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Sugar Beet (*Beta vulgaris*) Production as Affected by Tillage Systems, Planting Methods and Irrigation Intervals in Guneid area (Sudan)[1]

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Abstract: The present research was carried out at Guneid Sugar Cane Research Center during two successive seasons 2013/14 and 2014/15. The objective was to investigate the effect of four tillage systems (moldboard ploughing (T_1), disc ploughing (T_2), chisel ploughing (T_3) and disc harrowing (T_4)), three irrigation intervals (7, 10, and 14 days) and two planting methods (manual and mechanical) on sugar beet production. The parameters measured were machinery performance as effective field capacity (EFC), field efficiency (FE) and Fuel consumption (FC), some soil parameters (soil moisture content and bulk density), some crop parameters (root thickness (RT), crop root yield (RY), polarization or sugar content (Pol %), total sugar production (TSP) and cost of production. A spilt -split plot design with four replications was used in this study. The results showed that all machine performance parameters measured were significantly different and the highest EFC, FE and FC were recorded by the planter, ridger and chisel machines respectively. Tillage treatments and irrigation intervals interaction insignificantly affected soil moisture content and significantly ($P \leq 0.01$) affected soil bulk density. The highest values of RT (38.6 cm), RY (31.9 t/fed), Pol % (19.9 %) and TSP (4.9 t/fed) was recorded by ($T_3 \times M_2 \times I_1$), ($T_2 \times M_1 \times I_2$), ($T_4 \times M_2 \times I_3$) and ($T_2 \times M_1 \times I_1$) treatments respectively. The highest (4280 SDG/fed) and lowest (3290 SDG/fed) total cost of production was

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recorded by ($T_1 \times M_1 \times I_1$) and ($T_4 \times M_2 \times I_4$) treatments respectively. It can be concluded that generally disc ploughing with 10 days irrigation interval and manual planting can give higher crop root yield, higher TSP and lower cost of production at Guneid Sugar Cane Research Center.

Keywords: sugar beet, tillage, irrigation interval, planting method, Guneid, net return

INTRODUCTION

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). There are few investigations with respect to the effect of sowing methods on sugar beet productivity. In this concern, Zahoor *et al*. (2007) showed that planting methods significantly affected the root and foliage weights, of sugar beet crop. El-Geddawy *et al*. (2008) showed that mechanical sowing of sugar beet increased root and sugar yield and its components as compared with traditional method (manual sowing). 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. They reported average root yields of 71.5 - 81.0 ton/ha. These are very high yields compared to the international average yield of 34.2 ton/ha. The average yield of beet produced by Arab countries was 44.2 ton/ha (FAO 1995). The average sucrose content was in the range of 12.4 - 15.7%, which is below the values of sucrose content in Europe, but comparable to beet producing Arab countries. Another experiment was carried out at Um Dom during 1996/97 and 1997/98 seasons by Abdalla and Ali (2004) and Ali and Abdalla (2004) to determine the optimum sowing and harvesting dates for two cultivars of sugar beet. They reported that root and sugar yield were inversely proportional to delay in sowing date, but positively correlated with delay in harvesting date beyond 18 weeks after sowing. Several variety adaptability trials were carried out at Guneid and Sennar 1998/1999, Kenana 2000/2001 (Obeid and Tahir 2003). They all reported encouraging results of root and sugar yields. Root yields as high as 121.87 ton/ha with 15.6 % sugar content was reported in season 2002/2003 in experiments conducted at Dongola Research Station. Therefore, the main objective of this research was to determine the effect of some soil tillage practices, method of planting and irrigation intervals 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:

(1) To evaluate some machinery performance and soil parameters, such as effective field capacity field efficiency, fuel consumption rate, soil bulk density and soil moisture content.
(2) To determine some crop performance parameters, root thickness, crop root yield, sucrose percent (pol %), and sugar production.

(3) To evaluate the cost of sugar beet production for different treatments

MATERIALS AND METHODS

The study was conducted at Guneid Sugar Cane Research Center which lies on the eastern bank of the Blue Nile, 117 km south of Khartoum, latitude $14^{o}30'$N and longitude $33^{o}15'$E. The experiment was carried out for two successive growing seasons 2013/14 and 2014/15. The soil is classified as aridisol. The mechanical analysis of the soil showed clay 45 %, sand 28% and silt 27 %. The average bulk density 1.75 % and the average moisture content 15 %. Some chemical properties measured at three depths are shown in Table 1. Guneid Sugarcane Scheme is characterized by relatively cool winters, hot summers, low rainfall, low relative humidity and a potential evapotranspiration exceeding precipitation throughout the year.

Table 1 Some soil chemical properties for the experimental area

Parameter	Depths (cm)		
	0-15	15-30	30-45
pH (1:1)	8.43	8.42	8.43
EC (YS/CM)	641	640.5	695.3
P (ppm)	0.072	0.070	0.070
T.O.C (w/w%)	0.438	0.367	0.384
O.M (w/w%)	0.786	0.623	0.599
N (%)	0.069	0.065	0.066
SAR	1.74	1.98	2.19

Equipments used

Two tractors were used in this research study to draft the implements, Massey Ferguson (ET-80) and the Valtra 180 tractor. The implements used in this experimental work were commonly used for soil tillage in Sudan (FAO 1997).

Other equipments and materials used were, three types of sensitive balances, ELE electric oven, a standard soil auger. Two glass beakers with one litre capacity, Panasonic blender, a venial and filter paper, SUMA saccharimeter, SUMA brixometer, Atomic Absorption Spectrophotometer, Kjelldhal Vapodest 50s, Wagtech conductivity and pH meter, Jenway Spectrophotometer, measuring tape, stopwatch and a measuring cylinder (1000 ml).

Treatments and design

The tillage treatments used in the experiment were the following: T_1 Moldboard plough plus disc harrow plus ridging (Mo), T_2 Disc plough plus disc harrow plus ridging (Dp), T_3 Chisel plough plus disc harrow plus ridging (Ch), T_4 Two passes of disc harrowing plus ridging (Ha). The irrigation treatments were the following intervals: (I_1); 7days irrigation interval; (I_2), 10 days irrigation interval; (I_3), 14 days irrigation interval. The planting method treatments were, Manual planting (M_1), Mechanical planting (M_2). The treatments were arranged in a split - split plot design with four replications. Each replication consisted of tillage system treatments as main plot and each main plot was subdivided into two subplots (planting methods) and each subplot was further divided into three sub subplots for irrigation intervals. The main plot was 7 meters wide and 50 meters long. The space between the main plots was five meters and seven meters between replications. The space between sub-subplots was five meters.

Experimental land preparation

The land was prepared by the main tillage treatments (moldboard plough, disc plough, chisel plough 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 time of planting.

Cultural practices

Manual planting was carried out by twelve labors for planting the 48 sub subplots using a piece of iron of 1.5 meter long. The space between plants was 15 cm while between rows was 75 cm. Mechanical planting was done by a pneumatic planter with four units which was calibrated and used for planting the other 48 sub subplots. Lenard, monogerm seed variety was used for planting the experimental field.

The first irrigation water was applied after planting and the second one was applied after five days from the first one. From the second irrigation the three intervals of irrigation (7, 10 and 14 days) were applied. Two types of fertilizers were applied, superphosphate and urea. The recommended dose from superphosphate was 50 kg per feddan and was added at seeding. The recommended urea fertilizer was 100 kg per feddan and was applied in two doses, the first at seeding and the second after 45 days from germination. Attakan 350sc insecticide was used to control termites. Two weedings were carried out using a hand tool 'Naggama', the first after one month from planting and the second was after two months. The thinning to 1-2 plants per hole for manual planting was done during the second weeding.

Machinery performance measurements:

Field efficiency

The field efficiency (FE) of the implements and planter was calculated using the following equation:

$$FE\ (\%) = \frac{Te}{Te + Ta + Tt} \times 100$$

Where:

FE = Field Efficiency.
Te = Actual plot working time.
Ta = Interruption time losses.
Tt = Turning time losses.

Effective field capacity

The effective field capacity (EFC) of the implements and planter was calculated after determining the ground speed (S) of the tractor, using the following equation:

$$EFC = \frac{S \times W \times E}{4.2}$$

Where:

EFC = Effective Field Capacity (fed/hr)
S = Speed of the tractor (km/h).
W = Width of the machine (m).
4.2 = conversion factor to feddans

Fuel consumption

Fuel consumption (FC) for each operation using different machines was measured as follows:

$$FC = \frac{V \times 4200}{A}$$

Where:

FC = lit/fed
V = Amount of fuel used to refill the fuel tank (lit).
A = Plot area covered (m^2).

Soil moisture content measurement

Soil moisture content (SMC) as percentage was measured four times, before Crop Watt program was applied, after 45 days from planting, after 120 days from planting and at harvesting at three depths (0 – 15 cm, 15 – 30 cm and 30 – 45 cm). The soil moisture content (%) was determined using the following equation (Blake and Hartge, 1986):

$$M.C\ \% = \frac{Ww - Wd}{Wd} \times 100$$

Where:

M.C% = Percent soil moisture content on dry basis.
Ww = Wet weight of soil sample (gm).
Wd = Dry weight of soil sample (gm).

Soil bulk density measurement

Bulk density (BD) was determined in the laboratory. The samples were taken by auger at three depths, 0 – 15 cm, 15 – 30 cm and from 30 – 45 cm. Samples were dried and the bulk density was determined by the following equation:

$$Bd = \frac{Wd}{Vc} \times 100$$

Where:

Bd= Bulk density (gm/cm^3).
Wd = weight of dry sample (gm).
Vc = volume of sample (cm^3).

Crop performance measurements

Root thickness (RT)

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

Tuberous root yield (RY)

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

$$\text{Sugar beet root yield (t/fed)} = \frac{4200 \times \text{yield of one row kg}}{7.5 \times 1000}$$

Where:

7.5 = Area of one row (m^2). 4200 = Area of feddan (m^2).

Sugar Beet root chemical analysis:

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

The polarization or sugar content was determined by taking twenty-six mg of sliced beet + reagents (174 cm^3 lead acetate), mixed in a blender and filtered. 200 ml of the extract was read in a Saccharimeter according to (ICUMSA 1994).

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

$$\text{Sugar yield (TSP) (t/ fed)} = \frac{\text{ERS\%} \times \text{Yield of sugar beet per feddan (kg)}}{1000}$$

Estimated recovery sugar percent (**ERS %)** = Pol% - 2.5

Where: 2.5 = Expected losses of sugar content through production.

Crop production cost and statistical analysis

The total cost of sugar beet production was calculated as the cost of inputs used and the cost of different operations which were carried out by renting machinery and labour. Statistic-8 computer program was used for statistical analysis of the data collected.

RESULTS AND DISCUSSION

Field Machines Performance

Table 2 shows some field performance parameters of the individual machines used in the experiment. The analysis of variance showed highly significant difference (P≤ 0.001) among the implements for three measured parameters.

Table 2. Field performance of individual machines used in the experiment

Parameters	Implements						Prob.
	Mo	DP	Ch	Ha	Ri	Pla	
FE (%)	72.2	69.7	71.4	70.6	73.2	72.5	**
EF.C (fed/hr)	0.70	0.6	1.1	2.0	3.9	5.4	**
FC (liter/fed)	6.6	6.7	7.1	4	3.8	3	**

** highly significant at P≤ 0.01level. Ha= Disc harrow. Ri= Ridger Pla= Planter.

The main effects of treatments on measured parameters

Table 3 shows significant difference (P ≤ 0.05) among soil tillage treatments regarding soil moisture content. Also a highly significant difference (P ≤ 0.001) due to intervals of irrigation effect. The interaction of (T×I) on soil moister content was insignificant while for bulk density was highly significantly (P ≤ 0.001). The other interactions showed insignificance among both soil moister content and bulk density. It was also observed that root thickness (RT), crop root yield (RY), polarization or sugar content percent (Pol%) and total sugar production (TSP) significantly different among the effects of planting methods and irrigation interval except for the Pol %, it was insignificant. Tillage systems effect was insignificant for the above measured parameters. All interactions (T × M), (T × I), (M × I) and (T × M × I) effects were insignificant except for the interactions (T × M) and (M × I) which showed significant effects on RY and Pol% respectively.

The soil moisture content was generally observed to increase with depth for all tillage treatments. This was in agreement with the result obtained by Romanecka *et al.* (2009). The moldboard ploughing tillage treatment and 14 days irrigation interval was recorded the highest average soil moisture content and bulk density (Table 4). This could be due to better soil pulverization. Planting method was observed to have insignificant effect on both soil moister content and bulk density.

Table 3. Mean squares showing the main effects of tillage system, planting method and irrigation interval on measured parameters during 2014 – 2015 (average of two seasons)

Source of variance	SMC (%)	BD (g/cm^3)	RT(cm)	RY (t/fed}	Pol (%)	TSP (t/fed)
T	8.21^{*}	0.0004^{*}	46.89^{ns}	12.76^{ns}	14.48^{ns}	0.79^{ns}
M	204.77^{ns}	0.078^{ns}	281.88^{*}	149.60^{**}	9.86^{*}	2.27^{*}
T × M	4.06^{ns}	0.001^{ns}	1.61^{ns}	9.15^{*}	3.79^{ns}	0.61^{ns}
I	964.27^{*}	0.003^{*}	55.17^{*}	$38,11^{**}$	1.17^{ns}	1.60^{**}
T × I	2.84^{ns}	0.0004^{**}	10.08^{ns}	7.85^{ns}	3.64^{ns}	0.65^{ns}
M × I	29.27^{ns}	0.0007^{ns}	23.63^{ns}	16.86^{ns}	11.60^{*}	2.24^{ns}
T × M × I	4.39^{ns}	0.0005^{ns}	17.66^{ns}	21.72^{ns}	4.32^{ns}	0.48^{ns}

T = tillage system; M = planting method; I = irrigation interval

SMC = soil moisture content, BD = bulk density, RT = root thickness, RY = crop root yield, Pol% = sugar content or polarization percent, TSP = total sugar production

The results of root thickness, crop root yield, sugar pol % and total sugar production are shown in Tables 5 and 6. Disc ploughing tillage treatment recorded the highest average crop yield, sugar pol % and total sugar production, while chisel ploughing recorded the highest root thickness. Shahram *et al.* (2012) reported that moldboard and disc ploughing result in higher sugar beet production due to proper inversion of the soil, field preparation and crop establishment. 10-days irrigation interval gave the highest root thickness and crop root yield which may be due the high moisture content after irrigation that helped in proper root growth and distribution. The highest pol % and sugar production were obtained by 7-days irrigation interval. De Benito *et al.* (2002) reported that an increase in frequency from one to two irrigations per week significantly increased root development and yield. Manual planting recorded the highest crop root yield and total sugar production and this may be due to the high germination percentage and plant population accomplished under the manual planting, which disagreed with the results of Sarauskis *et al.*

(2010). While mechanical planting recorded the highest root thickness and sugar pol %. This may be due to available spaces between rows that helped in proper root growth. Therefore, the highest crop root yield was obtained by disc ploughing tillage system at 10-days irrigation interval and manual planting, whereas the total sugar production was recorded by disc ploughing tillage system at 7-days irrigation interval and manual planting.

Table 4. Effect of tillage, planting method and irrigation interval on: and bulk density

Treatments	M_1				M_2			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
				Soil moisture content				
T_1	21.0	23.7	24.8	23.2	21.0	23.4	24.8	23.1
T_2	18.2	20.8	22.1	20.0	18.0	21.0	22.8	20.6
T_3	16.4	20.7	21.5	19.5	16.3	18.6	19.1	18.0
T_4	15.5	18.8	17.6	17.3	16.4	18.0	19.6	18.0
Mean	17.8	21.0	21.7		17.6	20.2	21.1	
Overall T mean		T_1 = 23.1		T_2= 20.3	T_3= 18.7	T_4= 17.6		
L.S.D $T_{(P<0.05)}$					2.89			
Overall M mean		M_1= 20.1				M_2= 19.8		
L.S.D M $_{(P<0.05)}$					0.95			
Overall I mean		I_1 = 17.7		I_2 = 20.6		I_3 = 21.4		
L.S.D I $_{(P<0.05)}$					0.95			
				Bulk density				
T_1	1.24	1.21	1.29	1.25	1.25	1.22	1.28	1.25
T_2	1.22	1.20	1.28	1.23	1.23	1.21	1.29	1.24
T_3	1.22	1.22	1.26	1.23	1.23	1.21	1.30	1.25
T_4	1.20	1.20	1.27	1.22	1.22	1.22	1.27	1.24
Mean	1.22	1.21	1.27		1.23	1.21	1.28	
Overall T mean		T_1 = 1.25		T_2= 1.23	T_3= 1.24	T_4= 1.23		
L.S.D T $_{(P<0.05)}$					0.018			
Overall M mean		M_1= 1.23				M_2= 1.24		
L.S.D M $_{(P<0.05)}$					0.811			
Overall I mean		I_1 = 1.22		I_2 = 1.21		I_3 = 1.27		
L.S.D I $_{(P<0.05)}$					0.013			

T_1= Mo, T_2= Dp, T_3= Ch, T_4= Ha

Table 5. The interaction effect of tillage treatments, methods of planting and irrigation intervals on sugar beet root thickness (cm) and crop root yield (t/fed) 2014/2015

Treatments	M_1				M_2			
	I_1	I_2	I_3	mean	I_1	I_2	I_3	Mean
				Sugar beet root thickness (cm)				
T_1	34.5	33.2	31.4	33.0	34.7	37.0	33.1	34.9
T_2	33.8	35.9	29.9	33.2	35.3	34.4	33.1	34.3
T_3	32.4	33.4	33.3	33.0	38.6	38.3	37.1	38.0
T_4	34.8	34.7	32.1	33.9	35.7	34.1	35.4	35.1
Mean	33.5	34.3	31.7		35.9	35.9	34.7	
Overall T mean	T_1 =33.9	T_2= 33.7		T_3= 35.5		T4= 34.5		
L.S.DT $_{(P< 0.05)}$				4.55				
Overall M means	M_1= 33.2					M_2= 36.1		
L.S.D M $_{(P<0.05)}$				1.59				
Overall I means	I_1= 34.7	I_2 = 35.1				I_3 = 33.2		
L.S.D I $_{(P< 0.05)}$				1.70				
				Crop root yield (t/fed)				
T_1	29.4	31.2	25.4	28.7	26.7	26.3	21.4	24.8
T_2	30.7	31.9	28.0	30.2	29.2	23.9	26.5	26.5
T_3	24.6	27.2	22.9	24.9	22.1	27.4	23.6	24.4
T_4	27.9	26.3	23.3	25.8	23.1	25.4	22.3	23.6
Mean	28.1	29.4	24.9		25.3	25.8	23.5	
Overall T mean		T_1 = 26.75		T_2= 28.35	T_3= 24.65		T_4= 24.7	
L.S.D T $_{(P<0.05)}$				5.04				
Overall M mean		M_1= 27.6				M_2= 24.7		
L.S.D M $_{(P<0.05)}$				1.76				
Overall I mean		I_1= 26.7		I_2 = 27.35			I_3 = 24.2	
L.S.D I $_{(P<0.05)}$				2.45				

Table 6. Effect of tillage treatments, methods of planting and irrigation intervals on and TSP (t/fed) 2014/2015

Treatments	M_1				M_2			
	I_1	I_2	I_3	Mean	I_1	I_2	I_3	Mean
				Sugar beet Pol (%)				
T_1	18.2	16.5	17.4	17.4	18.8	18.7	20.0	19.2
T_2	18.7	17.3	17.3	17.8	18.1	18.5	16.9	17.8
T_3	18.5	16.6	16.6	17.2	16.8	18.3	16.8	17.3
T4	18.6	17.7	17.8	18.0	18.9	18.6	19.9	19.1
Means	18.5	17.0	17.3		18.2	18.5	18.4	
Overall T means		$T_1 = 18.3$		$T_2 = 18.7$	$T_3 = 17.25$		$T_4 = 18.5$	
L.S.DT($P<0.05$)					1.45			
Overall M means		$M_1 = 17.6$				$M_2 = 18.8$		
L.S.DM($P<0.05$)					1.20			
Overall I means		$I_1 = 18.35$		$I_2 = 17.75$		$I_3 = 17.85$		
L.S.DI($P<0.05$)					1.20			
				Total sugar production (t/fed) 2014/2015				
T_1	4.6	4.3	3.8	4.2	4.3	4.1	3.7	4.0
T_2	4.9	4.6	4.0	4.5	4.4	3.8	3.7	4.0
T_3	3.9	3.8	3.2	3.6	3.1	4.3	3.4	3.6
T_4	4.5	3.9	3.5	4.0	3.8	4.0	3.8	3.9
Means	4.5	4.2	3.6		3.9	4.1	3.7	
Overall T means		$T_1 = 4.1$		$T_2 = 4.3$	$T_3 = 3.6$		$T_4 = 4.0$	
L.S.D T ($P<0.05$)					0.81			
Overall M means		$M_1 = 4.1$				$M_2 = 3.9$		
L.S.D M ($P<0.05$)					0.40			
Overall I means		$I_1 = 4.2$		$I_2 = 4.15$		$I_3 = 3.65$		
L.S.D I ($P<0.05$)					0.44			

The cost of sugar beet production

The total cost (SDG/feddan) of sugar beet production for the different treatments and operations is shown in Table 7. The total cost of tillage treatments showed small differences, but the moldboard ploughing tillage system recorded the highest cost for both planting methods. The average manual planting cost was higher than mechanical planting by 341 SDG and this was mainly due to the high rent cost of labor. On the other hand the 7days irrigation intervals recorded the highest cost of irrigation intervals and this may be due to the number of irrigations during the season. The highest total interaction cost was recorded by the moldboard ploughing tillage system with manual planting and the 7 days irrigation interval (4280 SDG/fed) while the lowest cost was recorded by disc harrowing with mechanical planting and the 14 days irrigation interval (3290 SDG/fed).

Table 7. The gross returns, total cost and net returns of sugar beet production using different tillage treatments, irrigation intervals and methods of planting (SDG/fed)

Treatments	M_1				M_2			
	I_1	I_2	I_3	mean	I_1	I_2	I_3	Mean
T_1	4280	3920	3680	3960	3940	3580	3340	3620
T_2	4270	3910	3670	3950	3930	3570	3330	3610
T_3	4270	3910	3670	3950	3930	3570	3330	3610
T_4	4230	3870	3640	3913	3890	3530	3290	3570
Mean	4263	3902	3665		3922	3562	3320	
Overall M Mean =	M_1 = 3943 SDG/fed						M_2 = 3602 SDG/fed	

CONCLUSIONS

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

1. Generally, soil tillage treatments and irrigation intervals affect soil moisture content and bulk density and improved the crop yield and quality of sugar beet.
2. Irrigation intervals, Methods of planting significantly ($P \leq 0.05$) affect root thickness, crop yield and sugar beet production.
3. The Interactions between the three treatments show no significant differences, but generally disc ploughing with 10 days irrigation interval and manual method of planting record the highest crop yield, higher sugar beet production and lower cost of production.

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إنتاج بنجر السكر (*Beta vulgaris*) وتأثره بحزم نظم الحراثة وطرق الزراعة وفترات الرى فى منطقة الجنيد (السودان)[2]

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المستخلص: أجري هذا البحث فى مركز ابحاث سكر الجنيد في موسمين متتالين14/2013 15/2014. كان الهدف دراسة تأثير أربعة انظمه للحراثه (حراثة مطرحية، حراثة قرصية، حراثة ازميلية وحراثة بالمشط القرصى) وثلاث فترات للري (7، 10، و14 يوم) وطريقتين للزراعة (يدوية وميكانيكية) على انتاجية بنجر السكر. وكانت المعاملات قياس أداء الألات (السعه الحقليه الفعليه، الكفاءه الحقليه واستهلاك الوقود)، وبعض معاملات التربة (المحتوى الرطوبى وكثافه التربه) وبعض المعاملات للمحصول (سمك الجذر ، انتاجية المحصول، الاستقطاب أو محتوى السكر، وإنتاجية السكر) وتكلفة الإنتاج. تم استخدام تصمبم القطع المنشقة–المنشقة باربعة تكرارات. أظهرت النتائج أن كل معاملات أداء الآلات اظهرت فروق معنويه. وسجلت الة الزراعه، الطراد والمحراث الإزميلى أعلى سعه حقليه فعليه، كفاءه حقليه ومعدل استهلاك للوقود على التوالى. كان تاثير تفاعل نظم الحراثه مع فترات الرى على المحتوى الرطوبى للتربة غير معنويا، ومعنويا على الكثافة الظاهرية للتربة عند ($P \leq 0.01$). اعلى قيم ل RT

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(38.6سم)، RY (31.9 طن/فدان)، Pol% (19.9%) وTSP (4.9 طن/فدان) تم تسجيلها بالتفاعلات ($T_3 \times M_2 \times I_1$), ($T_4 \times M_2 \times I_3$), ($T_2 \times M_1 \times I_2$) و($T_2 \times M_1 \times I_1$) على التوالى. وسجلت أعلى تكلفة (4280 جنيه سودانى/ فدان) واقل تكلفة (3290جنيه سودانى/ فدان) اجمالية لإنتاج سكر البنجر لتفاعلات المعاملات ($T_1 \times M_1 \times I_1$) و($T_4 \times M_2 \times I_4$) على التوالى. يمكن الاستخلاص بصغة عامة ان الحرلثة القرصية مع طريقة الزراعة اليدوية و الري كل 10ايام يمكن ان يؤدى الى انتاجية عالية لمحصول بنجر السكر وسكر البنجر فى مركز ابحاث قصب السكر بجنيد.