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SEEDBED PREPARATION AND IRRIGATION DEPTHS AFFECTING SOIL PHYSICAL PROPERTIES AND RICE YIELD

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ABSTRACT

The goal of the present work is to assess an optimum system of seedbed preparation and irrigation depth for rice production. To achieve this goal five seedbed preparation systems and four irrigation depths were used to study their effect in clayey soil on some soil physical properties, rice yield, some yield components, water use efficiency, fuel consumption, energy requirements and production cost. The seedbed preparation systems were as follows, (A): Chiselling one pass + levelling, (B): Chiselling twice + levelling, (C): Chiselling twice + harrowing + levelling, (D): Chiselling twice + subsoilling + harrowing + levelling and (E): Moldboarding + harrowing + levelling, while irrigation depths were 60, 80, 100 and 120 mm per irrigation. The data indicated that soil bulk density and soil penetration resistance decreased for all seedbed preparation systems, while vice versa was noticed with the total porosity and void ratio. The highest relative decreases of bulk density and soil penetration resistance were 23.7 and 23.51% and the highest relative increases of soil porosity and void ratio were 26.67 and 66.03% respectively, at soil depth of 10-20 cm under seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling). The highest rice grain yield was 4.35 and 4.20 ton/fed for irrigation depth of 120 mm under seedbed preparation systems D and C, while the lowest values were 2.61 and 2.67 ton/fed for irrigation depth of 60 mm under seedbed preparation systems A and B respectively. Increasing irrigation depth from 60 to 80, from 80 to 100 and from 100 to 120 mm, the total rice grain yield increased by 26.36, 40.52 and 46.62%, respectively. The highest total energy requirement of 70.18 and 56.91 kW. h/fed were obtained under seedbed preparation systems D and E, but the lowest values were 25.01 and 36.75 kW. h/fed under seedbed preparation systems A and B. The minimum cost per unit production of 188.28 and 190 LE/ton were obtained for irrigation depth of 120 mm under seedbed preparation systems D and C, but the maximum values were 263.6 and 259.93 LE/ton for irrigation depth of 60 mm under seedbed preparation systems E and B respectively.

INTRODUCTION

Water is a vital and critical resource in Egypt. Today, there is an intention to save the irrigation water and to increase the yield per unit area. Both water and yield depend to a great extent on the quality of seedbed preparation and soil conditions. Surface irrigation method is still the most widely used in the valley land, water is spread across the land surface using basin, border and furrow methods. Seedbed preparation is the first and most important process in crop production. Tillage operations are one of the most important factors controlling both the suitability physical conditions of the soil. In Egypt, rice is considered one of the most important crops used for human consumption and many other purposes such as animal feeding.

Abdel-Maksoud et al. (1985) found that cotton yield increased by 0.748 ton/fed., due to effect of subsoiling at depth 50 cm compared to the conventional chiselling at 20 cm depth. They also found that the total costs were 37.75, 21.76, 11.05, 10.9 and 21.6 LE/fed under different soil managements (chiselling twice + levelling + ridger + manual planting); (chiselling twice + subsoiling + levelling + mechanical planting); (chiselling twice + levelling + mechanical planting); (chiselling twice + levelling + mechanical planting) and (chiselling once + harrowing + subsoiling + levelling + mechanical planting) at condition in this period.

Zin El-Din (1985) found that soil bulk density generally decreased due to tillage treatments except the no-tillage. The reduction in soil bulk density increased by increasing the ploughing depth at the top layer (0-10 cm). At the bottom layer (20-30 cm) the reduction was less than in the top and middle layers. He also found that the minimum energy required for seedbed preparation generally was obtained with the using of chisel plough. Energy needs by using of mouldboard plough were about (3-4) times the chisel plough.

El-Ansary and El-Mallah (1986) reported that subsoiling operations has significant favorable effect on soil bulk density and soil porosity. The system of chiselling twice or chiselling + harrowing, improves the soil physical properties. They also found that at the system (chiselling twice + harrowing twice) followed by subsoiling, cotton yield increased by 13% depending on using subsoiling than without subsoiling. They also concluded that subsoiling operations are considered economical process since the resulting increase of yield due to subsoiling covered the cost of operation and increased profit by 15-20% compared to non subsoiling treatment.

Ward (1988) found that the fuel and energy consumption values were 21.51, 31.34 and 38.02 L/fed and 21.75, 44,12 and 65.35 kW. h/fed under treatments of no-tillage, minimum tillage and conventional tillage.

El-Banna and Helmy (1992) found that conventional tillage is effective in increasing the porosity of compact soil near the surface more than two passes of chisel plough which gave higher degrees of tillage and porosity than shallow or deep ploughing.

Suliman et al. (1993) found that soil bulk density was decreased for all tillage systems, but, the total porosity and void ratio increased as follows. These effects were arranged in the following descending order: chisel plough one pass, chisel plough two passes, chisel plough three passes, disc harrow, rotary plough and no-tillage.

Whel (1993) studied the cost of tillage operations as reported in the official government announcements, chiselling two faces was 25 L.E/fed., chiselling three faces 35 L.E/fed, subsoiling (3 tines) 36 L.E/fed., and land leveller (3 m width) 20 L.E/fed.

Gharieb (1996) found that total fuel consumption and energy requirement were 23.25, 27.23 and 19.70 L/fed and 23.86, 24.2 and 20.55 kW.h/ton under treatments A (chiselling twice + disc harrowing + levelling + planting manually); B (chiselling twice + disc harrowing + levelling + planting with planter) and C (chiselling once + subsoiling + levelling + planting manually).

Abdel-Wahab et al. (1998) found that the soil bulk density was decreased by 18.18 and 21.19% for chisel and moldboard plough respectively. They also stated that the fuel consumption increased with the increase of ploughing depth from (0-10 cm) to (15 to 20 cm).

El-Saeed et al. (1998) found that the energy requirement increased by increasing the ploughing depth. The minimum value of power required for volume unit of distributed soil was 0.044 kW/m^3 by using chisel plough at 10 cm ploughing depth.

Naser (1999) indicated that the fuel consumption under treatments chiselling two faces +double disc + levelling, chiselling two faces + levelling and chiselling once + levelling were 23.8, 20.5 and 14.1 L/fed., respectively.

Younis et al. (2000) found that the fuel and energy consumption by chisel plough once face, chisel plough two faces, chisel plough three faces, land leveller and ridger were 4.69, 4.56, 5.38, 5.33 and 6.55 L/h., and 47.88, 36.07, 40.20, 25.49 and 43.96 kW. h/fed under average speed 3.31, 3.72, 4.30, 4.25 and 4.79 km/h, respectively. They also showed that the total cost of unit cotton producing under treatment (chiselling three faces + tooth harrow + land leveller + ridger) was 94.65 L.E/fed (111 L.E/ton).

Morad and Fouda (2003) found that the maximum reduction in soil bulk density and soil penetration resistance of 17.29 and 71.97% were observed under treatment T2 (Chiselling twice + rotary plow + land leveler).

The objectives of the present investigation are to study the effect of seedbed preparation and irrigation depths on the following points:

1. Some soil physical properties (bulk density, porosity, void ratio and penetration resistances).
2. Rice crop and water use efficiency.

3. Fuel consumption and energy requirements.
4. Production cost.

MATERIALS AND METHODS

A field experiment was carried out at EL-Manzala, Dakahlia Governorate, (المنزلة ، دقهلية) to study the interactions between some seedbed preparation systems and irrigation depths on some soil physical properties, rice yield and its components. The water use efficiency, fuel consumption, energy requirements and production cost analysis were evaluated. To achieve the aim of the present work, an experiment was designed as a randomized complete block with split-plot arrangement of treatment in three replicates. Main plot was seedbed preparation systems and the sub-plots were irrigation depths.

Seedbed preparation systems and irrigation depth treatments:

a- Seedbed preparation systems:

Five seedbed preparation systems in the present study were as follows:

(A) : Chiselling one pass + levelling.

(B) : Chiselling twice + levelling.

(C) : Chiselling twice + harrowing + levelling.

(D) : Chiselling twice + subsoilling + harrowing + levelling.

(E) : Moldboarding + harrowing + levelling.

b- Irrigation depth:

For each seedbed preparation system, four irrigation depths were applied. The irrigation depths for each irrigation were 60, 80, 100 and 120 mm, and the water depth for nursery was 160 mm, equivalent to about 4956, 6384, 7812 and 9240 m^3/fed/season (Q1, Q2, Q3 and Q4). The irrigation interval was 6 days for all treatments. The experiment was conducted in an area of 4.3 feddan. It was divided into 20 treatments and 60 plots. The plot area adopted was 6.0 x 50 m. The average forward speeds were 3.4 km/h for chiselling one pass, 3.9 km/h for chiselling twice, 3.1 km/h for moldboarding, 5.4 km/h for harrowing and 4.3 km/h for land levelling. The average depth of 25 cm for chisel plough, 25 cm for moldboard plough, 15 cm for disc harrow and 45 cm for subsoilling plough. This is for enhancing soil properties and leach out the salt down to deep layers or drains.

Materials:

The specifications of the different machinery used for seedbed preparation were as follows:

1-Tractors:

a- Romanian Universal tractor of 650 M type, made in Brasov, four cylinders, diesel engine, four stroke, hydraulic system, water cooled and four wheels; had 48.8 kW engine power.

b- Ford, made in USA, six cylinders, diesel engine, four stroke, hydraulic system, water cooled and four wheels; had 88.26 kW engine power.

2- Ploughs:

a) A mounted chisel plough consisted of seven shanks in two rows with 1.75 m width.
b) A moldboard plough; 3 blades with 1.2 m width.
c) A disc harrow with 260 cm working width and 24 discs.
d) A mounted subsoilling plough: with two shanks in one row 100 cm apart.

3- Levelling:

A trailed scraper local manufactured with two wheels and working width of 2.5 m. was used.

Rice (variety Giza 178) was planted as usual with conventional methods. The seedlings were transplanted in hills (about three single plants per hill) spaced at 20 x 20 cm between hills and rows. All conventional agricultural practices were applied as usually done for rice production and were the some for all treatments. Some physical and chemical properties of the soil are presented in Table 1.

Table1: Some physical and chemical properties of the soil experimental.

Soil depth, cm	Particle size distribution, %			Textural class	Particle density, g/cm^3	Bulk density, g/cm^3	Field capacity, %	P^H	EC, ds/m	Penetration resistance, N/cm^2
	Sand	Silt	Clay							
0-10	10.10	36.46	53.44	Clay	2.53	1.19	40.3	8.05	10.0	46.90
10-20	11.30	33.19	55.51	Clay	2.55	1.35	42.00	8.12	8.20	47.20
20-30	11.90	35.00	53.10	Clay	2.56	1.42	41.50	8.10	7.90	48.20
30-45	11.10	32.80	56.10	Clay	2.66	1.46	44.50	8.29	10.20	48.60
0-45	11.10	34.88	54.02	Clay	2.58	1.36	42.08	8.14	9.08	47.43

Methods:

At least three random samples were taken before starting the experiment and after rice harvesting for each treatment to determine the following parameters at four depths of 0-10, 10-20, 20-30 and 30-45 cm.

1- Soil physical properties:

a- Soil bulk density (B_d):

The soil samples were determined at four depths of 0-10, 10-20, 20-30 and 30-45 cm to determine soil bulk density according to Black (1965).

$$B_d = M_s/V_t \quad \text{...(1)}$$

Where:

M_s : dry soil mass, g and V_t : total soil volume, cm^3

- Relative decrease of bulk density:

The percentage of reduction in soil bulk density (PB_d) was calculated as follows:

$$PB_d = 100\ (B_{d1} - B_{d2})/B_{d1} \quad \text{..............................(2)}$$

Where :

B_{d1}:bulk density before treatments, g/cm^3 and

B_{d2}: bulk density after treatments, g/cm^3.

b- Soil particle density (D_s):

The soil samples were determined at four depths of 0-10, 10-20, 20-30 and 30-45 cm to determine soil particle density according to:

$$D_s = M_s/V_s \quad \text{..(3)}$$

Where:

V_s : volume of soil solids, cm^3 .

c- Total soil porosity (E):

Volume of pore space as the ratio to the total soil volume can be determined as the soil porosity by using the following formula:

$$E = 100\ (1 - B_d/D_s) \quad \text{..(4)}$$

- Relative increase of soil porosity:

The percentage of relative increase in soil porosity (RIE) was calculated as follows:

$$RIE = 100\ (E_1 - E_2)/E_1 \quad \text{.....................................(5)}$$

Where:

E_1: soil porosity before treatments, % and

E_2: soil porosity after treatments, %.

d- Void ratio (e):

The void ratio was calculated using the following formula:

$$e = (D_s/B_d) - 1 = (V_t - V_s)/V_s \quad \text{.............................. (6)}$$

- Relative increase in void ratio:

The percentage of relative increase in void ratio (RIe) was calculated as follows:

$$\mathbf{RIe = 100\,(e_1 - e_2)/e_1} \quad \text{...(7)}$$

Where :

e_1 and e_2 : void ratio before and after treatments, %.

e- Soil Penetration resistance:

Soil penetration resistance was measured using a penetrometer. The percentage of reduction in the soil penetration resistance (PR) was calculated from the following formula:

$$\mathbf{PR = \{(R_1 - R_2)/R_1\}\ 100} \quad \text{.......................................(8)}$$

Where:

R_1: soil penetration resistance before operations, N/cm^2 and

R_2 : soil penetration resistance after operations, N/cm^2.

2- Irrigation depths:

The irrigation water applied for each experimental plot was measured using plastic siphons, with an inner diameter 10 cm and 50 cm length from unlined irrigation field channels located along the experimental plot. Water head on the siphon was measured during irrigation. The irrigation water quantity (discharge rate) delivered through a plastic siphon of 10 cm inner diameter was calculated by the following equations (Israelsen and Hansen, 1962):

$$\mathbf{q = C\,a\sqrt{2gh}} \quad \text{..(9)}$$

Where:

q: siphon discharge rate, m^3/s; C: an empirical discharge coefficient, found to be 0.71; a: cross-sectional area of the siphon, m; g: gravity acceleration, m/s^2, and h: average effective head on siphon, m.

$$\mathbf{Q = q \times T \times n} \quad \text{...(10)}$$

where:

Q: water volume, m^3/plot; q: siphon discharge rate; m^3/s;

T: total irrigation time, min, n: number of siphon tube per each plot.

3-Fuel consumption rate:

The fuel consumption rate was determined for each field operation by measuring the decrease in fuel level in the fuel tank in the duration time of the operation.

4-Energy requirement (ER):

Energy requirement for each field operation and total energy for each treatment (TE) were calculated using the following equations:

$$\mathbf{ER} = \frac{\textbf{Machine power (kW)}}{\textbf{Actual field capacity (fed/h)}}\text{, kW.h/fed} \quad \ldots\ldots\ldots\ldots(11)$$

TE (kW.h/fed) = $\sum$**ER** = summation of energy requirements for all operations applied under each treatment.

The draft for each machine was measured using a hydraulic dynamometer.

$$\textbf{Draft} = \frac{\pi\left(\Phi_1^2 - \Phi_2^2\right)}{4} \times p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(12)$$

Where :

p: dynamometer pressure reading, kg/cm^2,

Φ_1^2 : diameter of piston, cm and

Φ_2^2 : diameter of rod, cm.

$$D_1 = \textbf{draft} \times \frac{\textbf{speed}}{\textbf{const.}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(13)$$

$$D_2 = \textbf{rolling resistance} \times \frac{\textbf{speed}}{\textbf{const.}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

$$D_3 = (\textbf{draft} + \textbf{rolling resistance}) \times \frac{\textbf{speed}}{\textbf{const.}} \times \frac{\textbf{slip percent}}{\textbf{100 - slip percent}} \quad ..(15)$$

Machine power = $D_1 + D_2 + D_3$ (Suliman, 1982) ………… …....(16)

Where:

D_1: drawbar pull power, kW;

D_2: power consumed by rolling resistance, kW,

D_3 : power consumed in slip, kW, and, **const.**: a conversion factor.

5- The rice yield and yield components:

The rice yield was determined as the final goal to evaluate the effect of seedbed preparation systems and irrigation regimes on rice production. Plant samples were collected from the center of the rows in each plot at different treatments after 130 days after transplanting for studying the yield and its components. At harvesting, the following data were recorded: grain yield, straw yield, panicles number/m^2, seed index (1000 grain mass), panicle length, plant height and harvest index.

6-Water use efficiency (WUE):

Water use efficiency was calculated according to the following formula:

$$WUE = \frac{\text{Total grain yield (kg/fed)}}{\text{Total water applied (m}^3\text{/fed)}}, \quad kg/m^3 \quad \ldots\ldots\ldots\ldots\ldots(17)$$

7- Total production costs:

The total production costs of rice yield included seedbed preparation systems, irrigation system cost, transplanting costs, fertilization cost, weed control cost, pest control cost and harvesting costs.

Capital cost was calculated using the current dealer prices for equipment and installation according to 2003 price level. The cost of mechanized operations was based on the initial cost of machine, interest on capital, fuel cost and oil consumed, cost of maintenance, and wage of the operator according to the following formula (Awady,1978).

$$C = \frac{P}{h}\left(\frac{1}{e} + \frac{I}{2} + t + r\right) + (0.9hp \times F \times S) + \frac{W}{144} \ldots\ldots\ldots\ldots\ldots(18)$$

Where:

C: hourly cost, L.E/h; **P**: capital investment, L.E; **h**: yearly operating hours; **e**: life expectancy; **I**: interest rate; **t**: taxes and overheads ratio; **r**: repairs ratio of the total investment; **0.9**: A factor including reasonable estimation of the oil consumption in additions to fuel; **hp**: horsepower of engine; **F**: specific fuel consumption in L/hp.h; S: fuel price L.E/L.; **W**: labor wage rate per month in L.E, and **144**: reasonable estimation of monthly working hours.

8- Cost per unit production

Cost per unit production was calculated by using the following formula:

$$\text{Cost per unit production} = \frac{\text{Total production costs (LE/fed)}}{\text{Total grain yield (ton/fed)}} \text{ LE/ton.} (19)$$

9- Net profit:

The economical profit of rice yield was calculated by using the following formula (Younis et al.,1991):

$$P = (Yt \times d) - Ct \ldots\ldots\ldots\ldots\ldots(20)$$

Where:

P: net profit, LE/fed; **Yt**: total grain yield, ton/fed;

d: yield price, 600 LE/ton, and, **Ct**: total production costs, LE/fed.

RESULTS AND DISCUSSION

1-Effect of seedbed preparation systems on some soil physical properties

a- Bulk density:

The effect of different seedbed preparation systems and irrigation depths on soil bulk density before and after treatments, is shown in Fig.1. The soil bulk density decreased with increasing the soil depth in all treatments. This phenomenon may return to the increasing of the soil distribution volume. The data in Fig.1 indicate that the soil bulk density after treatments decreased with increasing soil depth than before treatments. The least bulk density value was obtained in the seedbed preparation system D compared to the other different treatments. This effect was more evident in the four upper successive layers of 0-10, 10-20, 20-30 and 30-45 cm. The data indicated that the highest relative decreases of bulk density of 18.49, 23.7, 14.79 and 13.7% were obtained at soil depths of 0-10, 10-20, 20-30 and 30-45 cm under seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling). But the lowest values were 8.41, 11.85, 11.27 and 2.74% under seedbed preparation system A (Chiselling one pass + levelling). The relative decreases of soil bulk density at depth 0-10 cm was reduced by 8.41, 11.77, 16.81, 18.49, and 15.97 % as a result of using seedbed preparation systems A, B, C, D and E respectively. Meanwhile at depth of 10-20 and 20-30 cm, the relative decreases of soil bulk density was reduced by 11.85 and 11.27%, 14.07 and 13.38%, 17.78 and 14.09%, 23.7 and 14.79%, and 18.52 and 16.2 % as a result of the same using seedbed preparation systems, respectively. Increasing soil depth from 0-10 to 10-20 and to 20-30 cm, the relative decreases of soil bulk density was reduced by 39.95, 13.73 and 18.72%; 99.88, 50.04 and 25.02%; 119.86, 100 and 31.23% and 89.89, 56.29 and 43.75% as a result of using seedbed preparation systems B, C, D and E compared to seedbed preparation system A, respectively. With the use of seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling) at soil depth of 30-45 cm, the relative decreases of soil bulk density of 13.7% was noticed due to the use of subsoiler for enhancing soil properties and leaching out the salt down to deep layers or drains. It was found that soil bulk density decreased after seedbed preparation system and the effect was higher in the upper layer than the lower layer due to the breakdown of soil structure. These results are in agreement with Zin El-Din (1985), El-Ansary and El-Mallah (1986), Suliman et al. (1993), Abdel-Wahab et al. (1998), El-Saeed et al. (1998) and Morad and Fouda (2003).

b- Soil porosity

Fig. 2 illustrates the effect of different seedbed preparation systems and irrigation regimes on total soil porosity. The soil porosity increased as the soil bulk density decreased. It was found that porosity values increased after seedbed preparation than before. The data indicated also that the porosity decreased gradually with depth. It was found that the deeper layers were more compacted than the surface soil layers.

The data indicated that the highest relative increases of the soil porosity (26.67%) was obtained under seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling). Meanwhile, the lowest value of 7.48% was obtained under seedbed preparation system A (Chiselling one pass + levelling). The relative increases of soil porosity at depth of 0-10, 10-20 and 20-30 cm, increased by 7.48, 13.32 and 14.04%; 10.46, 15.83 and 16.66%; 14.94, 20.0 and 17.54%; 16.43 26.67 and 18.42% and 14.18, 20.83, and 19.31 % as a result of using seedbed preparation systems A, B, C, D and E respectively, before seedbed preparation system compared to after treatments. These results are in agreement with El-Ansary and El-Mallah (1986), El-Banna and Helmy (1992) and Suliman et al. (1993).

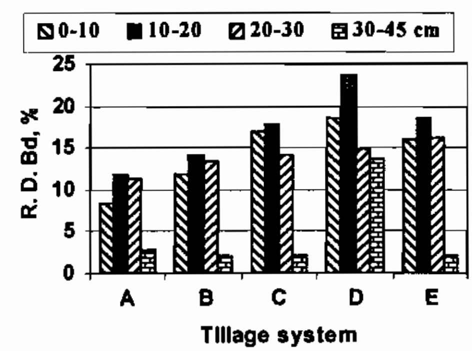

Fig. 1: Relative decrease of soil bulk density (R. D. of B. d.) under different treatments.

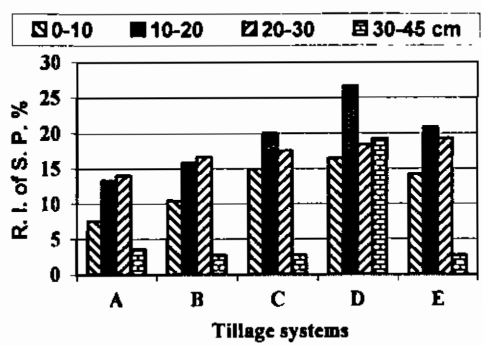

Fig. 2: Relative increase of soil porosity (R. I. of S. P.) under different treatments.

c- Void ratio:

The effect of different seedbed preparation systems and irrigation regimes on void ratio in different soil layers before and after treatments is shown in Fig.3. Generally, the void ratio of all soil layers at the end of the experiment are higher than those before. The void ratio increased for all seedbed preparation systems. The relative increases of void ratio increased by 13.23, 28.57 and 28.52%; 25.22, 34.76 and 34.62%; 38.19, 45.89 and 36.74%; 42.18, 66.03 and 38.98% and 35.88, 48.26 and 43.34% for soil depths of 0-10, 10-20 and 20-30 cm under seedbed preparation systems A, B, C, D and E respectively. These results are in agreement with Suliman et al. (1993). The void ratio decreased by increasing the soil depth from 0-10 to 20-30 cm since increasing the soil layer depth increased soil compaction. The seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling) gave the highest relative increases of the void ratio.

d- Soil penetrability:

The soil penetration resistance has a good indication of soil physical properties. The decreases of the soil penetration resistance allows the roots of the plants easily to penetrate the soil.

As shown in Fig.4, the soil penetration resistance increased by increasing ploughing depth, since increasing the soil layer depth increased the soil compaction. As illustrated in Fig. 4, the penetration resistance values were greatly affected by seedbed preparation systems and irrigation depths. The relative decreases of penetration resistance has the highest values of 19.44, 23.51, 15.06 and 13.49% at soil depths of 0-10, 10-20, 20-30 and 30-45 cm, under seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling), but the lowest values were 3.89, 7.23 and 6.02% for soil depths of 0-10, 10-20 and 20-30 cm under seedbed preparation system A (Chiselling one pass + levelling), respectively. This may be attributed to initial soil moisture distribution through soil profile.

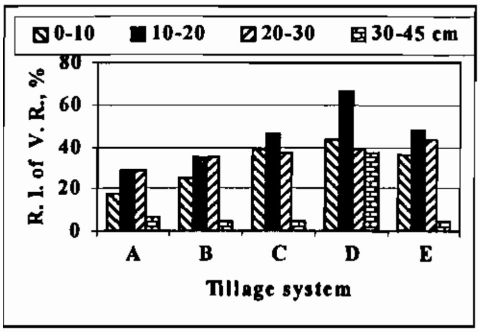

Fig. 3: Relative increase of void ratio (R. I. of V. R.) under different treatments.

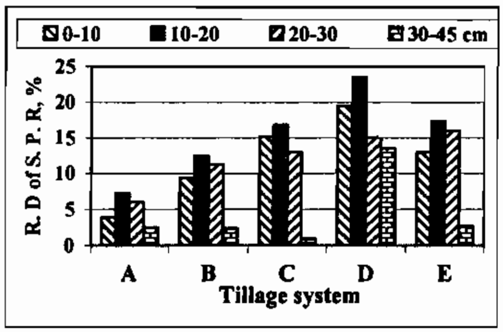

Fig. 4: Relative decrease of penetration resistance (R. D of S. P. R.) under different treatments.

Generally, for all seedbed preparation systems, the penetration resistance values decreased at surface soil layer until tillage depth. This may be due to soil compaction caused by seedbed preparation implements. It can be noticed also from Fig. 4 that the seedbed preparation systems D, C, E and B produced soil penetration resistances of 16.18, 10.34, 9.44 and 5.62% less than value obtained by seedbed preparation system A under the top soil layer (0-10 cm depth). The relative soil penetration resistances decreased by

3.89 and 7.23%; 9.29 and 12.48%; 15.12 and 16.82%; 19.44 and 23.51% and 12.96 and 17.36% for soil depths of 0-10 and 10-20 cm under seedbed preparation systems A, B, C, D and E. Meanwhile, at soil depth of 20-30 and 30-45 cm, the relative decrease values were 6.02 and 2.48%; 11.25 and 2.33%; 13.0 and 1.0%; 15.06 and 13.49%; 16.01 and 2.64% under the same seedbed preparation systems, respectively. The seedbed preparation system D gave the highest relative decreases of the soil penetration resistance values under all soil depths. These results are in agreement with El-Saeed et al. (1998) and Morad and Fouda (2003).

2- Effect of seedbed preparation systems and irrigation depth on rice yield and yield components:

a- Yield components:

The effect of different seedbed preparation systems and irrigation depth on rice yield and some rice yield components is shown in Table 3. The data in Table 3 indicate that the rice plant height, panicles length, 1000-grain mass, rice straw and grain yields increased under seedbed preparation system D and irrigation depth of 120 mm compared to different treatments. Concerning the harvest index, the results revealed that it also increased but under seedbed preparation system E and irrigation depth of 120 mm as compared to different treatments. Data also indicate that plant height, panicles length, 1000-grain mass and rice straw increased with increasing irrigation depth for each irrigated from 60 to 120 mm. This means that the increase in straw yields with increasing irrigation depth can be attributed to the increment of plant height, panicles length and 1000-grain mass. The desirable effects of increasing irrigation water on these growth attributes led to highest grain yield.

b- Rice grain yield:

Table 3 shows that seedbed preparation systems and irrigation depths have a great effect on rice yield. The irrigation depth of 120 mm/irrigation gave the highest rice grain yield of 4.35 ton/fed under seedbed preparation system D. This may be due to the preserving of high amount of irrigation available water in the root zone that is favorable for root growth and optimum seedbed preparation increasing, but the irrigation depth of 60 mm gave the lowest yield (2.61 ton/fed) under seedbed preparation system A. The relationships between rice grain yield and irrigation depth show that by increasing irrigation depth from 60 to 80, from 80 to 100 and from 100 to 120 mm, the rice grain yield increased by 34.56, 47.79 and 54.41%, respectively under seedbed preparation system C, but the relationships between rice grain yield and seedbed preparation systems show that the rice yield increased by 2.17, 13.82, 17.89 and 13.28%, under seedbed preparation systems B, C, D and E compared to seedbed preparation system A, respectively, under irrigation depth of 120 mm.

3- Effect of seedbed preparation systems and irrigation depth on water use efficiency (WUE):

Data registered in Table 3 show that the WUE is affected by irrigation depth and seedbed preparation systems. The highest WUE value of 0.59 kg/m^3 was remarked at irrigation depth of 60 mm and seedbed preparation system D, but the lowest value was 0.34 kg/m^3 under irrigation depth of 120 mm and seedbed preparation system A. Data in Table 3 show that adding irrigation depths of 60, 80, 100 and 120 mm, the WUE decreased from 0.55 to 0.55, 0.51 and 0.45 kg/m^3 under seedbed preparation system E.

Table 3: Effect of seedbed preparation systems and irrigation depths on rice yield, some yield components and WUE.

Seedbed preparation system	Irrigation regimes	Plant height, cm	Panicle length, cm	Panicles number/m^2	1000 grain mass, g	Total yield		Harvesting index	WUE, kg/m^3
						Grain, ton/fed	Straw, ton/fed		
A	Q1	79.5	17.3	291	21.95	2.61	3.50	0.43	0.53
	Q2	84.6	19.1	382	23.14	3.19	4.13	0.44	0.50
	Q3	87.9	20.4	400	24.17	3.56	4.80	0.43	0.46
	Q4	90.1	20.9	403	24.23	3.69	4.99	0.43	0.40
	Mean	85.5	19.4	369	23.37	3.27	4.36	0.43	0.47
B	Q1	79.9	17.9	300	22.16	2.67	3.57	0.43	0.54
	Q2	85.7	19.8	401	23.69	3.36	4.67	0.42	0.53
	Q3	89.8	20.7	411	24.23	3.76	4.93	0.43	0.48
	Q4	91.2	21.0	420	24.53	3.77	5.03	0.43	0.41
	Mean	86.7	19.9	383	23.65	3.39	4.55	0.43	0.49
C	Q1	81.1	18.1	351	22.73	2.83	3.62	0.44	0.57
	Q2	88.3	21.0	420	23.91	3.66	4.97	0.42	0.57
	Q3	93.3	21.9	430	24.47	4.02	5.23	0.44	0.52
	Q4	94.2	22.3	445	24.88	4.20	5.78	0.42	0.46
	Mean	89.2	20.8	412	23.95	3.65	4.90	0.43	0.52
D	Q1	83.3	20.9	363	22.90	2.92	4.00	0.42	0.59
	Q2	89.1	21.3	425	23.96	3.67	4.81	0.43	0.58
	Q3	94.3	22.0	437	24.52	4.03	5.01	0.45	0.52
	Q4	95.3	22.9	451	24.99	4.35	5.68	0.43	0.47
	Mean	90.5	21.8	419	24.09	3.74	4.88	0.43	0.54
E	Q1	82.7	19.3	339	22.60	2.72	3.73	0.42	0.55
	Q2	87.8	20.8	417	23.90	3.52	4.85	0.42	0.55
	Q3	92.8	21.4	428	24.46	3.97	5.22	0.43	0.51
	Q4	93.1	21.8	440	24.73	4.18	5.18	0.45	0.45
	Mean	89.1	20.8	406	23.92	3.63	4.75	0.43	0.52

4- Effect of seedbed preparation systems and irrigation depth on fuel consumption :

Data in Fig. 5 reveal that the fuel consumption is affected by types of ploughs and ploughing depth. Data in Fig. 5 show that the highest fuel consumption value of 29.6 L/fed was noticed under seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling). But the lowest value was 10.55 L/fed under seedbed preparation system A (Chiselling one pass + levelling). Data in Fig. 5 show that the fuel consumption value under seedbed preparation system D increased by 64.36, 47.67, 19.93 and 18.92% as compared to seedbed preparation systems A, B, C and E respectively. These results are in agreement with Ward (1988), Gharieb (1996), Abdel-Wahab et al. (1998) and Naser (1999).

5- Effect of seedbed preparation systems and irrigation depth on energy requirements and energy per unit production :

Data clarified that the energy requirements are affected by different seedbed preparation systems and ploughing depth. Energy requirements can be arranged in decreasing order as follows: D, E, C, B and A. The highest total energy requirement value of 70.81kW.h/fed was recorded under seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling). Meanwhile, the lowest value was 25.01 kW.h/fed under seedbed preparation system A (Chiselling one pass + levelling). Data indicated that the energy requirement increased substantially as the ploughing depth increased. As expected, subsoiler and mouldboard plough need the highest values of energy requirement, while the chisel plough need the lowest value. These results are due to decrease in ploughing depth and smaller clod sizes. Data in Fig. 6 reveal that the energy requirements per unit production can be arranged in decreasing order as follows: D, E, C, B and A. It is clear that seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling) required the highest value of energy per unit production of 24.05 kW.h/ton. Meanwhile, seedbed preparation system A (Chiselling one pass + levelling) required the lowest value of 6.78 kW.h/ton. These results are in agreement with Zin El-Din (1985), Ward (1988), Gharieb (1996), El-Saeed et al. (1998) and Younis et al. (2000).

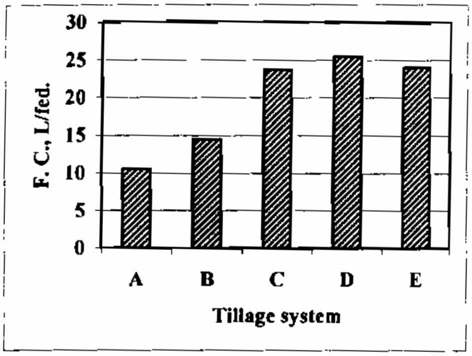

Fig. 5: Fuel consumption (F.C.) under different treatments.

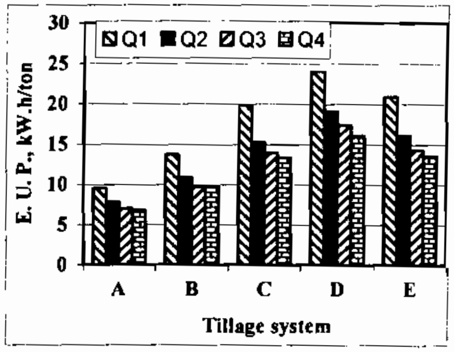

Fig. 6: Energy unit production (E.U.P.) under different treatments.

6- Effect of seedbed preparation systems and irrigation depth on total costs and cost per unit production:

The cost per unit production as influenced by irrigation depth and seedbed preparation systems is shown in Fig. 7. The minimum costs per unit production were 188.28 and 190 LE/ton, under irrigation depth of 120 mm and seedbed preparation systems D and C. Meanwhile, the maximum values were 263.6 and 261.69 LE/ton under irrigation depth of 60 mm and seedbed preparation systems E and A respectively. Data indicate that the mean costs per unit of rice grain production values of 223.5, 218.93, 215.65, 210.03 and 208.39 LE/ton were obtained under seedbed preparation systems A, B, E, D and C respectively. The cost per unit production can be arranged in decreasing order as follows: A, B, E, D and C. Unit cost decreased by 16.51, 21.0, and 20.9%; 18.82, 23.47 and 20.81%; 21.06, 24.59 and 24.9%; 18.18, 22.22 and 25.2% and 18.95, 26.32 and 27.49% by increasing the irrigation depth from 60, 80, 100 to 120 mm under seedbed preparation systems A, B, C, D and E, respectively. Adding irrigation depth from 60 to 80, 80 to 100 and 100 to 120 mm, the costs per unit of rice grain production decreased by 5.32, 23.52 and 23.85%. This may be due to the increase in yield which was greater than total cost. These results are in agreement with Abdel-Maksoud et al. (1985), Whel (1993) and Younis et al. (2000).

7- Effect of seedbed preparation systems and irrigation depth net profit:

The net profits as influenced by irrigation depth and seedbed preparation systems are shown in Fig. 8. The highest net profit value was 1791LE/fed, for irrigation depth of 120 mm under seedbed preparation system D, but the lowest value was 883 LE/fed, for irrigation depth of 60 mm under seedbed preparation system A.

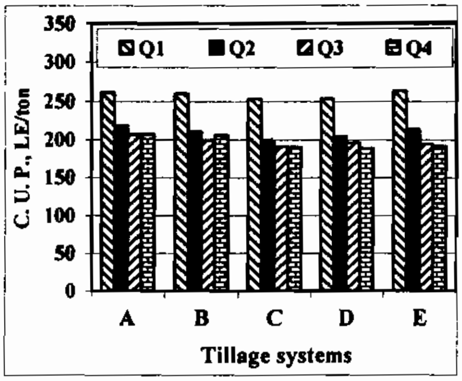

Fig. 7: Cost per unit production (C.U.P.) under different treatments.

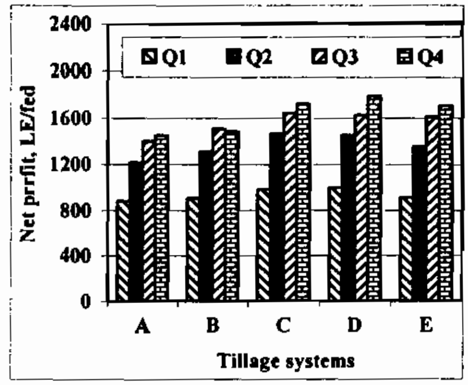

Fig. 8: Net profit under different treatments.

CONCLUSION

The obtained results can be summarized as follows:

1. The seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling) was considered the best system under conditions of clay soil as it improved soil physical properties (decreasing soil bulk density and soil penetration resistance and increasing the total porosity and void ratio).
2. The irrigation depth of 120 mm and seedbed preparation system D gave the highest rice grain yield of 4.35 ton/fed, meanwhile, the irrigation depth of 60 mm and seedbed preparation system A (Chiselling one pass + levelling) gave the lowest yield of 2.61 ton/fed.
3. The highest water use efficiency was 0.589 kg/m^3 under seedbed preparation system D and irrigation depth of 60 mm, meanwhile, the lowest value was 0.339 kg/m^3 under seedbed preparation system A and irrigation depth of 120 mm.

The minimum costs per unit production was 188.28 LE/ton under irrigation depth of 120 mm and seedbed preparation system D, meanwhile, the maximum value was 263.6 LE/ton under irrigation depth of 60 mm and seedbed preparation system E.

The highest net profit was 1791 LE/fed, under irrigation depth of 120 mm and seedbed preparation system D, meanwhile, the lowest value was 883 LE/fed, under irrigation depth of 60 mm and seedbed preparation system A.

Finally, it could be concluded that, under the similar conditions:

The seedbed preparation system D (Chiselling twice + subsoilling + harrowing + levelling) was the best system under clayey soil where it gave the optimum seedbed preparation, increased rice yield, some yield components, minimum costs per unit production and highest net profit.

The irrigation depth of 120 mm/irrigation can be recommended for optimum rice yield under the same conditions.

REFERENCES

Abdel-Maksoud, S. E.; M. S. A. Shehata and M. S. El-Shal (1985). Select the proper space and seedbed preparation for producing difference kinds of cotton under Egyptian conditions. Misr J. Ag. Eng., 2 (4): 121-130.

Abdel-Wahab, M. K., M. A. Arnaout and M. M. EL-Sharabasy (1998). Selecting the proper system for mechanizing grain crops harvesting in the small holdings. Misr J. Ag. Eng., 15 (1) : 133-144.

Awady, M. N. (1978). Engineering of tractors and agricultural machinery. (In Arabic), Textbook. Fac. of Agric. Ain Shams Univ. :289 p.

Black, C. A. (1965). Method of soil and water analysis. Part 2: Madison, Wisconsin, USA.

El-Ansary, M. Y. and M. M. El-Mallah, (1986). The effect of subsoiling and other seedbed preparation practices on cotton growth and yield. Misr J. Ag. Eng., 3 (1): 73-87.

El-Banna, E. B. and Helmy, M. A. (1992). Influence of precision tillage system on soil compaction, power requirements and wheat crop yield. Misr J. Ag. Eng., 9 (4): 537-558.

El-Saeed, K. M.; Z. M. Imara and M. K. El-Said (1998). Effect of plough type on some physical properties of clay soil. Misr J. Ag. Eng., 15 (2): 276-290.

Gharieb, M. M. (1996). Study on selecting the proper mechanical method of cotton planting. M. Sc. Th., Agric. Eng. Dep. Fac. of Agric. Zagazig Univ.

Israelsen, O. W. and V. E. Hansen, (1962). Irrigation principles and practices. 3rd Ed. John Wiley and Sons. Inc., N. Y.

Morad, M. M. and T. Fouda (2003). Selection of optimum mechanization system for flax production. Misr J. of Ag. Eng., 20 (3): 879-890.

Naser, M. N. (1999). Different types of grain-drill opener effects on wheat production. Misr J. Ag. Eng., 16 (3) : 588-611.

Suliman, A. E.; G. E. Nasr and W. M. I. Adawy, (1993). A study on the effect of different systems of tillage on the physical properties of the soil. Misr J. of Ag. Eng., 10 (2): 169-189.

Ward, M. I. H. (1988). Sources of power in farm land. M. Sc. Th., Fac. of Agric., Zagazig Univ.

Whel, A. E. (1993). A study on the effect of systems of tillage on the physical properties of the soil. M. Sc. Th., Fac of Agric. Alex. Univ.

Younis, S. M., G. E. M. Naser and M. N. Al-Dean (2000). Technical and economical studies on mechanization of seedbed preparation for cotton production. Misr J. Ag. Eng., 17 (1) : 55-78.

Younis, S. M.; Shaiboon A. M. and Aref A. O. (1991). Evaluation of some mechanization methods of rice production in Egypt. Misr J. Ag. Eng., 8 (1) : 39-49.

Zin El-Din, A. M. A. (1985). Comparative study between different tillage methods. M. Sc. Th., Fac. of Agric, Alex. Univ.

د. أحمد الراعى إمام سليمان ، الجرارات الزراعية ، وزارة الزراعة ، 1982 : 280-284.

تأثير إعداد مرقد البذرة وأعماق الرى على بعض الصفات الطبيعية للتربة وإنتاجية محصول الأرز

السادات إبراهيم عبد العال* عبد الله مصطفى قشطة* عبد المحسن لطفى**

يعتبر إعداد مرقد البذرة وكمية مياه الرى من أهم العوامل المؤثرة على الإنتاج الزراعى فى مصر، لذلك اتجه التفكير فى هذا البحث إلى دراسة تأثير بعض نظم إعداد مرقد البذرة مع إضافة أعماق من مياه الرى بهدف الوصول إلى افضل نظام لإعداد الأرض مع أنسب عمق من مياه الرى لمحصول الأرز. حيث تم تنفيذ التجربة في مركز المنزلة بمحافظة الدقهلية ، لدراسة تأثير خمسة نظم لإعداد الأرض وأربع أعماق من مياه الرى فى كل ريه على بعض الخواص الطبيعية للتربة (الكثافة الظاهرية والمسامية الكلية ونسبة الفراغات البينية ومقاومة التربة للاختراق) وكمية محصول الأرز ومكوناته وكفاءة استخدام المياه ومعدل استهلاك الوقود والطاقة والتكاليف وصافى الربح. وكانت نظم الخدمة المستخدمة كالآتى:-

(A): محراث حفار وجه واحد + قصابيه للتسوية.

(B): محراث حفار وجهين (فك وثنى) + قصابيه للتسوية.

(C): محراث حفار وجهين (فك وثنى) + مشط قرصى + قصابيه للتسوية.

(D): محراث حفار وجهين (فك وثنى) + محراث تحت التربة + مشط قرصى+ قصابيه للتسوية.

(E): محراث قلاب مطرحى + مشط قرصى + قصابيه للتسوية.

ومعاملات الرى (أعماق الرى) هى 60 ، 80 ، 100 ، 120 مم/فدان.ريه.

ويمكن تلخيص أهم النتائج المتحصل عليها ما يلي:

1- حققت المعاملة (D) أفضل إعداد للأرض والتي تمثلت في انخفاض قيم الكثافة الظاهرية، ومقاومة التربة للاختراق وزيادة قيم المسامية والفراغات البينية للتربة وذلك لجميع الأعماق.

2- أظهرت النتائج أن كمية مياه الرى المضافة بعمق 120 مم/ريه حققت أعلى إنتاجية لمحصول الحبوب (4.35 طن/فدان) مع نظام الخدمة (D) ، بينما كانت أقل إنتاجية للمحصول (2.61 طن/فدان) عند ما أضيفت المياه بعمق 60 مم/ريه مع نظام الخدمة (A).

3- أدت زيادة كمية مياه الرى المضافة بعمق من 60 إلى 120 مم/ريه إلى زيادة كبيرة في كمية المحصول ومكوناته.

4- أقل تكاليف لإنتاج الطن من المحصول (188.28 جنيها) مع إضافة كمية مياه الرى بعمق 120 مم/ريه عند استخدام نظام الخدمة (D) ، بينما كانت أعلى تكاليف (263.6 جنيها) عند ما أضيفت كمية مياه الرى بعمق 60 مم/ريه مع استخدام نظام الخدمة (E).

5- تحقق أكبر صافى ربح من فدان الأرز عند استخدام نظام الخدمة (D) مع إضافة كمية مياه الرى بعمق 120 مم/ريه هو 1791 جنيها، بينما كان أقل صافى ربح يقدر بحوالى 889 جنيها عند استخدام نظام الخدمة (A) مع إضافة كمية مياه الرى بعمق 60 مم/ريه.

وبناءا على النتائج السابقة يمكن التوصية عند زراعة محصول الأرز تحت هذه الظروف إستخدام نظام الخدمة (D) مع إضافة كمية مياه الرى بعمق 120 مم/ريه للحصول على أعلى إنتاجية للمحصول (4.35 طن/فدان) واقل تكاليف لإنتاج الطن من المحصول (188.28 جنيها) وأعلى صافى للربح (1791 جنيه/فدان).

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