Misr J. Ag. Eng., 25(4): 1131-1147 FARM MACHINERY AND POWER

EFFECT OF SEED BED PREPARATION SYSTEM AND FERTILIZER MANAGEMENT ON SOIL WATER STORGE AND BARLEY PRODUCTION YIELD

Derbala[*], A.; Abd El-Kader, N.[**]; and T. Fouda[*]

ABSTRACT

The experiments were carried out to study the effect of seed bed preparation system and fertilizer management on soil physical properties, soil water storage, water distribution efficiency and barley yield. The experimental soil was classified as a heavy clay compacted and barley v. Giza 123 was planted, surface irrigation system was used. Three seed bed preparation systems were used: the first system was chisel plough (twice) and land leveler, the second was chisel plough (one pass) followed by rotary plough and land leveler and the third was no tillage with land leveler as a control. Three fertilizer management were conducted using mineral fertilizer 100% N mineral, organic fertilizer 100% N organic and mixed 50% N mineral and 50% N organic fertilizers. The obtained results reveal to the following: seed bed preparation systems using chisel plough one pass followed by rotary plough and land leveler and organic fertilization management by manure fertilizing machine (treatment, E) is considered the proper system for soil water storage and for producing barley crop. Whereas the maximum reduction in bulk density of 15.97 %, maximum increase in soil porosity of 53.2 %, maximum increasing in accumulative infiltration rate were 6.28 cm, maximum value in soil water storage and water distribution efficiency of 392.45 $m^3.fed.^{-1}$ and 57.35 %, respectively. Finally, the maximum barley yield of 1.86 ton/fed with minimum criterion cost of 58.94 L.E/ton.

INTRODUCTION

Water stored in the soil is the great importance to increase and stabilize yields this can be achieved by an adequate selection of tillage system and fertilizer management which increase the water availability for crop by increasing soil infiltration and allowing a better development of root system depending on soil conditions.

*) Agric. Eng. Dept., Faculty of Agric., Tanta University, Egypt.
**) Soil and Water Dept., Faculty of Agric., Tanta University, Egypt.

Lal (1999) studied the effects of three tillage methods on the physical properties of a clayey soil. Tillage treatments included no-till (NT), chisel plowing (CP) and moldboard plowing (MP). The results had a significant effect on soil bulk density (Ãb), and mean Ãb measured was 1.34 $Mg.m^{-3}$ for 0 to 10 cm depth and 1.39 $Mg.m^{-3}$ for 10 to 20 cm depth. Although not significantly different, trends in Ãb were NT > MP >CP for 0 to 10 cm depth and NT >MP > CP for 10 to 20 cm depth. The data on saturated hydraulic conductivity (Ks) were highly variable and treatments had no effect. Moisture retention characteristics differed significantly among depths but not among treatments.

Sivakumar et. al. (1999) found that a large response to fertilizer as small additions of fertilizer phosphate increased the soluble phosphate in the soil. Fertilizer application resulted in a small increase in water use (7–14%). Increased barley yield due to the application of fertilizer was accompanied by an increase in the water use efficiency (WUE). The beneficial effect of fertilizers could be attributed to the rapid early growth of leaves which can contribute to reduction of soil evaporative losses and increased WUE. The average increase in the WUE due to the addition of fertilizer was 84 %.

Jerry et al. (2001) stated that a survey of the literature reveals a large variation in measured WUE across a range of climates, crops and soil management practices. It is possible to increase WUE by 25 to 40 % through soil management practices that involve tillage. Overall, precipitation use efficiency can be enhanced through adoption of more intensive cropping systems in semi-arid environments and increased plant populations in more temperate and humid environments. Modifying nutrient management practices can increase WUE by 15 to 25 %. Water use efficiency can be increased through proper management and field scale experiences show that these changes positively affect crop yield.

Ardell et al. (2002) stated that the average spring soil NO_3–N (0 - to 120 cm depth) levels in the conservation tillage CT, minimum tillage MT and no tillage NT plots were 144, 136 and 117 kg N ha^{-1}, respectively.

Morad and Fouda (2003) studied the total energy required to produce one ton of flax under different treatments. Energy values can be arranged in descending order as follows: (chiseling twice, rotary plow, land leveler, manual planting and mechanical harvesting by pulling machine required the highest value of energy (23.64 kW.h/ton). While treatment (chiseling twice, rotary plow, land leveler, mechanical planting by seed drill and manual harvesting) required the lowest value of energy (16.10 kW.h/ton). They showed that seed yield values were 550, 570 and 620 kg/fed while straw yield values were 2.64, 2.73 and 3.20 ton/fed under manual, broadcasting and seed drill, respectively.

El-Tarhony and Fouda (2005) compared tillage systems (conventional tillage using moldboard plough with disc harrow and rotary cultivator (T_1), reduced tillage (T_2) using rotary cultivator, (T_3) disc harrow, (T_4) chisel plough and no tillage (T_5) as a control. They found that with the use of tillage systems T_1, T_2, T_3 and T_4 the fuel consumption values were 27.70, 6.21, 11.20 and 10.10 L/ha, energy requirements values were 81.25, 16.70, 30.70 and 28.40 kW.h/ha. While the sorghum yield values were 2.9, 3.1, 2.3, 2.6 and 1.9 $kg.m^{-2}$ under treatments T_1, T_2, T_3, T_4 and T_5, respectively.

Chiroma et al. (2006) concluded that combining the practice of flat bed cultivation with mulching may eliminate the need for ridging in increasing the productivity of crop yield. A four year field experiment was conducted to evaluate the influence of land configuration practices with or without wood-shavings mulch on water conservation, yield and water use efficiency. Differences in soil water storage at various sampling dates were significant only in some cases in each year, but trends were towards greater soil water storage in the mulched treatments than in the non-mulched treatments, irrespective of tillage method. Growth parameters such as plant height and leaf area index indicated significant differences between treatments on only some measurement dates in each year.

Cantero-Martinez et al. (2007) compared different tillage systems, established at three locations according to their degree of aridity. Results reveal that conservation tillage was most effective in increasing yield under the driest conditions at A_1 (10–15%), still effective with a smaller advantage under slightly wetted conditions at A_2 (5–10%) but ineffective at A_3 the wettest site. Conservation tillage only increased water use in some years at A_1 and never at the other two sites.

Therefore, the objective of this work was to select a suitable seed bed preparation system with optimum fertilizer management to increase water use efficiency and soil water storage for maximum crop yield. Also, to minimize energy requirements and cost of production.

MATERIALS AND METHODS

This research was carried out at Faculty of Agriculture-Farm, Tanta Univ. El-Gharbia Governorate, Egypt. The experiment was initiated on Jan 2007. The experiments were designed to select a suitable seed bed preparation system and fertilizer management for producing barley crop (Hordeum vulgare L.) v. Giza 123. The mechanical analysis of the experimental soil was classified as a heavy clay soil compacted as shown in Table 1, parameters measured throughout the farm included the real density which was 2.63 $g.cm^{-3}$.

Table 1: Soil mechanical analysis and physical properties of the experimental soil

Particle size distribution, %			Texture	Bulk density, $g.cm^{-3}$	Field capacity, %	pH	EC $ds.m^{-1}$	OM, %
clay	silt	sand						
44	40	16	clay	1.44	31	7.14	4.02	1.50

Machines specification:

The technical specification of the experimental equipment are summarized as follows:

-Tractor Belarus-MTZ-90 type, made in Russian, four cylinders, four stroke, diesel engine, hydraulic system, water cooled, four wheels, engine power (66.18 kW) at 2200 r.p.m.

-Mounted chisel plough: Local, number of tines, 9 with working width of 225 cm, overall dimensions, 1650 x 2000 x 1050 mm,

-Mounted rotary plough (ADH 114 local made) with 32 blades corresponding to 160 cm working width.

-Trailed land leveler (local made) with 3.05 m working width.

-Mounted broadcasting machine (local made) length 120 cm, diameter of spinner 50 cm with 15 m working width

-Manure fertilizing machine (local made) rear discharge spreader, the overall dimensions, 400 x 200 x 115 cm, load capacity 3.5 m^3.

Plowing depth was in general 10-12 cm at a speed of 3.5 km/h while harrowing and leveling were conducted at a speed of 4.8 km/h.

Experiments:

The experiment was conducted to evaluate seed bed preparation system and fertilizer management on soil physical properties, soil water stored, water distribution, irrigation efficiencies and barley yield. The experimental area was about 3 feddans divided into three equal plots (1 feddan each), 9 treatments namely: A, B, C, D, E, F, G, H and I were carried out in each plot and replicated three times in a completely randomized block design.

Treatment A: seed bed preparation system by chisel plough (twice) and then land leveler with mineral fertilizing (100 % N mineral) recommended dose by broadcasting machine.

Treatment B: seed bed preparation system by chisel plough (one pass) with rotary plough and then land leveler with mineral fertilizing (100 % N mineral) recommended dose by broadcasting machine.

Treatment C: no tillage with land leveler with mineral fertilizing (100 % N mineral) recommended dose by broadcasting machine.

Treatment D: seed bed preparation system by chisel plough (twice) and then land leveler with organic fertilizing (100 % N organic) by manure fertilizing machine.

Treatment E: seed bed preparation system by chisel plough (one pass) with rotary plough and then land leveler with organic fertilizing (100 % N organic)by manure fertilizing machine.

Treatment F: no tillage with land leveler with organic fertilizing (100 % N organic)by manure fertilizing machine.

Treatment G: seed bed preparation system by chisel plough (twice) and then land leveler with mixed mineral and organic fertilizing (50 % N mineral with 50 % N organic) by manure fertilizing machine.

Treatment H: seed bed preparation system by chisel plough (one pass) with rotary plough and then land leveler with mixed mineral and organic fertilizing (50 % N mineral with 50 % N organic) by manure fertilizing machine.

Treatment I: no tillage then land leveler with mixed mineral and organic fertilizing (50 % N mineral with 50 % N organic) by manure fertilizing machine.

Fertilizer management:

Fertilizers were added to the soil mechanically using the broadcasting machine for mineral fertilizer (F_1), manure fertilizer machine for both organic (F_2) and the mixture fertilizer (F_3).

The recommended amounts of nitrogen and super phosphate were added as follow:

F_1: mineral 100% N mineral from nitrogen (52.49 kg N/fed.) with phosphor (6.758 kg P/fed.),

F_2: organic 100 % N organic from farm yard manure (0.9 % N) and

F_3: mixed mineral and organic 50 % F_1 with 50 % F_2.

Phosphorus doses as calcium super phosphate (15.5 %), organic fertilizer (F_2) and 50 % organic fertilizer (F_3) were dressed once only directly before cultivation of barley. Nitrogen doses as ammonium nitrate NH_4NO_3 (34.997 % N) (F_1) and 50 % mineral fertilizer (F_3) were divided in three doses, the first i.e. active dose (20 % of the recommended nitrogen amount before cultivation, the second dose (40 %) after 50 days from sowing and the third (40 %) was added after 70 days from sowing.

Mineral fertilizing speed was about 3.2 km/h while both organic and the mixture fertilizing speed were 2.8 km/h.

Planting methods:

Barley was planted mechanically using the broadcasting machine with a seed rate of 50 kg/fed. and the planting speed was about 3.2 $km.h^{-1}$.

Irrigation system:

The surface irrigation system was used in this experiment. The applied irrigation depth was 100 mm/irrigation for all treatments. This applied water was measured by flow tube and time recorded by stopwatch. Soil samples were collected for each tillage and fertilizer treatments before and 48 h after irrigation at soil depth from 0 to 0.40 m. Also, soil samples were taken in between the first and the second irrigation by the same manner.

Soil measurements:

Bulk density: Soil bulk density was measured by core method (Blake and Hartge, 1986).

Soil porosity: The soil porosity was measured before and after each operation and it was calculated using the following formula:

$$S_p = (1 - D_b/D_p) * 100$$

Where: S_p = soil porosity in percent,

D_b = bulk density in g . cm^{-3} and D_p = particle density in g . cm^{-3}.

Infiltration rate: Infiltration rate was determined using double ring at three different sites along furrow in three replicates for each treatment and it measured for three hours until steady state according to (Cuenca 1989).

Water measurements:

Application efficiency: Application efficiency (E_a) was calculated at each treatment according to (Israelsen and Hansen, 1962) as follows:

$$E_a = (w_s/w_f) \times 100$$

Where: E_a = irrigation application efficiency in percent,

w_s = stored water within irrigation in mm and

w_f = depth of water diverted to the area irrigated in mm.

Water distribution efficiency: It was calculated according to James (1988) as follows:

$$E_d = (1 - s/d) * 100$$

Where: E_d = water distribution efficiency in percent,

s = average numerical deviation from “d” in cm and

d = average of soil water depth stored along the furrow.

Water use efficiency: It was determined according to Awady et al. (1976) as follows:

WUE ($kg.m^{-3}$) = Average yield ($kg.ha^{-1}$)/Amount of applied water m^3/ha.

Soil water storage: Soil water storage is determined as an amount of applied water in one irrigation in proportion to wetted area and wetted depth of soil.

Harvesting method: Manual harvesting: using the conventional method.

Yield measurements:

The harvesting was done at 23/5/07 (about 130 days). At maturity of plants, one meter square from all treatments were taken to measure the length of plant, biomass yield (grain yield $kg.m^{-2}$, straw yield $kg.m^{-2}$) and the following traits, i.e. 1000 grain weight (g), total yield ($kg.m^{-2}$) and harvesting index (grain yield/total yield) were recorded.

Energy requirements:

Energy requirements can be calculated by using the following equation:

Energy requirements (kW.h/fed.) = Power required (kW) / Effective field capacity (fed./h)

Estimation of the required power to operate each machine was carried out by accurately measuring the decrease in fuel level in the fuel tank immediately after executing each operation. The required power was calculated according to Barger et al. (1963) as follows:

$$p(kW) = w_f \times c.v \times \eta_{th} \times 427/75 \times \frac{1}{1.36}$$

Where: W_f = rate of fuel consumption in kg/sec,

c.v = calorific value of fuel in kcal/kg, (average c.v of solar fuel is10000 kcal/kg) 427–thermo–mechanical equivalent, kg.m/kcal.

η_{th} = thermal efficiency of the engine (considered to be 30 % for diesel engines).

Cost analysis:

The cost of mechanical processes was determined according to Awady (1978) as follows:

$$c = \frac{p}{h}\left(\frac{1}{e} + \frac{i}{2} + t + r\right) + (0.9hp \times f \times s) + \frac{w}{144}$$

Where: c = hourly cost, P = capital investment, h = yearly operating hours, e = life expectancy, i = interest rate, t = taxes and over heads ratio, r = repairs ratio of the total investment, 0.9 a factor including reasonable estimation of the oil consumption in addition to fuel, hp = horse power of engine and f = specific fuel consumption, L/hp.h

The operational cost can be calculated as follows:

Operational cost = hourly cost (L.E./fed.)/effective field capacity (fed./h)

Cost per unit of production = operational cost (L.E./fed.)/crop yield (ton/fed.)

RESULTS AND DISCUSSION

The obtained data will be discussed under the following items:

Effect of seed bed preparation system and fertilizer management on some soil physical properties

Soil physical properties were determined before and after each treatment. The results in Table 2 show that there are differences in the soil bulk density, soil porosity and accumulative infiltration rate under using different seed bed preparation systems and fertilizer management.

Table 2: Effect of seed bed preparation system and fertilizer management on soil physical properties

Fertilizer	Soil before tillage	Mineral fertilizer by broadcasting machine			Organic fertilizer by manure fertilizing machine			Mixed fertilizer by broadcasting machine		
Treatment		A	B	C	D	E	F	G	H	I
Bulk density, $g.cm^{-3}$	1.44	1.41	1.40	1.43	1.21	1.23	1.33	1.25	1.30	1.35
Soil porosity, %	45	46.4	46.8	45.6	53.1	53.2	49	52.5	50.6	48
Accumulative infiltration rate, cm	1.98	2.16	5.2	2.16	3.42	6.28	2.7	3.1	5.92	2.5

A, D and G using chisel plough (twice) and land leveler

B, E and H chisel followed by rotary plough and land leveler

C, F and I no tillage with land leveler

Bulk density generally decreased due to tillage. The maximum reduction in bulk density of 15.97 % was observed under treatment D (chisel plough twice and land leveler with organic fertilizer by manure fertilizing machine). This can be explained by the fact that the density decreases by increasing tillage procedures involved in the treatment. Also, the same effect was obtained with treatment D which treated organic fertilizer 100 % (confirmed with Ghuman and Sur, 2001).

Data in Table 2 showed that the maximum value in the soil porosity was 53.2 % under treatment E, while the minimum value was 45.60 % under treatment C. These results confirmed with the obtained data of bulk density.

The accumulative infiltration rate is affected by the changes that occur due to physical characteristics caused by tillage practices and fertilizer management. The maximum value of accumulative infiltration rate was 6.28 cm under treatment E, while the minimum value was 2.16 cm under treatment C. The accumulative infiltration rate was inversely related to the bulk density values in various treatments (confirmed with Ghuman and Sur, 2001).

Effect of seed bed preparation system and fertilizer management on water measurements

Seed bed preparation system and fertilizer management were carried out to improve application efficiency, distribution efficiency, water use efficiency and amount of water storage.

The values of water application efficiency and water distribution efficiency are shown in Fig. 1. The maximum values of the application efficiency and the distribution efficiency were 76.72 % and 57.35 % under treatment E, respectively. While the minimum values were 52.09 % and 49.90 % under treatment C, respectively. Treatment E had developed the water application efficiency compared with the others. Because the amount of water stored in root zone was increased under treatment E and these results were confirmed with the decrease of bulk density and increase the total porosity and accumulative infiltration rate. Also, treatment E had developed the water distribution efficiency compared with the others. Because the soil under treatment E (chisel followed by rotary plough and land leveler) was not compacted.

The values of the water use efficiency and the amount of water storage are shown in Figs. 2 and 3. The highest value of water use efficiency means that less amount of irrigation water and high crop yield. The maximum values of the water use efficiency and the amount of soil water storage were 2.22 $kg.m^{-3}$ and 392.45 $m^3.fed.^{-1}$ under treatment E, respectively. While the minimum values were 1.07 $kg.m^{-3}$ and 185.56

$m^3.fed.^{-1}$ under treatment C, respectively. Because adding manure to the soil tended to increase both storage of water, total porosity, accumulative infiltration rate and decrease the bulk density (Table 2). On the other hand, no tillage treatment tended to increase the losses of water, then decreased in the soil water stored may be observed.

Effect of seed bed preparation system and fertilizer management on plant characteristics and crop yield

Tillage systems and fertilizer management have a great effect on the plant features such as length of plant, weight of 1000 grain, the average biological yield and harvest index. It was observed in Table 3 that the maximum length of plant of 98.50 cm was remarked under treatment H. It decreased to 75.50 cm under treatment C.

Table 3: Effect of seed bed preparation systems and fertilizer management on plant characteristics and crop yield

Fertilizer	Mineral fertilizer by broadcasting machine			Organic fertilizer by manure fertilizing machine			Mixed fertilizer by broadcasting machine		
Treatment	A	B	C	D	E	F	G	H	I
Length of plant, cm	81.25	86.00	75.50	95.00	96.51	88.25	89.50	98.50	82.00
Weight of 1000 grain, g	48.60	44.7	29.20	48.90	51.4	41.4	45.2	48.60	36.50
Biological yield, ton/fed.	0.900	1.457	0.722	1.275	1.866	0.995	1.218	1.531	0.952
Harvest index, %	0.34	0.35	0.24	0.33	0.39	0.27	0.28	0.30	0.26

A, D and G using chisel plough (twice) and land leveler
B, E and H chisel followed by rotary plough and land leveler
C, F and I no tillage with land leveler

Also, data show that the maximum weight of 1000 grain of 51.40 g was noticed under treatment E while decreased to 29.20 g under treatment C. Table 3 also shows that the maximum biological yield and harvest index were found under treatment E. These results were confirmed with the bulk density, total porosity, air field capacity, water application efficiency, water distribution efficiency and water use efficiency. The obtained data confirmed with those obtained by (Ghuman and Sur 2001). It is evident from these results that treatment E is an alternative and sustainable practice of soil management and it also improved soil properties (Table 2).

Energy requirements for barley production

Table 4 shows the fuel consumption and power required for each machine. While Fig. 4 shows the effect of seed bed preparation systems and fertilizer management on energy requirements. Values can be arranged in descending order as follows: I, F, E, H, B, G, D and A, respectively. It is clear that treatment A, using chisel plough (twice) and land leveler with fertilizing by broadcasting machine, required the highest value of energy (48.18 kW.h/ton). While treatment I required the lowest value of energy (17.25 kW.h/ton).

Table 4: Fuel consumption, power and energy requirements for the used equipment

Fertilizer	Fuel consumption, L/fed.	Power required, kW	Field capacity, fed./h	Energy requirements, kW.h/fed.
Chisel plough 1st	6.2	19.84	1.40	14.17
Chisel plough 2st	5.75	18.40	1.44	12.77
Rotary plough	6.3	20.16	2.61	7.75
Land leveler	2.9	9.28	1.37	6.77
Broad casting	3.2	10.24	1.06	9.66
Manure fertilizing machine	15.2	48.64	3.20	15.20

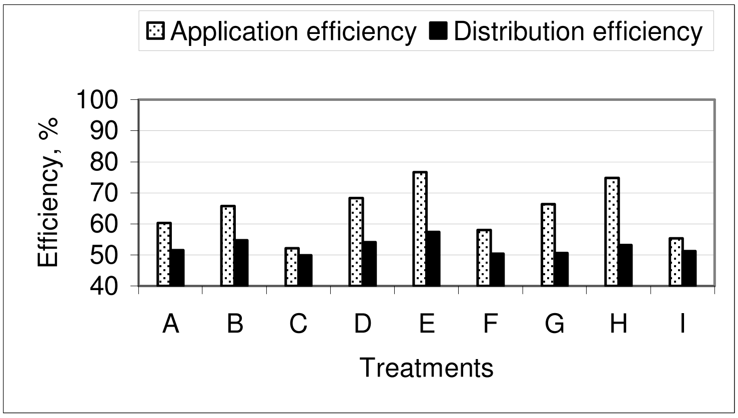

Fig. 1: Effect of seed bed preparation system and fertilizer management on the application efficiency and the distribution efficiency

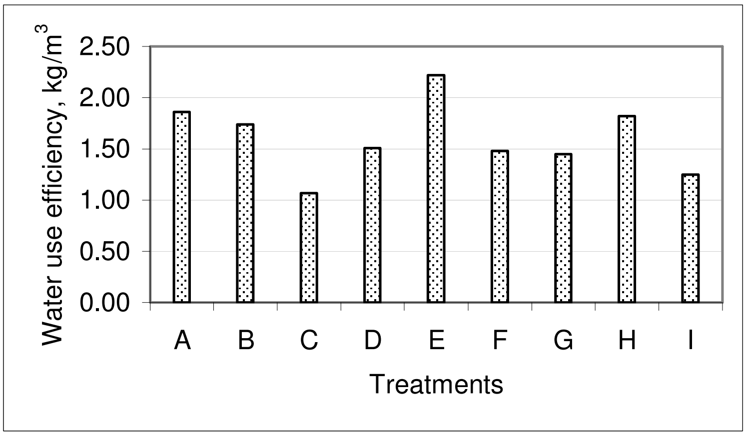

Fig. 2: Effect of seed bed preparation systems and fertilizer management on water use efficiency

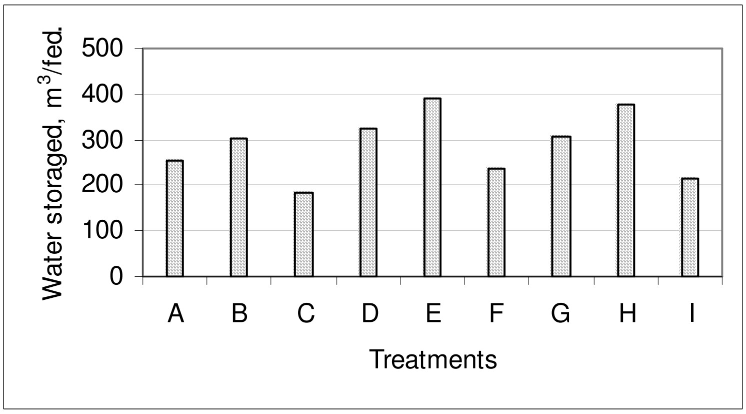

Fig. 3: Effect of seed bed preparation systems and fertilizer management on the amount of soil water storage

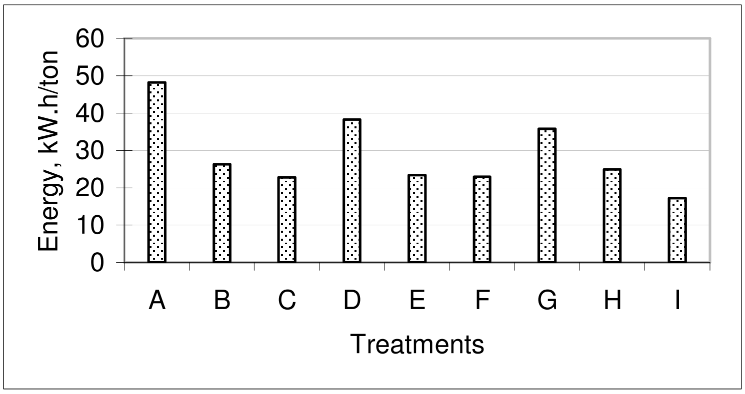

Fig. 4: Effect of seed bed preparation systems and fertilizer management on energy requirements

Cost requirements for barley production

Fig. 5 represents the cost per unit of production for the different treatments. The cost per unit of production can be arranged in descending order as follows: E, F, I, H, B, C, G, D and A, respectively. It is evident that treatment E recorded the lowest value of cost per unit of production 58.94 L.E/ton.

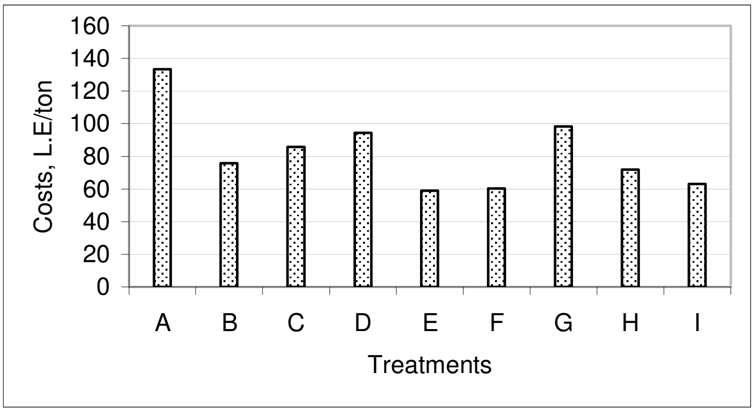

Fig. 5: Effect of seed bed preparation systems and fertilizer management on cost per unit of production

CONCLUSION

Sees bed preparation system by chisel plough one pass with rotary plough with land leveler is recommended for producing barely crop as it records maximum yield and minimum cost comparing with the other treatments. Organic fertilization by manure fertilizing machine is recommended as it improves soil physical properties and increases soil water storage.

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الملخص العربي

تأثير نظم إعداد التربة ومعاملات التسميد على خزن ماء التربة وإنتاجية محصول الشعير

أسعد عبد القادر دربالة*   ناصر ابراهيم عبدالقادر   طارق زكي فوده***

أجري هذا البحث لإختيار أنسب طريقة لإعداد مرقد البذرة ومعاملات التسميد التي تحقق أفضل ظروف للإنبات من خلال الحفاظ على تخزين الماء في التربة وكذلك تقليل الطاقة المستهلكة وذلك من خلال دراسة تأثير عمليات إعداد التربة ومعاملات التسميد المختلفة على الخواص الطبيعية للتربة وعلى سلوك الماء في التربة من خزن وكفاءة توزيع وانتشار. تم حساب الطاقة المستهلكة وتكاليف الإنتاج وكذلك الإنتاجية الكلية لمحصول الشعير وذلك بمزرعة كلية الزراعة جامعة طنطا موسم 2006 – 2007.

وقد أجريت التجارب باستخدام المعاملات الآتية:

A- حرث مرتين بالمحراث الحفار + land leveler + تسميد معدنى 100 % بألة نثر السماد المعدنى (Broadcasting)

B- حرث مرة بالمحراث الحفار + المحراث الدوراني + land leveler + تسميد معدنى 100 % بألة نثر السماد المعدنى

* - قسم الهندسة الزراعية - كلية الزراعة - جامعة طنطا – مصر.
** - قسم الأراضي والمياة - كلية الزراعة - جامعة طنطا – مصر.

C- بدون حراثة + land leveler + تسميد معدنى 100 % بألة نثر السماد المعدني (Broadcasting)

D- حرث مرتين بالمحراث الحفار + land leveler + تسميد عضوى 100 % بواسطة Manure fertilizer machine

E- حرث مرة بالمحراث الحفار + المحراث الدوراني + land leveler + تسميد عضوى 100 % بواسطةManure fertilizer machine

F- بدون حراثة + land leveler + تسميد عضوي 100 % بواسطة Manure fertilizer machine

G- حرث مرتين بالمحراث الحفار + land leveler + تسميد مختلط (عضوي 50% + معدنى 50% بواسطةBroadcasting)

H- حرث مرة بالمحراث الحفار + المحراث الدوراني + land leveler + تسميد مختلط (عضوي 50% + معدنى 50% بواسطةBroadcasting)

I- بدون حراثة + land leveler + تسميد مختلط (عضوي 50% + معدنى 50% بواسطة Broadcasting)

وكانت النتائج كالتالي :

النظام الأمثل هو النظام (E) حرث مرة بالمحراث الحفار + المحراث الدوراني + تسميد عضوي 100 % بواسطةManure fertilizer machine لتحسين المواصفات الطبيعية للتربة وزيادة خزن الماء بالتربة وإنتاجية الشعير حيث سجلت النتائج عندها أعلى نسبة إنخفاض في الكثافة الظاهرية للتربة وكانت 15.97 %، أعلى نسبة إرتفاع في المسامية للتربة % 53.2، وأعلى نسبة ارتفاع في الرشح للتربة كانت 6.28 سم وأعلى قيمة لكفاءة إستخدام المياة كانت 2.22 kg/m^3 بينما خزن الماء للتربة كان 392.45 m^3/fed وكفاءة التوزيع % 57.35 وكفاءة إضافة الماء كانت % 76.72. وكذلك سجلت أعلى إنتاجية لمحصول الشعير .1.86 t/fed مع أقل تكلفة لوحدة الإنتاج حيث كانت .58.94 L.E/t.