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Effect of different Tillage Practices on sugar beet production in heavy clay soil

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Abstract: *One of the main reasons, limiting the sugar beet production in Sudan is inappropriate use of tillage and planting equipments in the farmer's field. The current study was carried out to evaluate the effects of different tillage practices on growth and yield of sugar beet at farmer's field at the Guneid Sugar Cane Research Center, Gezira state-Sudan during October 2013 – April 2014 and repeated in October 2014- April 2015 to evaluate the effect of different tillage practices on the growth and yield of sugar beet. Randomize complete block design with four treatments and three replications were used in the study. The treatments T1: Moldboard plow plus disk harrow plus ridging (MDHR); T2: Disk plow plus disk harrow plus ridging (DDHR); T3: Chisel plow plus disk harrow plus ridging (CDHR); T4: Two passes of disk harrowing plus ridging (TDHR) were applied. The results showed that, maximum germination percentage (67.3%) and (63.7%) were obtained, when T1 (MDHR) and T2 (DDHR) were used, while minimum germination rate (56.7%) was recorded when T4 (TDHR) was used. Maximum Plant population, crop yield and Sugar production from sugar beet (26157, 29.2 ton/fedd and 4.4 ton/fedd respectively) were recorded in T2 (DDHR).*

Keywords: sugar beet, tillage practices, root yield, sucrose percent and sugar production

INTRODUCTION

Low crop productivity is one of the major problems that are facing agricultural production in the Sudan. Low crop productivity in addition to high production costs, low prices and high taxes had all resulted in a general deterioration of the agricultural sector. This has contributed in converting agriculture from an attractive business to a repellent activity and caused many farmers to abandon agriculture and migrate to cities. The agricultural sector in the Sudan contributes to about 48% of the Gross Domestic Production (GDP) and to about 93% of the foreign currency earnings (Ministry of Finance and National Economy, 1996). It also employs about 65% of the labor force.

Sugar beet (*Beta vulgaris*) is one of the most important sugar production crops (Abdel-Motagally and Attia, 2009). It is a hardy biennial plant whose root contains a high concentration of sucrose (15-20 %). It is grown commercially for sugar production in a wide variety of temperate climates. Sugar beet accounts for 30% of the world's sugar production. During its first growing season, it produces a large (1-2 kg) storage root whose dry mass is 15-20 % sucrose by weight. In commercial sugar beet production, the root is harvested after the first growing season. In most temperate climates, sugar beet is planted in the spring and harvested in autumn (Draycott 2006). Although, for most situations conventional tillage has been the main tillage method for establishing sugar beet, but since the first part of the 20th century (Ecclestone, 2004), the costs, as well as the environmental concerns have led farmers and researchers to adopt alternative tillage methods and a considerable attention and emphasis on the shift to the conservation tillage methods, *i.e*., reduced tillage, minimum tillage and no-tillage methods (Iqbal *et al*. 2005; Rashidi *et al*. 2009). Conservation tillage methods may reduce yield of sugar beet (Draycott 2006). Shahram *et al.* (2012) studied the effect of different tillage methods on yield and quality of sugar beet. No significant differences were found in root yield, sugar content, alpha-amino nitrogen and molasses. In a recent study, Alamouti and Navabzadeh (2007) reported that deep tillage had the greatest effect on soil bulk density, organic carbon, infiltration rate, and crop yield compared to semi deep and shallow tillage systems. Sugar beet can be cultivated under any irrigation system. Worldwide, the most prevalent irrigation system is gravity-fed furrow irrigation. However, others showed an improvement in yield and efficiency with the smaller amounts of water that can be applied using drip irrigation (Sharmasarkar *et al*. 2001; Tognetti *et al*. 2003). The first trials of sugar beet in Sudan were conducted in nineteen thirties at Gezira Research Station. Some work was carried out by EL-Karouri and EL- Rayh (2006) at Um Dom during 1994/95-1996/97 seasons, sponsored by Arab Authority for Agricultural Investment and Development (AAAID), to investigate the production of some sugar beet genotypes.

One of the main reasons, limiting the sugar beet production in Sudan is inappropriate use of tillage and planting equipments in the farmer's field. Tillage implements which are being used in the field had various effects on crop yield (Ahmad et al., 1990; Rehman et al., 1995; Usman et al., 2010). Crop yield and production can be increased by use of proper tillage operations (Memon et al., 2013) Therefore, the main objective of this study was to determine the effect of some soil tillage practices on growth and yield of sugar beet at the central clay plain of Gezira State. The specific objectives, through which the main objective is to be achieved, are the following: some crop performance parameters such as root thickness, crop root yield, and sucrose percent (pol %), and sugar production.

MATERIALS AND METHODS

Experimental Site, Design and Treatment Applications

This study was conducted at farmer's field in at the Guneid Sugar Cane Research Center which located 117 km south of Khartoum, on 14o30′N Latitude, 33o15′E Longitude at the eastern bank of the Blue Nile, during October 2013 – April 2014 and repeated in October 2014- April 2015 to evaluate the effect of different tillage systems on the growth and yield of sugar beet (Fig. 1). The soil analysis showed that the soil at the site was heavy clay, clay 45%, sand 28% and silt 27%.. The water requirement of the crop during the research was fulfilled by canal water from the main canals of the scheme. A randomize complete block design (RCBD) with four treatments and four replications was used in this study resulting in a total of 16 plots. The treatments were designed as follows:
T1 = Moldboard plow plus disk harrow plus ridging (MDHR),
T2 = Disk plow plus disk harrow plus ridging (DDHR),
T3 = Chisel plow plus disk harrow plus ridging CDHR),
T4 = Two passes of disk harrowing plus ridging (TDHR).
The net plot size was 350 m^2 (7 × 50) for each treatment. The plots were separated by a distance of 5m and seven meters between replications and by distance of 10 m at the end of two sub plots for the tractor turning. Each plot had buffer areas at two ends for tractor acceleration and deceleration to ensure the tractor travelled at a specified constant speed within the plot. The speeds of ploughing were determined using the tractor hand throttle and constant gear ratio (monitored on the tractor's dash board). The land was prepared by the main tillage treatments (moldboard plow, disc plow, chisel plow and disc harrow) before three weeks from planting for every replication, then the land was harrowed by the disc harrow before one week from planting and also furrowed by ridger at the same time of planting. After the soil was prepared the crop was sown in rows on October in both years using a pneumatic planter with four units which was calibrated and used for planting the other 16 sub subplots to plant the seed 75 cm between rows and 15 cm between plants. Lenard, monogerm seed type was used for cultivating the experiment field.
The quantity and variety of seed, fertilizer, measures for the protection of plants, quantity of irrigation water, harvesting and threshing methods were same for all treatments.

Measurements

Plant germination percentage

The plant germination ratio was determined for the tillage treatments by the following equation:

$$Germination\ ratio\% = \frac{Number\ of\ \ germinated\ seeds}{Number\ of\ actual\ seeds\ per\ row} \times 100$$

Root thickness

The tab meter was used to measure the thickness of the tuber at harvest. It was measured by putting the measuring tab around the middle of the tuber and measuring the root thickness. Five plants per sub subplot were selected randomly and measured from harvested rows and then the average was taken.

Plant population

At harvest, the number of tubers was counted for an area of 7.5 m^2 (area of one row). The number of tubers per hectare was determined by the following equation:

$$\text{Number of tubers per hectare } = \frac{10000\ \times\ \text{ number of tubers counted per area}}{7.5\ \text{m}^2}$$

Where:

7.5 = Area of one row (m^2).

10000 = Area of hectare (m^2).

Crop yield (tuber and leaf)

A spring balance was used to determine the weight of the sugar beet tuber and the weight of the leaves at the end of the season by harvesting one row 7.5 m^2 from each treatment. The leaves were separated from tuber and weighted. The weight of the sugar beet tubers and the weight of the leaves were determined by the following equations:

$$\text{Sugar beet ton per hectare} = \frac{10000 \times \text{ yield of one row kg}}{7.5 \times 1000}$$

$$\text{Leaves weight in ton per hectare} = \frac{10000 \times \text{ yield of one row kg}}{7.5 \times 1000}$$

Where:

7.5 = Area of one row (m^2).

10000 = Area of hectare (m^2).

Sugar Beet chemicals analysis

Before beet was harvested, 5 tubers were selected randomly from each sub subplot and then topped, cleaned from soil, crushed and sliced fine enough and samples were taken to determine the sugar beet chemical components.

Sucrose percent in beet (Pol%) analysis

The polarization or sugar content was determined by taking twenty six mg of sliced beet + reagents (174 cm3 lead acetate), mixed in a blender and filtered. 200 ml of the extract was read in a Saccharimeter following (ICUMSA, 1994).

Estimated recovery sugar (ERS%) analysis

The sugar beet estimated recovery sugar (ERS%) was determined by following equation:

$$\text{ERS \%} = \text{Pol\%} - 2.5$$

Where:

2.5 = Expected losses of sugar content through production.

Sugar production from sugar beet

The sugar production from sugar beet ton sugar per feddan was determined by the following equation:

$$\text{Sugar ton per Feddan} = \frac{\text{ERS\%} \times \text{ Yield of sugar beet per Feddan kg}}{1000}$$

Statistical analysis

Statistical analysis was accomplished by Statstix 8. Analysis of variance (ANOVA) was used to evaluate the significance of each treatment on all parameter under this study in a randomized complete block design with 4replications.Comparison of means was performed with Duncan’s multiple range tests

RESULTS AND DISCUSSION

In order to determine the effect of different tillage practices on Plant germination percentage, Root thickness, Plant population or number of Tubbers, Sugar beet Crop yield, Sucrose percent in beet (Pol), Sugar production from sugar beet, the variance analysis are given in Table 1.

Table 1: Statistical description of variation for all observed parameters affected by different tillage practices (average of two seasons):

Observed Parameters	M. S	P. value	Std. Error	CV %
Plant germination percentage	66.1475	0.0049	1.3034	3.67
Root thickness (cm)	9.00750	0.0596	0.8307	3.99
Plant population (No. of Tubbers)	7572927	0.0000	43.849	0.31
Sugar beet Crop yield (Ton/fed.)	32.3433	0.0034	0.8490	5.82
Sucrose percent in beet (Pol%)	2.81000	0.0156	0.3399	3.24
Sugar production from sugar beet (Ton/fed.)	0.97556	0.0142	0.1963	8.72
Effective field capacity (fed/hr)				

Fuel consumption (Lit/fed.)

Effect of Different tillage practices on germination ratio (%):

In order to determine the effect of different tillage practices on plant germination percentage the variance analysis are given in Table 1. A statistically highly significant difference ($P<0.05$) was observed in plant germination percentage between different tillage practices (Table 1).

Figure 2 indicates the effect of different tillage practices on germination percentage (when averaged over two seasons) at experiment site. It is clear that the MDHR (T1) recorded maximum GR percentage (67.3%) which is non-significant with DDHR 63.3% and its significant effect with the other two tillage practices (CDHR and TDHR) based on the LSD test, while the TDHR (T4) recorded the minimum GR percentage of (56.7%) which is non-significant with DDHR 63.3% while its significant with other two tillage practices (CDHR and TDHR) Fig. 1. In general the (GR) in MDHR was found to be higher than DDHR, CDHR and TDHR by 6%, 14.1% and 18.7% respectively, this result was in line with Shahram et al. (2012) who reported that moldboard and disc ploughing result in higher sugar beet production due to proper inversion of the soil, field preparation and crop establishment. Similar results have been shown previously by Prasad (1995) and Rizwan et al (2017).

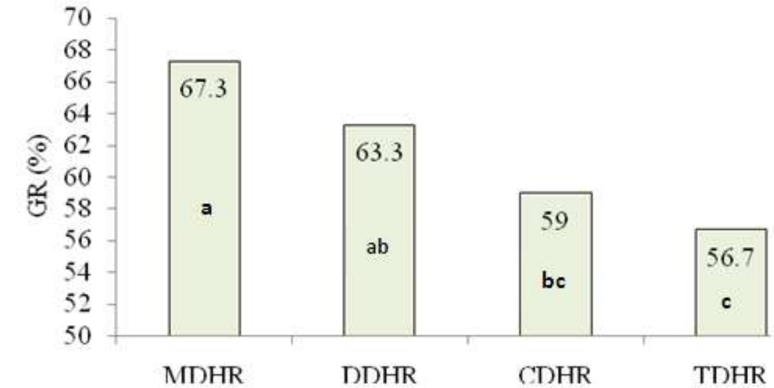

Fig. 1: Two seasons Mean germination rate (%) affected by Different tillage practices.(mean followed by the different letter differ significantly according to LSD test

Effect of Different tillage practices on Root thickness (cm)

Data of root thickness per square meter is presented in Table 1. Analysis of variance showed that different tillage implements have no significant effect on root thickness. Maximum root thickness was obtained, when CDHR (38.6 sig. with other practices based on the LSD test) was used, while minimum root thickness was recorded when MDHR (34.7) was used. CDHR showed significant results with other practices based on the LSD test, MDHR showed non-significant results for DDHR (35.3) and TDHR (35.7). In general the root thickness in CDHR was found to be higher than MDHR by 10.1%, DDHR by 8.5% and TDHR by 7.5%.

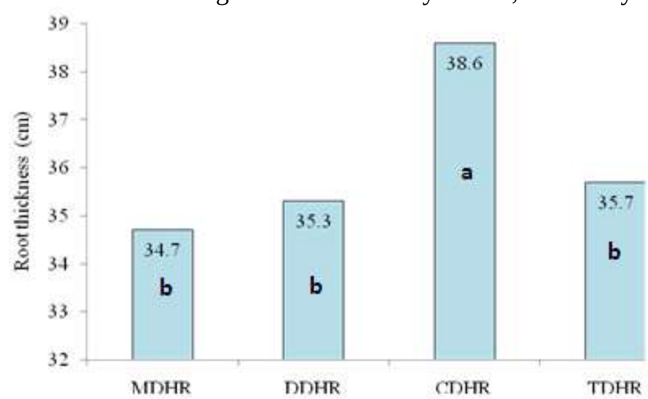

Fig.2: Two seasons Mean Root thickness (cm) affected by Different tillage practices.(mean followed by the different letter differ significantly according to LSD test

Effect of Different tillage practices on Plant population (No. of Tubbers)

Over the course of the study, tillage practices significantly different ($P<0.05$) affect Plant population (Table 1).

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As shown in Figure 3, Tillage implement DDHR yielded 26157 Tubbers which were significantly higher than all other tillage implements. The CDHR yielded significantly lowest productive Tubbers (22412) as shown in (Fig.3). These results are in line with findings of Prasad (1995). Similar results have been reported previously (Asadi et al., 1998; Hemmat and Asadi, 1998).

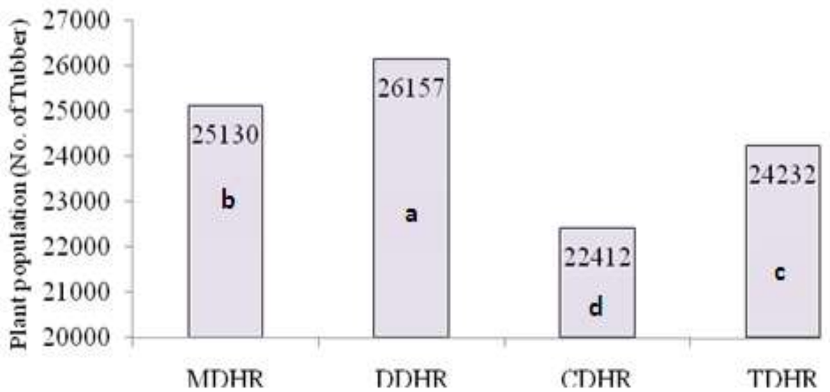

Fig. 3: Two seasons Mean Plant population (No. of Tubbers) affected by Different tillage practices.(mean followed by the different letter differ significantly according to LSD test

Effect of Different tillage practices on Sugar beet Crop yield (Ton/fed.)

The variance analyses of the average values of two seasons for Sugar beet Crop yield were presented in table 1. Average crop yield values and LSD test estimates are shown in fig. 4. The effect of tillage implements practices on the Sugar beet Crop yield was statistically highly significant ($P \leq 0.05$). The highest Sugar beet Crop yield was obtained from DDHR (29.2), CDHR gave the lowest yield (22.1). The Sugar beet Crop yield value with MDHR was greater compared to TDHR and CDHR. In general the yield in DDHR and MDHR was found to be higher than other two practices. this result agree with Shahram et al. (2012) who mentioned that moldboard and disc ploughing result in higher sugar beet production due to proper inversion of the soil, field preparation and crop establishment.

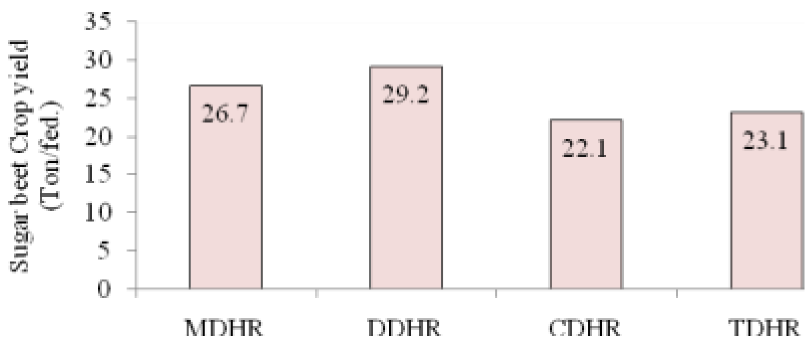

Fig. 4: Two seasons Mean Sugar beet Crop yield (Ton/fed.) affected by Different tillage practices.(mean followed by the different letter differ significantly according to LSD test

Effect of Different tillage practices on Sugar production from sugar beet (Ton/fed.)

The differences in Sucrose percent in beet (Pol%) as well as Sugar production from sugar beet (Ton/fed.) between different tillage practices were statistically significant ($P<0.05$) (Table 1).

Sugar production from sugar beet produced by operating various tillage practices were worked out, and such results are presented in Figures 5. The results indicated the highest Sugar production was recorded with DDHR and MDHR. The lowest Sugar production was detected with CDHR. In general the root thickness in DDHR was found to be higher than CDHR by 28.8% and TDHR by 13.6%. This result is closely related and in line with that obtained in previous parameters measured such as crop yield and number of tubbers in the field of experiment.

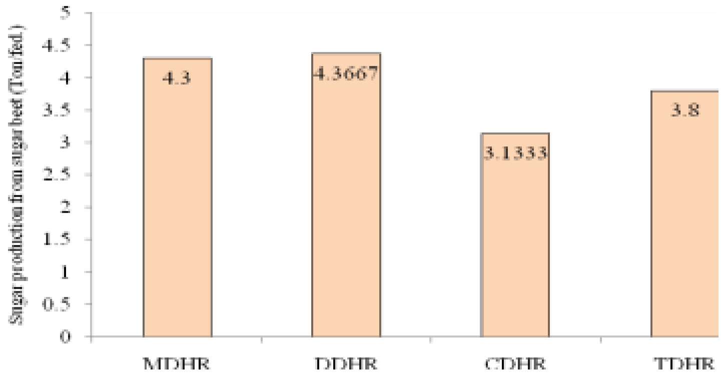

Fig. 5: Two seasons Mean Sugar production from sugar beet (Ton/fed.) affected by Different tillage practices.(mean followed by the different letter differ significantly according to LSD test

CONCLUSIONS

From the results of this study the following conclusions can be drawn:

1. Generally, soil tillage practices affect and improved the crop yield and quality of sugar beet.
2. MDHR (T1) recorded maximum GR percentage which is non-significant with DDHR and its significant effect with the other two tillage practices
3. The root thickness in CDHR was found to be higher than MDHR, DDHR and TDHR.
4. There were significant differences in Plant population among the tillage practices. Plant population under DDHR was greater than the others implements.
5. Sugar beet Crop yield and Sugar production from sugar beet were significantly affected by tillage practices; DDHR recorded highest amount in both of parameters

REFERENCES

Prasad J, 1995. A comparison between a rotavator and conventional tillage equipment for wheat soybean rotations on a vertisol in Central India. Soil and Tillage Research, 37: 19 I - I99.

Ahmad MK, MS Khan and MI Makhdum, 1990. Influence of different tillage implement for wheat production in Barani areas of Punjab. Sarhad Journal of Agriculture, 6: 179-184

Usman K, SK Khalil, AZ Khan, IH Khalil and MA Khan, 2010. Tillage and herbicides impact on weed control and wheat yield under rice-wheat cropping system. Soil and Tillage Research, 110: 101-107.

Rehman MU, M Amin and MK Khattak, 1995. Effect of different tillage operation on emergence and yield of wheat. AMA Agricultural Mechanization in Asia, Africa and Latin America, 26: 62-64.

Memon SQ, MS Mirjat, AQ Mughal and N Amjad, 2013. Effect of conventional and nonconventional tillage practices on maize production. Pakistan Journal of Agriculture, Agricultural Engineering and Veterinary Science, 29: 155-163

Shahram, M.N.; Majid, R.; Seyyed, M.O.M. and Mehrdad, N. (2012). Effect of Different Tillage Methods on Yield and Quality of Sugar Beet. Ardabil Province Jahad-e-Keshavarzi Education Center, Ardabil, Iran Department of Agricultural Machinery, Takestan Branch, Islamic Azad University, Takestan, Iran Middle-East *Journal of Scientific Research*, 12(6), 859-863

Muhammad Rizwan , Junaid Nawaz Chauhdary, Umer Draz Khan and Muhammad Arsalan (2017). Effects of Different Tillage Implements on the Growth and Yield of Wheat in Cotton-Wheat Zone of Pakistan. Pakistan Journal of Life and Social Sciences (2017). 15(1): 7- 10.

Ministry of Finance and National Economy ―The economic overview‖, Sudan Government, Khartoum, 1996.

Abdel-Motagally, F.M.F. and Attia, K.K. (2009). Response of sugar beet plants to nitrogen and potassium fertilization in sandy calcareous soil. *International. Journal Of Agriculture and Biology.* 11, 695-700.

Draycott, A.P. (2006). Introduction, pp. 1-8. Sugar beet book. UK: Blackwell Publishing house.

Ecclestone, P. (2004). To plough or not to plough? British Sugar Beet Review, 72, 7-11.

Iqbal, M.; Hassan, A.U.; Ali, A. and Rizwanullah, M. (2005). Residual effect of tillage and farm manure on some soil physical properties and growth of wheat (Triticum aestivum L.). International Journal of Agriculture and Biology 7, 54-57.

Rashidi, M.; Gholami, M. and Khabbaz, B.G. (2009). Response of yield and yield components of tomato (Lycopersicon esculentum) to different tillage methods. International Journal of Agriculture and Biology 11, 626-630.

Shahram, M.N.; Majid, R.; Seyyed, M.O.M. and Mehrdad, N. (2012). Effect of Different Tillage Methods on Yield and Quality of Sugar Beet. Ardabil Province Jahad-e-Keshavarzi Education Center, Ardabil, Iran Department of Agricultural Machinery, Takestan Branch, Islamic Azad University, Takestan, Iran Middle-East Journal of Scientific Research, 12(6), 859-863.

Alamouti, M.Y. and Navabzadeh, M. (2007). Investigating of plowing depth effect on some soil physical properties. Pakistan Journal of Biological Sciences 10, 4510-4514.

Sharmasarkar, F.C.; Sharmasarkar, S.; Miller, S.D.; Vance, G.F. and Zhang, R. (2001). Assessment of drip and flood irrigation on water and fertilizer use efficiencies for sugarbeets. Agricultural Water Management, 46: 241-251.

Tognetti, R.; Palladino, M.; Minnocci, A.; Delfi ne, S. and Alvino, A. (2003). The response of sugarbeet to drip and low-pressure sprinkler irrigation in southern Italy. Agricultural Water Management, 60, 135-155.

EL Karouri, M.O. and El Rayeh, A. (2006). Prospects of sugar beet production in the Sudan. Journal of agricultural investment (JAI).4, 89-92

ICUMSA, Method Book, (1994). International Commission for Uniform Methods of Sugar Analysis, GS 6(1-3).