COMPARATIVE STUDY FOR THE EFFECT OF DIFFERENT TILLAGE SYSTEMS ON WATER CONSUMPTION AND SUGAR BEET YIELD

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Abstract

Field experiments were carried out at Sakha Agricultural Research Station, Water Requirement Dept., Kafr El-Sheikh Governorate during the growing season of 2004/2005. The objective of the present study was to find out the effect of preparation on water requirement and sugar beet yield. Soil characteristics (bulk density, porosity, infiltration rate and soil pulverization) were measured under four different tillage systems. In the same manner, fuel consumption, slippage and field capacity were undertaken. Power and energy requirements, total cost of seedbed preparation systems, water applied and yield components were calculated. The obtained results revealed the following points:

a) Results indicated a clear significant in relative increase of soil volume, rate of disturbed soil and yield.

b) The highest value of soil pulverization degree was 95.11 % for chisel plough(two passes) followed by rotary tiller. On the other hand, it was reached its minimum value (78.85 %) by using mouldboard plough followed by rotary tiller.

c) The highest value of energy requirement was 27.23 kW.h/fed; for mouldboard plough whilst, the minimum value was 12.04 kW.h/fed; for disk harrow (two passes).

d) The total cost of disk harrow two passes was the cheaper where, it reached 18.8 L.E/fed; meanwhile, the chisel plough two passes followed by rotary tiller costed about 46 L.E/fed.

e) The maximum value of water consumption was 2390.64 m^3/fed; for mouldboard plough followed by rotary tiller. However, the minimum value was 2035 m^3/fed; for chisel plough one pass followed by rotary tiller.

f) Mouldboard plough followed by rotary tiller gave the maximum value of water use efficiency of 12.55 kg/m3. While, the minimum value was 8.97 kg/m3 for chisel plough one pass followed by rotary tiller

g) The maximum value of root yield was found to be 30.00 mt/fed by using mouldboard plough followed by rotary tiller. Whilst, chisel plough followed by rotary tiller gave the minimum value of 18.260 mt/fed.

INTRODUCTION

Sugar beet is considered as one of the most important crops, not only for sugar production but also for fodder and organic matter for the soil. It extends to the use of its bi-products in producing untraditional animal feed. Therefore, the government is planning to increase the growing area of sugar beet and improving the technique of agricultural processes.

The production of sugar in the world depends on two main crops namely, sugar cane and sugar beet. The cultivated area of sugar beet in Egypt during 2003, was 142638 feddans gave 2.857728 tons sugar beet roots and 71.319 tons beet tops (Agricultural. Statistics, 2003)

Seedbed environment clearly affectes plant growth through its role on soil physical properties. Therefore, by controlling different types of seedbed preparations to get the most uniform soil moisture that resulted in higher crop yield is a main vital way of effective water management. So, the main goal of this study is to determine the most convenient seedbed environment from soil water relationship point of view.

Tillage and ploughing implementation are practiced for improving seedbed conditions. Before seed sowing, it is necessary to create a suitable seedbed for good seed germination. A correct tilth will ensure the adequate moisture and air quantities needed for plant growth.

According to Robinson (1977), the main objectives tillage may be conveniently discussed under the following headings:

- i- Production of a suitable tilth or soil structure.
- ii- Controlling of soil moisture, aeration and temperature.
- iii- Control of weeds.
- iv- Controlling soil pests.

El-Banna *et al.* (1987) indicated that no clear relationship between the degree of pulverization and crop yield. The favorable influence of tillage the root penetration, aeration of roots and movement of soil water have been very strong with deep, moderate and shallow depth implements, respectively. Therefore the maximum yield has been obtained with mouldboard, while rotary plough (one pass) gave the lowest yield.

Kanwar (1989) determined the effect of tillage system on the variability of soil-water tensions and soil-water content. The tillage systems were (no till, chisel plough, paraplough and mouldboard plough). This study resulted in the following conclusions:

- a- On the average, chisel plough maintained lower soil moisture tensions in the 0.0 to 0.3 m soil layer when compared with both the no tillage an conventional tillage plots.

b- Although the no-till system tends to show more soil water storage in the top 0.9m of the soil profile than the other three tillage system.

El-Nakib and Fouad (1990) studied the effect of minimum tillage with conditioner implement on soil physical properties. They showed that soil bulk density decreased after tillage operation, the decrease in bulk density value was much more in the upper layer 0-10 cm. Also, they indicated that the ploughing increases pore spaces of the soil.

Al-Tahan *et al.* (1992) studied the effect of ploughing depths using different plough types on some physical properties of soil. The results of ploughing depth showed that the values of bulk density were significantly lower at 10-15cm depth. On the other hand, results of the interaction between plough types (moldboard, disk and chisel) and ploughing depth indicate that chisel plough at 10-15cm depth gave significant less bulk density.

The current study was devoted to:

1-Find out the effect of different seedbed preparation systems on some soil physical properties and water used efficiency that results in maximum crop production of sugar beet yield.

2-Evaluate the field performance for tillage cost.

MATERIALS AND METHODS

Field experiments were carried out in seasons 2004 and 2005 at the experimental farm of Sakha Agric. Res. Station, Water Requirement Dept., Kafr El-Sheikh Governorate, to study the effect of seedbed preparation and water relation on yield of sugar beet. Mechanical analysis and water characteristics of the experimental soil at Sakha are shown in Table (1).

Table 1. Mechanical analysis and water characteristics of soil at Sakha Agricultural Research Station, Water Requirement Dept., Kafr El-Sheikh.

Soil depth (cm)	Mechanical analysis			Texture	Bulk density (g/cm^3)	Water characteristics			O.M (%)
	Sand (%)	Silt (%)	Clay (%)			Field Cap. (%)	Permanent wilting point (%)	Available water (%)	
0-15	12.3	33.3	54.40	Clay	1.26	47.50	25.81	21.69	1.65
15-30	20.20	34.20	45.60	Clay	1.29	39.87	21.66	18.21	1.48
30-45	20.40	38.20	41.40	Clay	1.31	38.40	20.86	17.54	1.05
45-60	21.10	37.40	41.50	Clay	1.38	36.39	19.78	16.61	0.72

Sugar beet variety (Helena) as winter crop was used .Sowing date was November 15 seasons 2004/2005 by using mechanical planting. All cultural practices were the same as recommended by Ministry of Agriculture except for the seedbed and irrigation practices, which were under investigation. Harvesting dates for sugar beet was May 20.

Climate Condition.

The meteorological data of air temperature (C°), relative humidity (%), rainfall (mm) and wind speed (km/day) at Sakha station during the year of study seasons 2004/2005.

Table 2. Climatological elements at Sakha area during 2004 and 2005*.

Month	Temp. (C°)			Rel. hum. (%)			Wind speed (km/day)	Rain fall (mm)
	Max.	Min.	Mean	Max.	Min.	Mean		
Nov	24.0	12.5	18.28	75.0	51.5	63.25	142.0	60.0
Dec	17.0	7.0	12.00	70.8	44.5	57.65	89.5	8.6
Jan	18.5	6.9	12.70	64.0	48.0	56.00	132.0	-
Feb	19.5	6.7	13.10	76.0	51.0	63.50	147.0	40.9
Mar	22.0	7.5	14.75	76.0	46.0	61.00	149.0	4.4
Apr	25.0	10.0	17.50	72.0	96.5	59.30	206.0	0.4
May	29.5	14.0	21.75	68.0	41.0	54.50	171.0	-
June	31.5	19.0	25.25	70.0	41.0	55.50	149.0	-

*Starting of the growing season of sugar beet as winter crop.

Thinning: After six weeks from planting date the thinning operation was done in order to leave only one plant in the hill and remove the others by manually.

Fertilizer, irrigation and weed control were:

80 kg/fed nitrogen, 30 kg/fed; phosphate as P_2 O_2 and 50 kg potassium, irrigation and weed control were the same for all treatments as recommended.

The experimental treatments were as follow:

M_1= Chisel plough 11.0cm depth one pass + Rotary plough.

M_2=Chisel plough 19.0cm depth two passes +Rotary plough.

M_3=Mouldboard plough 27.0cm depth + Rotary plough

M_4=Disk harrow 15.0cm depth two passes.

Technical specifications of equipment used in this study are shown in Table 3.

Table 3. Technical specification of implements.

Item	Width (cm)	Mass (kg)	Specifications
Chisel plough	200	380	Mounted, 7- shanks
Disk harrow	240	1000	Trailed, 28-disks,2 group
Mouldboard plough	140	225	Mounted, 3-bottoms
Rotary plough	160	260	Mounted, 43-blades

A 60.4 kW four wheel drive Kubota M 7500 DT tractor was used for all ploughing systems as a mobil power. A pneumatic planter was used in the present study and its specifications was as follow: Italian made, number of rows 4, row spacing adjustable 60 cm, working width of 240 cm and total mass 1000 kg.

Measurements:

Bulk density P_b)

Bulk density was calculated by using the following formula:

$P_b = M/v_b$, g/cm^3..........(1)

Where:

M= The oven dry mass of the soil in the container, g;

V_b= Bulk volume of the soil in the container or volume of container, $cm.^3$

Soil porosity (P_s);

Soil porosity was calculated by using the following formula:

$P_s = 1 - \rho_b/\rho_s$ ....(2)

Where:

ρ_b = Bulk density, $g/cm;^3$

ρ_s = Real density (2.65 g/ cm^3).

Infiltration rate (I.R)

Double ring infiltrometer was used, the diameter of inside ring was 29cm and 50cm height. While the outer ring has a diameter of 40cm width the same height of 50cm. The space between the two rings was filled with water. In other words, infiltration rate is simulated the vertical water movement in direction from the inside ring to the soil. The reading I.R. was recorded at time intervals of 0, 5, 15, 20, 30, 45, 60, 90, 120 and 180 minutes. Then I.R. was computed as follows (Hansen *et al.* 1979)

$I_{ave} = d/t$, cm/h..........(3)

Where:

I_{ave} = The average take in cm /h;

d = The water depth that entered the soil surface, cm ;and

t = The elapsed time, h.

1- Soil pulverization:

The percentage of pulverized soil and clods were used as an indication of seedbed preparation quality. The degree of soil pulverization was calculated according to the following equation: (Helmy *et al.* 1994).

$P_s = (M_c/M_t) \times 100$ .... (4)

Where:

P_s = Pulverized soil, % (Pulverized soil mass to total mass);

M_c = Mass of crumbing soil which has dimensions equal or less than 100mm, kg;

M_t = Total soil mass in ploughed area of $1m^2$ at specific depth, kg;

$M_t = M_c + M_{c1}$

M_{c1} = Mass of soil clods which has dimensions greater than 100 mm, kg.

Helmy *et al.* (1994) indicated that for a good soil pulverization P_s must be ≥ 75 %.

The relative increase, (Rv) in soil volume after ploughing may be expressed dimensionally, as the increase in soil surface above the original soil surface divided by total height of disturbed soil after ploughing as in the form:

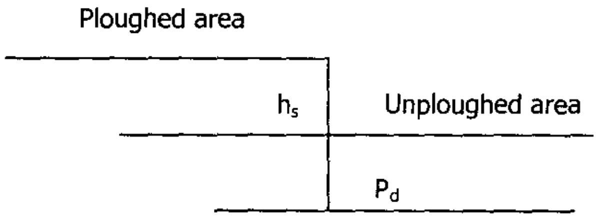
$R_v = h_s / P_d$ ....(5)

Where:

R_v = Relative increase in soil volume after ploughing;

P_d = Ploughing depth, cm and

h_s = Average increase in height above soil surface after ploughing, cm



Soil volume disturbed:

The total volume of disturbed soil for each implement during operation was calculated by using the following formula:

$V = 4200 F_c d$ ....(6)

Where:

V = Rate of soil volume disturbed, m^3/h;

F_c = Field capacity, fed/h; and

d = Ploughing depth of cut, m.

Actual field capacity:

The theoretical field capacity (TFC) was calculated by using the following formula:

$$TFC = \frac{wxSx100}{4200}, fed/h \text{ ....(7)}$$

The actual field capacity (AFC) was calculated as follows:

$$AFC = \frac{1}{Actual\ total\ time\ in\ hours\ required\ per\ fed}, fed/h \text{ ....(8)}$$

Fuel consumption:

Local manufactured of fuel consumption apparatus 4000 ml capacity assembled by the authors was used to measure the decrease in fuel level in the fuel tank immediately after executing each operation.

Energy requirements:

Energy requirements was calculated by using the following equation:

$$Er = \frac{Power\ required, kW}{Effective\ field\ capacity, fed/h}, kW.h/fed \text{ ....(9)}$$

The brake power required was calculated by using the following equation according to (Embaby, 1985).

$$P_r = \left(F_c \, x \frac{1}{3600} \right) x \, \rho_f \, x \, L.C.V. \, x 427 \, x \, \eta_m \, x \, \eta_{th} \, x \frac{1}{75} x \frac{1}{1.36}, \text{ kW} \quad \text{..............(10)}$$

Where:

F_c = Fuel consumption rate, L/h;

$L.C.V.$ = Lower calorific value of fuel kcal/kg; (average $L.C.V.$ of solar is 10000 kcal/kg);

427 = Thermo mechanical equivalent, kgm/kcal;

η_{th} = Thermal efficiency of the engine (considered to be about 40% for diesel engine);

η_m = The mechanical efficiency of the engine (considered to be about 80% for diesel engine);

ρ_f = Density of the fuel, kg/L (For solar fuel 0.85 kg/L).

Costs analysis:

The following equation of (Awady, 1987) was taken into account to determine the cost per hour for different tillage operations:

$$C = \frac{P}{h} \left(\frac{1}{L} + \frac{i}{2} + a + r \right) + (0.9 w x f x u) + b \quad \text{..............(11)}$$

Where:

C = Cost per hour of operation, L.E/h;

P = Estimated price of tractor or machine, L.E;

h = Estimated yearly hours of operation;

L = Life expectancy of the machine in years;

i = Annual interest rate;

a = Annual taxes and over heads;

r = Annual rapairs and maintenance rate;

0.9 = A correction factor for rated load ratio and lubrication

w = Engine power, hp;

f = Specific fuel consumption, L/hp.h;

u = Fuel price, L.E/L and

b = Hourly labour wage, L.E/h.

Characteristics of sugar beet root

- Root length, cm.
- Root diameter, cm.
- Root volume, cm^3.

The root volume was measured by immersing it in a container filled with water and received the excess water in calibrated cylinder.

Root yield in ton / Fed (met/Fed).

The average yield of the harvested roots (R y) was determined by weighing the roots lifted by hand-shovel that in the manual harvesting using the following equation (Taieb 1997):

$$R_y = \frac{M x 4200}{A x 1000} \text{, ton / fed ;} \quad \text{......(12)}$$

Where:

M = The mass of lifted roots, kg;

A = The harvested area, m^2.

Sugar yield in ton /fed.

Sugar yield per feddan equals to root yield per feddan (ton) multiplied by sucrose percentage

Irrigation water consumption:

The irrigation water, at Sakha Agriculture Research Center, is pumped from the main canal to a concrete canal. It was allowed to flow from the canal to the furrow lines through plastic pipes (siphons). Flow was maintained under constant head. The irrigation intervals were 25 days for all the treatments. The stream of irrigation was cut of at 80% of the irrigation run soil moisture content was determined at depth of 60 cm just before and after irrigation to calculate the water consumptive use according to (Israelson and Hansen, 1962):

$$Cu = \frac{\theta_2 - \theta_1}{100} xDxBd \quad \text{......(13)}$$

Where:

CU = Water consumption use in cm;

θ_1 = Soil moisture % before irrigation (on dry weight basis);

θ_2 = Soil moisture % after irrigation (on dry weight basis);

D = Soil depth in cm;

Bd = Bulk density g/cm.^{3}

Water use efficiency (W.U.E.):

Water use efficiency (W.U.E) expressed as the weight of yield consumptive water can be obtained by the following equation as described by (Vites, 1965):

$$W.U.E = \frac{Root\ yield\ in\ kg / fed.}{Water\ applied\ in\ m^3 / fed} \text{, kg / m}^3 \quad \text{......(14)}$$

$$W.U.E = \frac{Sugar\ yield\ in\ kg / fed}{Water\ applied\ in\ m^3 / fed} \text{, kg/m}^3 \quad \text{......(15)}$$

RESULTS AND DISCUSSION

1-Some soil physical properties:

Bulk density:

Values of bulk density as tabulated in Table 4. showed that the values increased from 1.13 to 1.29 g/cm^3 with increasing of soil depth from 0 to 60 cm. This is due to the compaction of lower soil depths resulted from the ploughing process, which reduces pore spaces.

Soil porosity:

Data tabulated in Table 4. cleared that the trend of total soil porosity has a reverse direction to that of bulk density values. The degree of porosity is measuring way to evaluate the aeration of soil. Since, the seedbed preparation depth is concentrated in the upper 15cm. Therefore, it is expected to have the highest value of porosity at the surface and vise versa by increasing soil depth. Another reason for increasing soil porosity at the surface soil layer is due to the decay of plant roots that grow and distribute within the top soil layer

Table 4. some soil physical properties*: -

Soil depth, cm	Bulk density, g/cm^3	Soil porosity, %
0-15	1.13	57.0
15-30	1.17	55.0
30-45	1.24	53.0
45-60	1.29	51.0

*The values were average of ten replicates.

Infiltration rate (mm/h)

Fig. 1 indicates the effect of four different tillage systems ploughing before on infiltration rate the soil. It is obvious that the values of infiltration were relatively high at the beginning of measurements. As the upper soil layer becomes saturated, the potential difference in saturation water depth and soil profile decreased. Then the values of infiltration decreased to reach about a constant value at the end of experiment (El-Gohary, 1978). The highest value of infiltration rate was obtained by using mouldboard plough followed by rotary tiller. In the same time the unploughed soil gave the lowest values of infiltration rate.

2- Rate of disturbed soil volume:

Fig. 2 illustrates the effect of four different ploughing systems on the rate of disturbed soil volume. It can be noticed that the volume unit values of disturbed soil were 634.01, 1148.35, 1831.78 and 1634.85 m^3/h for chisel plough one pass, chisel plough two passes, mouldboard plough and disk harrow two passes, respectively. Chisel plough with 11.0cm depth gave the lowest value of the disturbed soil volume unit because chisel plough lift unplowed soil more than the other plough type. Whilst, the Mouldboard plough at 27.0 cm depth gave the highest value of the disturbed soil volume unit.

3- Soil pulverization:

Table 5 shows the effect of plough types and ploughing depth on the pulverization degree. Generally, the pulverization degree increased by decreasing the plowing depth with all plow types, because the clods with diameter more than 100mm were increased by increasing plowing depth with all plough types. The average values of soil pulverization degree were 79.41, 68.84, 76.93 and 66.16% for M_1, M_2, M_3 and M_4 respectively.

Table 5. Effect of four tillage systems on soil pulverization degree and clod sizes after ploughing*.

Items	Tillage systems parameters	Chisel plough one pass		Chisel plough two passes		Mouldboard plough		Disk harrow two passes	
		kg	%	kg	%	kg	%	kg	%
After ploug-hing	Clods	45	35.71	31	16.85	124	42.03	23	15.97
	Pulverized soil	81	64.29	153	83.15	171	57.97	121	84.03
	Mobilized soil	126	79.41	184	68.84	295	76.93	144	66.16
	Mass of $1m^2$ at*	158.67	-	267.3	4.89	383.47	-	217.67	-
After rotary	Final clods	16	12.7	9	95.11	62.39	21.15	-	-
	Pulverized soil	110	87.30	175		232.61	78.85	-	-

* Total soil mass in m^2 ploughed area was calculated at 1398 kg/m^3 soil bulk density and ploughing depth (in Table 5)

The ploughing depth (pd), increase the height of soil surface (hs) and the relative increase in soil volume (Rv) are listed in Table 6 for four different tillage methods. Ploughing with mouldboard plough gave the greater ratio of the relative increase in soil volume due to the bigger clod sizes and the greater depth. Whilst the chisel plough one pass, chisel plough two passes and disk harrow gave the less ratio of the relative increase in soil volume. It was found that the relative increase of soil volume referred to ploughing and ranged in between 25% in chisel plough one pass to 26% in chisel plough two passes, mouldboard plough reached 31% while it was 21% for disk harrow are shown in Table 6.

Table 6. Effect of tillage systems on relative increase in soil volume of clayey soil.

Ploughing Character	Chisel plough one pass	Chisel plough two passes	Mouldboard plough	Disk harrow two passes
hs, cm	2.94	5.11	8.56	3.35
Pd, cm	11.0	19.0	27.0	15.0
Rv	0.267	0.269	0.317	0.223

Fuel consumption:

Table 7 indicates the effect of plough types on fuel consumption. It can be noticed that the rate of fuel consumption was 8.1, 11.20, 13.7 and 9.50 L/h for chisel one pass, chisel two-passes, mouldboard and disk harrow, respectively. Also, the values of power required were 25.60, 35.39, 39.43 and 30.02 kW for the same tillage systems, respectively.

Energy requirements:

Energy requirement increases by increasing fuel consumption rate. Average values of energy requirement were 19.25, 24.75, 27.23 and 12.04 kW.h / fed. for chisel one-pass, chisel two-passes, mouldboard and disk harrow two passes, respectively Table 7. It is clear that, the highest value was obtained with mouldboard. While, the lowest value was obtained with disk harrow.

Field capacity for tillage implements:

The obtained values of effective field capacity were found to be 1.33, 1,43, 2.50, 1.59 and 1.34 fed/h for chisel one-pass, chisel two-passes, disk harrow, mouldboard plough and rotary plough, respectively Table 7.

Table 7. Effect of seedbed preparation systems on effective field capacity, fuel consumption, power and energy requirements.

Treatments	Effective field capacity, (fed./h)	Fuel consumption, (L/h)	Power required, (kW)	Energy required, (kW.h/fed.)
Chisel one-pass	1.33	8.10	25.60	19.25
Chisel two-passes	1.43	11.20	35.39	24.75
Mouldboard	1.59	13.70	43.29	27.23
Disk harrow two passes	2.50	9.50	30.02	12.04
Rotary tiller	1.34	6.30	19.91	14.86

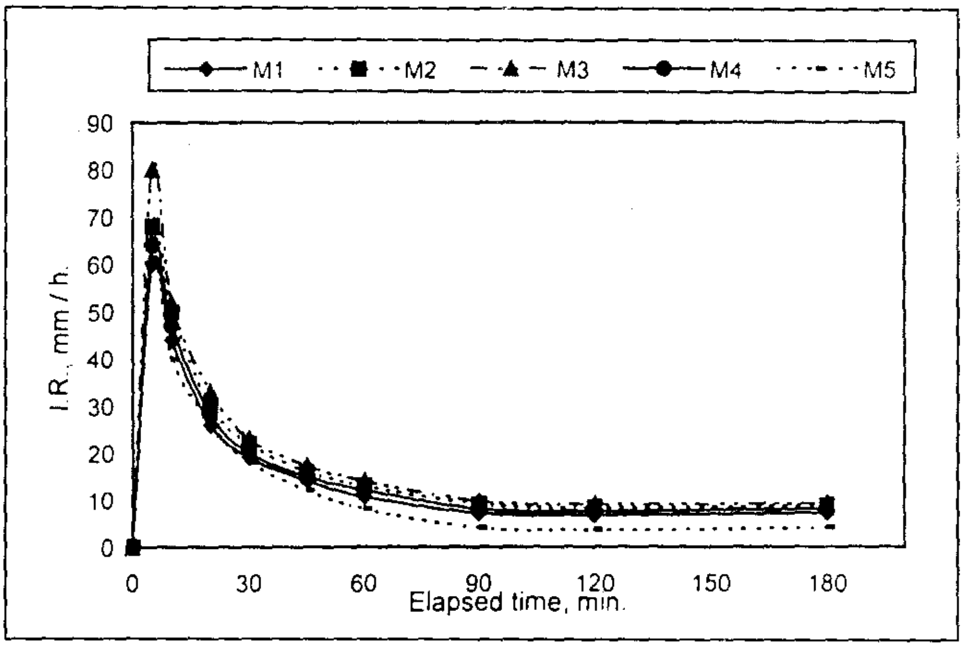


Fig. 1. Infiltration rate during 3 hours for different ploughing operation.

M_1 = Chisel plough one p pass + Rotary

M_2 = Chisel plough two p passes + Rotary

M_3 = Moldboard plough + R

M_4 = Disc harrow

M_5 = Before ploughing

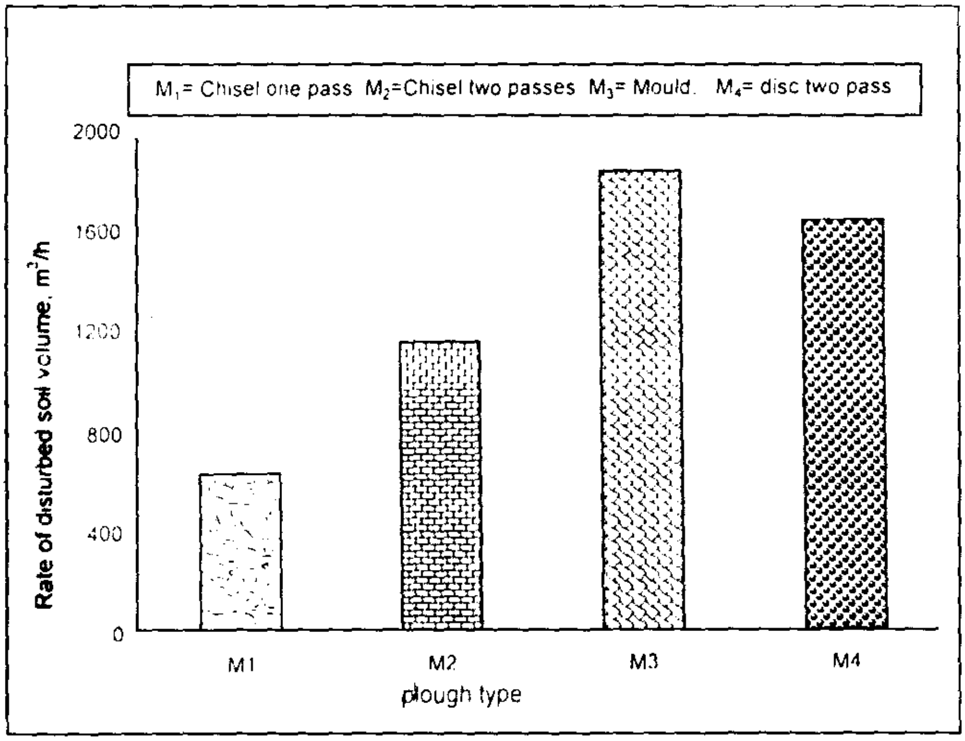


Fig. 2. Effect of ploughing systems on rate of disturbed soil volume.

Yield and it's components:

Root size (Length, diameter and volume):

The average root length, diameter and volume at harvest time as affected by different tillage systems are indicated in Table 8.

Table 8. Effect of different tillage systems on root size.

Item	Chisel one pass + Rotary	Chisel two passes + Rotary	Mouldboard + Rotary	Disk harrow two passes
Length, cm	29.5	37.0	40.0	31.5
Diameter, cm	22.0	30.0	35.0	25.6
Volume, cm^3	275.0	620.0	750.0	600.0

The mouldboard plough + rotary produced longer roots 40.0 cm. while chisel plough one-pass + rotary produced a shorter one 29.5 cm. However, the highest values of root diameter 35.0cm was obtained with mouldboard plough + rotary, while the lowest value 22.0cm was obtained with chisel one-pass + rotary. On the other hand the root volume increased significantly with increasing the rate of disturbed soil volume. The values of root volume which obtained from the experiments were 275.0, 620.0, 750.0 and 600.0 cm^3 for chisel one-pass + rotary, chisel two-pass + rotary, mouldboard + rotary and disk harrow two passes, respectively.

Root yield, (mt/fed.):

Data presented in Table 9 indicates the effect of four different tillage systems on root yield. The values of root yield, which obtained from the experiments, were 18.26, 24.00, 30.00 and 22.23 mt/fed. for chisel one-pass + rotary, chisel two-passes +rotary, mouldboard + rotary, and disk harrow two passes, respectively. The highest root yield 30.0 mt/fed. was obtained from mouldboard + rotary. On the other hand the lowest value of 18.260 Mg/fed was obtained from chisel one-pass + rotary. This is due to the micropores increase in the root growth zone and lower porosity of such environments.

Sugar yield, (mt/fed.):

The sugar yield is an important yield parameter of sugar beet because it is the final form that the consumer uses. The effect of four different tillage systems on sugar yield was presented in Table 9. The results indicated that the average of sugar yield with chisel one-pass + Rotary, chisel two-passes + Rotary, Mouldboard + Rotary and Disk harrow two passes were 3.00, 4.00, 4.70 and 3.30 mt/ Fed., respectively. Sugar yield is related not only to root yield but also to the root volume. The best values of sugar yield was 4.70 mt/fed; with mouldboard + rotary, while the worst value was 3.0 Mg/fed. with chisel one-pass + rotary.

Cost of seedbed preparation per feddan:

Table 9 indicates the cost of seedbed preparation systems per feddan. The obtained values of the cost for the four various seedbed preparation systems were found to be 31.60, 46.00, 36.12 and 18.80 L.E/fed. for chisel one pass followed by rotary tiller, chisel plough two passes followed by rotary tiller, mouldboard plough followed by rotary tiller and disk harrow two passes, respectively.

From the listed data it is clear that the disk harrow gave the minimum cost per feddan (18.80 L.E/fed.), while the chisel plough two passes followed by rotary tiller gave the maximum cost per feddan (46.00 L.E/fed.).

Water consumption:

Values of irrigation water consumption m^3/fed. for tillage systems are shown in Table 9. The total water consumption was 2035.32, 2208.78, 2390.64 and 2189.00 m^3/fed. for treatments chisel one pass + rotary, chisel two passes + rotary, mouldboard + rotary and disk harrow two passes, respectively.

Also, the W.U.E is depending upon the two factors of crop yield and consumed water. Values of W.U.E. as shown in Table 9. The values of W.U.E. were 8.97, 10.87, 12.55 and 10.15 kg/m^3 for root yield, while the W.U.E. were 1.47, 1.81, 1.97 and 1.51 kg/m^3 for sugar yield were obtained under the same tillage systems, respectively. The highest W.U.E. of root and sugar yield were 12.55 and 1.97 kg/m^3 for the mouldboard plough + rotary. While the lowest W.U.E. where 8.97 and 1.47 kg/m^3 for the chisel one-pass + rotary.

Table 9. Water use efficiency (kg/m^3) for both root and sugar yield under different seedbed preparation.

Treatments	Water consumption m^3/fed	Yield, (kg/Fed)		W.U.E., (kg/m^3)		Cost of seedbed Preparation Systems, (L.E/fed.)
		Root	Sugar	Root	Sugar	
Chisel one-pass + R*	2035.32	1826	3.00	8.97	1.47	31.60
Chisel two-passes + R*	2208.78	2400	4.000	10.87	1.81	46.00
Mouldboard + R*	2390.64	3000	4.70	12.55	1.97	36.12
Disk harrow two passes	2189.88	2223	3.30	10.15	1.51	18.80

R*: Rotary

CONCLUSION

From the previous results can be concluded that:

a-The soil bulk density increases from 1.13 to 1.29 g/cm^3 by the increase of soil depth from o to 60 cm. However, the soil porosity had a reverse proportion al with the ploughing depth.

b- That, the highest value of soil pulverization degree was 95.11 % for chisel plough two passes followed by rotary tiller. Whilst, the minimum value was of 78.85 % by using mouldboard plough followed by rotary tiller.

c- The highest value of energy requirement was 27.23 kW.h/fed.for mouldboard plough whilst, the minimum value was 12.04 kW.h/fed for disk harrow two passes.

d- The maximum value of water consumption was 2390.64 m^3/fed. for mouldboard plough followed by rotary tiller. However, the minimum value was 2035 m^3/fed for chisel plough one pass followed by rotary tiller.

e- Mouldboard plough followed by rotary tiller gave the maximum value of water use efficiency of 12.55 kg/m^3. In the same time, the minimum value was 8.97 kg/m^3 for chisel plough one pass followed by rotary tiller.

f- The maximum value of root yield was found to be 30.0 mt/fed by using mouldboard plough followed by rotary tiller. On the other hand, chisel plough followed by rotary tiller gave the minimum value of 18.26 mt/fed.

g- The total cost of disk harrow two pass was the cheapest where, it reached 18.8 L.E/fed meanwhile, the chisel plough two pass followed by rotary tiller reached its maximum value of about 46 L.E/fed.

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دراسة مقارنة لتأثير نظم الخدمة المختلفة علي استهلاك مياه الري وإنتاجية محصول بنجر السكر

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أجرى البحث لدراسة انسب الطرق الملائمة لعملية إعداد مرقد البذرة وتأثيرها علي الخـواص الطبيعية للتربة ومدي الاستفادة من مياه الري المضافة بغرض تعظيم إنتاجية المحصول. ولتحقيق هذا الهدف أقيمت تجربة بحقل المقننات المائية بمحطة البحوث الزراعية بسخا – محافظة كفـر الشـيخ خلال الموسم الزراعى ٢٠٠٤/٢٠٠٥م لمساحة فدانين حيث تم خدمتها بنظم حرث مختلفة وزراعتها بمحصول بنجر السكر (صنف – هلينو). **ولقد اشتملت الدراسة علي المعاملات التالية:-**

أ- النظام الأول :- حفار وجه واحد + عزاقة دورانية. ب- النظام الثـاني:- حفـار وجهـين + عزاقة دورانية.

ح- النظام الثالث:- قلاب مطرحي + عزاقة دورانية. د- النظام الرابع:- مشط قرصي وجهين.

ويمكن تلخيص النتائج المتحصل عليها كما يلي:-

١- أوضحت النتائج فروق عالية المعنوية للزيادة النسبية لحجم التربة المثار بين معاملات الحراثـة المختلفة حيث أعطى النظام الثالث ٣١ % زيادة في حجم التربة بالمقارنة بالنظام الرابع والتي كانت فيه ٢١ %.

٢- بينت النتائج أيضا ان اعلي درجة لتنعيم التربة تم الوصول إليها كانت ٩٥,١ % عنـد اسـتخدام النظام الثاني، بينما كانت اقل قيمة لدرجة التنعيم ٧٨,٨٥ % عند إستخدام النظام الثالث.

٣- تزداد الطاقة المطلوبة لعملية الحرث بزيادة عمق الحرث، حيـث أعطـي المحـراث القـلاب المطرحي اعلي قيمة ٢٧,٢٣ كيلو وات. ساعة / فدان عند عمق ٢٧ سم، بينما كانـت أقـل قيمـة ١٢,٠٤ كيلو وات. ساعة / فدان عند إستخدام المشط القرصي وجهين عند عمق ١٥ سم.

٤- أقل تكلفة لنظام الخدمة كانت عند استعمال النظام الرابع حيث بلغت ١٨,٨٠ جنيه / فدان، بينمـا أعطي النظام الثاني اكبر قيمة حيث وصلت إلى ٤٦,٠٠ جنيه / فدان.

٥- توجد علاقة طردية بين عمق الحرث والاستهلاك الكلي لمياه الري حيث وصـلت أعلـي قيمـة ٢٣٩٠ م٣ / فدان عند استخدام النظام الثالث بعمق ٢٧ سم، بينما كانت أقل قيمة ٢٠٣٥ م٣ / فـدان عند إستخدام النظام الأول للحراثة بعمق ١١سم.

٦- تزداد كفاءة استخدام مياه الري بزيادة عمق الحرث، حيث وصلت أعلي قيمة ١٢,٥٥ كجم / م٣ لنظام الخدمة الثالث، بينما كانت أقل قيمة ٨,٩٧ كجم / م٣ لنظام الخدمة الأول لعملية الحرث.

٧- أمكن ترتيب النظم المختلفة المستخدمة لاعداد الأرض لانتاج محصول بنجر السكر طبقا للإنتاجية حسب الترتيب التالي: النظام الثالث (٣٠,٠ طن/فدان) > النظام الثاني ٢٤,٠ طن/فدان > النظام الرابع ٢٢,٢٣ طن/فدان > النظام الأول (١٨,٢٦٠ طن / فدان)