	Length of internode (cm)
T_0	62.8^{d}	0.4^{a}	11.80^{c}	110.1^{c}	0.4^{a}	22.10^{a}
T_{15} H	91.2^{c}	0.4^{a}	12.70^{c}	125..1^{a}	0.6^{a}	16.63^{b}
T_{15} C	106.5^{b}	0.5^{a}	14.78^{b}	121.8^{a}	0.5^{a}	18.80^{b}
T_{25} H	110.3^{a}	0.4^{a}	16.78^{a}	107.0^{c}	0.6^{a}	15.78^{b}
T_{25} C	107.1^{b}	0.5^{a}	14.20^{b}	114.8^{b}	0.5^{a}	17.10^{b}
LSD	5	5	5	2.5	5	5
S ±	3.30	0.015	0.53	4.93	0.02	0.80
C. V. %	5.95	6.02	6.60	7.37	7.18	7.55

Similar letters are not significant different at the 0.05 level of probability according to Duncan Multiple Range Test.

Table 2. Effect of Tillage depth and pattern on number of leaves per plant and flag leaf length (cm) of sorghum

	Location 1		Location 11	
Treatments	Number 0f leaves	Flag leaf length (cm)	Number 0f leaves	Flag leaf length (cm)
T0	7.63	31.17c	6.40	19.63e
T15 H	8.37	27.80e	8.18	27.93c
T15 C	8.20	33.47b	8.67	29.70b
T25 H	8.60	35.48a	8.00	32.60a
T25 C	8.27	24.50e	8.78	31.60a
LSD	1.3	2.5	0.95	2.5
S ±	0.24	1.25	0.44	1.26
C. V. %	5.01	7.11	9.46	7.72

Similar letters are not significant different at the 0.05 level of probability according to Duncan Multiple Range Test.

Yield attributes

The results of seed yield and yields components are shown in Tables 3, 4 and 5. The tillage depth (25cm) with headland operation (T25H) had a highest numbers of seeds per panicle in two locations, while treatment T0 (no tillage) had a lesser number of seeds per panicle. The results indicated that 100 seed weight had no significant different among treatments in both locations. Generally the tillage improved seed weight per panicle in the two locations, however the T25 H treatment had a highest seeds weight per panicle. This is because the T25 H treatment had a highest number of seeds per panicle compared to others. Mohammed et al. (2011b) found that the tillage depth, 15 cm 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 (25cm) 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. Mohammed et al. (2011b) found that tillage depth of 15cm was effective and recommended to improved vegetative growth and productivity of grain sorghum. Tillage depth (15 cm) was highest in number of panicles/m2, number of grains per panicle and final grain yield (t/ha).

Agbede et al. (2008) concludes that zero tillage was most suitable for sorghum in the forest-savanna transition zone. Mechanized tillage reduced growth and nutrient uptake and yield of sorghum. The advocacy of zero tillage is consistent with the need to reduce soil manipulation and attendant degradation of soil. Mohammed (2010) suggested that crop productivity and water use efficiency (WUE) in the rain-fed environment can be improved with minimum tillage and crop residues retention.

Table 3. Effect of Tillage depth and pattern on panicle length (cm) and panicle width (cm) of sorghum

	Location 1		Location 11	
Treatments	Panicle length (cm)	Panicle width (cm)	Panicle length (cm)	Panicle width (cm)
T0	16.00	2.77	13.80	3.07
T15 H	10.90	2.87	13.70	4.30
T15 C	11.70	4.60	14.20	4.00
T25 H	12.50	4.53	14.77	4.30
T25 C	13.23	2.67	14.40	3.83
LSD	5	5	-	-
S ±	0.28	0.21	0.76	0.35
C. V. %	4.02	10.61	9.31	15.66

Similar letters are not significant different at the 0.05 level of probability according to Duncan Multiple Range Test.

Table 4. Effect of Tillage depth and pattern on number of seeds per panicle, and seed weight per panicle (g) of sorghum

	Location 1		Location 11	
Treatments	No. of seeds per panicle	Seed weight per panicle	No. of seeds per panicle	Seed weight per panicle
T0	257.50	5.27	480.00	13.27
T15 H	166.27	7.77	760.67	18.47
T15 C	550.90	16.27	677.50	20.80
T25 H	1075.40	30.80	833.77	19.80
T25 C	376.50	7.17	687.5	17.60
LSD	5	5	-	-
S ±	53.90	2.26	85.99	2.03
C. V. %	19.24	29.05	21.63	19.55

Similar letters are not significant different at the 0.05 level of probability according to Duncan Multiple Range Test.

Table 5. Effect of Tillage depth and pattern on grain yield (t/ha) and 100- seed weight of sorghum

	Location 1		Location 11	
Treatments	Grain yield (t/ha)	100- seed weight (g)	Grain yield (t/ha)	100- seed weight(g)
T0	0.84	1.60	2.12	2.70
T15 H	1.24	2.00	2.96	2.40
T15 C	2.60	2.60	3.33	2.50
T25 H	4.93	2.63	3.17	2.57
T25 C	1.15	2.03	2.82	2.23
LSD	5	-	-	-
S ±	0.03	0.23	0.46	0.16
C. V. %	14.71	18.03	63.90	11.42

Similar letters are not significant different at the 0.05 level of probability according to Duncan Multiple Range Test.

CONCULSION

Based on the results of this study, chisel plough at depth of 25cm with headland operation had the highest grain yield and yields components and preferred to maximized the productivity of grain sorghum in gardoud soil like Khorelabeid and Kaba areas in North Kordofan of Sudan.

REFERENCES

Abdalla, A. N. 2006. Effect of Tillage on soil Moisture storge of three Gardoud soils of North Kordofan State, Sudan. Ph.D Thesis, University of Kordofan, Elobied, Sudan.

Agabawi, K.A. 1975. Agriculture in Sudan. Sudan Agriculture Rural Development Projects Course. World Bank/Sudan Ministry of Finance, Khartoum.

Agbede, T.M. Ojeniyi S.O and. Awodun, M.A 2008 Effect ofTillage Method on Growth, Grain Yield and.NutrientContent of Sorghum (Sorghum bicolor L.) in ForestSavanna transition Zone of Nigeria, Int. J. Sustain. CropProd., 3(5): 35-39.

Aikins, S.H.M. and Afuakwa, J.J. 2010. Effect of Four Different Tillage Practices on Cowpea Performance. WorldJournal of Agricultural Sciences, 6 (6): 644-651.

EAR. S. 1999. Agro- biodiversity in Kordofan Rigron. SpecialAssignine Report of multiciplinary team from ElobeidAgricutural Research Station (EARS) submitted to theRANC National Biodiversity Action Plan,SUD (97) G31(HCFENRS), Khartoum.

El Naim, A M; Ahmed, S E (2010). Effect of Weeding Frequencies on Growth and Yield of Two Roselle (Hibiscus sabdariffa L) Varieties under Rain-fed. Australian Journal of Basic and Applied Sciences, 4(9): 4250-4255.

El Naim, A M; Ibrahim, I M; Abdel Rahman, M E; Ibrahim E A (2012). Evaluation of Some Local Sorghum (Sorghum Bicolor L.Moench) Genotypes in Rain-fed. International Journal of Plant Research. 2(1): 15-20

Gomez, K.A. and A.A. Gomez, 1984. Randomized complete block design analysis. In: Statistical procedures for agricultural research. John Willey and Sons, NewYork

Hamdeh- Abum N. H.2004. The effect of tillage treatments on soil water holding capacity and on soil physical condition In: 13th International Soil Conservation Organisation Conference –Brisbane, July 2004 Conserving Soil and Water for Society: Sharing Solutions.

ICRISAT. 1986. International Crop Research Institue for theSemi-Ard Tropics. Annual Report.

Khan F.U.H., Tahir A.R. and Yule I.J. 2001. Intrinsic implication of different tillage practices on soil penetration resistance and crop growth. Int. J. Agri. Biol. 3: 23-26.

Lal, R. 1983. No-till farming: Soil and water conservation and management in the humid and sub-humid tropics. IITA Monograph No. 2, Ibadan, Nigeria.

Mohamed, E. ;El Naim, A. M.; Ebeadallah, B. E. and Khalid A. Ibrahim, K. A. (2011a). Effect of tillage and farm yard manure ion vegetative growth indices of grain sorghum under rainfed. International Journal of Current Research. 3 (6): 393-397

Mohamed, E. ;El Naim, A. M.; Ebeadallah, B. E. and Khalid A. Ibrahim, K. A. (2011b). Effect of tillage and farm yard manure in yield and yield components of sorghum under rainfed. International Journal of Current Research. 3 (6): 389-392

Mosaddeghi, M.R., A.A. Mahboubi and A. Safadoust, 2009. Short-term effects of tillage and manure on some soil physical properties and maize root growth in a sandy loam soil in western Iran, Soil and Tillage Research, 104: 173- 179.

Licht, M.A. and. Al-Kaisi, M., 2005. Strip-tillage effect onseedbed soil temperature and other soil physicalproperties,Soil and Tillage Research, 80: 233-249

Ohiri, A.C. and Ezumah, A.C. (1991). Tillage effects on cassava production and some soil properties. Soil and Tillage Research 17: 221 – 231.

Olaoye, J.O., 2002. Influence of tillage on crop residue cover,soil properties and yield components of cowpea in derived savannah ectones of Nigeria, Soil and Tillage Research, 64(3-4): 179-187.

Raddad, K., 2005. Water Supply and Water Use Statistics in Jordan, pp:20–22. IWG-Env, International Work Session on Water Statistics, Vienna

Rashidi, M. and Keshavrzpour, F. 2007. Effect of DifferentTillage Methods on Grain Yield and Yield Components ofMaize (Zea mays L.). Intl. J. Agric. Biol., 9(2): 274- 277

Rashidi, M. and F. Keshavarzpour, 2008. Effect of different tillage methods on soil physical properties and crop yield of Melon (Cucumis melo).American-Eurasian J. Agric. & Enviorn. Sci. 3(1):43-48

Srivastava, A.K., Goering, C.ERohrbach R.P. and Buckmaster,D.R 2006. Engineering Principles of AgriculturalMachines, (2nd edn), American Society of Agricultural andBiological Engineers, Michigan.