Misr J. Ag. Eng., 26(3): 1104 - 1119 FARM MACHINERY AND POWER

EFFECT OF DIFFERENT TILLAGE SYSTEMS ON SOME WATER REQUIREMENTS AND COTTON CROP YIELD

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ABSTRACT

The present investigation was conducted at Sakha Agricultural Research Station , Kafr EL-Sheikh Governorate to study the effect of different seedbed preparation on water requirements and cotton yield.

Five treatments were used in this study as follows :A) Disc harrow , B) Chisel plough one-pass + disc harrow , C) Chisel plough two - passes + disc harrow , D) Chisel plough one - pass + subsoiler + disc harrow and E) Chisel plough two – passes + subsoiler + disc harrow .

Results showed that the chisel plough was effective in lowering field efficiency to about 65.0 % compared to 92.0% of the subsoiler plough .The slip ratio were the disc harrow about 4.0% compared to 13.06% for subsoiler plough. Generally, the cost of seedbed preparation per fadden was 8.0 L.E/fed for the disc harrow and 23.0 L.E/fed with the subsoiler plough. The yield calculated for each treatment was as follow 4.29,5.17,5.77,6.55 and 6.36 Kantar / fadden for treatments A, B,C,D and E, respectively . Water requirements were 3033, 3185, 3205, 3319 and 3591 m^3/fed for the same above-mentioned treatments. Field water use efficiency calculated for each treatment and recorded as follows: 0.22,0.26,0.28,.0.31 and 0.28 Kg / m^3 for the same above mentioned treatments. Also, water application efficiency recorded as follows: 73.05,73.63,75.02,74.18 and 70.91%.

The soil pulverization degree were 74.6, 73.7, 72.0, 70.4 and 69.0 % for A, B, C, D, and E, respectively.

INTRODUCTION

Cotton is considered as one of the most important fiber crop in Egypt. It is one of the major cash crops and plays a vital role in increasing the Egyptian national income.

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Cotton lint is the most important vegetable fiber in the world in addition to its importance for oil production from seeds. The Egyptian cotton has excellent qualities. These qualities, in fact are the result of an extremely favorable weather, a high fertile soil and irrigation management.

Seedbed preparation is the most important operation in crop production. Optimum tillage operations encourage root development, penetration and provide an optimum air- water balance as well as maximum water storage capacity. The comparative study on tillage system found that a minimum tillage and rotary tillage resulted in lower cotton yield than chisel.**Abernathy el al. (1975).** The performance of disc harrow after chiseling is more performable than chisel twice where it increased picked cotton. This is due to the effect of harrowing in improving physical seedbed properties **Abdel – Maksoud et al. (1985)**. The deep tillage or subsoiling may play an important and effective role in breaking down soil layers to improve soil bulk density. The system of chiseling twice or chiseling and harrowing improve soil physical properties **El– Ansary and El-Mallah (1986)**.

In India, reported that the seed cotton yield increased with intensity of tillage and the highest yield was obtained in conventional tillage plots **Nehru et al. (1992). Metwalliy (1999)** studied the combined mechanization system of primary tillage and planting methods for cotton crop. He found that the highest yield was 425.5 kg/fed recorded with moldboard plow at 5.0 Km/h forward speeds with manual planting. The improved tillage (shiseling twice to working depth of 15 cm followed by disc harrowing and leveling) produced the highest cotton yield of 1838 kg/fed. **El – Said and Ismail (1994).** The soil bulk density was decreased after tillage operation. Such decrease after tillage may be attributed to the breakdown of soil compaction, because ploughing increases pore spaces and therefore reduces soil bulk density **Taieb (1998)**.

Tillage and soil surface management play roles in the management of water resources and in alleviating water – related constraints to agricultural production and environment quality. Appropriate tillage systems can be used to facilitate drainage and decrease water retention in the root zone, increase the rate of infiltration to improve soil water storage, change porosity and tortusity to influence soil – water evaporation, and enhance macro pore flow to regulate leaching of agricultural chemical and salts.

Improving soil structure through conservation tillage and mulch farming techniques can also increase irrigation efficiency. Moisture – conserving benefits of conservation tillage and mulch farming techniques are widely known **Lal (1991).**

The reduction in soil moisture content due to tillage operations increased by increasing the ploughing depth at all the ploughs. The minimum reduction was obtained with no tillage **Zein Al – Din (1985**). At the top layer (0-10 cm) maximum reduction was obtained with the chisel plough. At the bottom layer (20-30 cm) the maximum reduction was obtained with the rotary plough. **Tahr et al.(1975)** concluded that 3300 – 3500 m^3 / fed. was considered as water requirements for cotton in the North West of Delta for silt clay soil which had saline water table deeper than 70 cm. **Zahran et al.(1979)** found that the seasonal water consumptive use for the recommended irrigation intervals was 62.18 cm (2612 m^3 / fed.) in 1977 and 58.46 cm (2455 m^3 / fed.) in 1978.

The objectives of this study were to investigate the effect of seedbed preparation methods on machine performances, power requirements, seed cotton yield tillage cost and water requirements.

MATERIAL AND METHODS

The present investigation was conducted at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate during 2007 season. The field experiments were carried out to study the effect of different seedbed preparation system and water requirements on yield of cotton variety (Giza , 86). The treatments were used as follows:

A) Disc harrow, B) Chisel plough one – pass + disc harrow

C) Chisel plough two – passes + disc harrow, D) Chisel plough one – pass+ subsoiler + disc harrow,E) Chisel plough two – passes + subsoiler + disc harrow.

The equipment used in this study were:

1- Agricultural tractor.

The tractor type used in this study was Ford 110 hp at 2575rpm (82.1 kW) – diesel engine – 6 cylinders.

2- Tillage equipment:

Three different types of seedbed preparation machine were used:

i) **Disc harrow**: Source of manufacture American – John Deere model- trailed type – number of discs 14 – working width 340 cm – working depth 15 cm – total mass 1000 kg .

ii) **Chisel plough :**

Source of manufacture local- Egyptian model .– mounted type – number of shares 7 arranged in 2 rows– working width 175 cm –total mass 470 kg

iii) Subsoiler :

Source of manufacture local- Egyptian model .–mounted type – number of shares one – total mass 200 kg .

iv) Cotton planter :

A Brazil planter (Jomil) was used to plant the mechanical plots . It consists of four planting units . The distance between rows 70 cm and between plants was 25 cm.

Parameters of the study:

1- Some physical properties of soil :

Table1: Mechanical analysis for the experimental sites and soil water characteristics at different depths .

Soil depth cm	Mechanical analysis			Texture class	Soil water characteristics		
	Sand %	Silt %	Clay %		Field capacity %	Wilting point %	Available water %
0 – 20	18.42	25.53	56.05	Clayey	44.3	24.10	20.20
20-40	22.54	26.16	51.30	Clayey	39.0	21.21	17.80
40-60	18.41	33.21	48.38	Clayey	36.8	20.00	16.80

The soil in which the experiments were under taken was fairly uniform without distinct change in texture soil is clayey in texture and not saline as shown in Table 1 which presents the mechanical analysis for the experimental sites at different depths from zero to 60 cm.

i) **Bulk density** ($\wp_b$) :

The bulk density of the soil was determined by using a cylindrical with known volume and was calculated by using the following formula :

$$(\wp_b) = \frac{M}{v_b} , g / cm^3 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

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

V_b = Is bulk volume of the soil in the container or volume container,cm^3

ii) **Soil porosity** (E) :

Soil porosity was calculated from the real and bulk density by using the following formula :

$$E = 1 - \frac{\wp_b}{\wp_r} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Where:

$\wp_r$ = Real density , g / cm^3 = 2.65 g / cm^3

iii) **Void ratio** (Vr) :

Void ratio was calculated by using the following formula :

$$v_r = \frac{\wp_r}{\wp_b} - 1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

iv) **Soil hardness** (Hn) :

Five different places were chosen at random for measuring the soil hardness by using the soil pentrometer .The soil penetration resistance is indicated in Table 2.

Table 2:Average bulk density($\wp_b$) in g/cm3 ,soil Porosity(E), void ratio (Vr) and hardness (Hn) , kg/cm^2 as affected by seedbed preparation.

Soil depth cm	M.C %	Before ploughing				After ploughing			
		$\wp_b$	E	Vr	Hn	$\wp_b$	E	Vr	Hn
0-20	15.62	1.30	0.51	1.04	12.0	1.00	0.62	1.65	10.2
20-40	21.20	1.40	0.47	0.89	16.0	1.20	0.55	1.21	14.1
40-60	27.71	1.51	0.43	0.75	20.0	1.34	0.49	0.98	18.1

2- Yield and its components :

a**) Number of open bolls / plant** :

Estimated as the average number of harvested bolls / plant .

b**) Average boll mass (g)** :

Estimated as : (the average mass of 50 bolls)

c**) Cotton yield per feddan** :

Determined from the yield of each plot then transformed to Qantar/feddan

3- Machine performance :

a)Required power :

The fuel consumption during the operations was estimated by using the following formula **Suliman et al.(1993)**

Required power = $\left(F_c \times \frac{1}{3600}\right) \times \wp_f \times lcv \times 427 \times \zeta_{th} \times \zeta_m \times \frac{1}{75} \times \frac{1}{1.36}, kW$ ……………..(4)

Where :

Fc = The fuel consumption , L/h .

$\wp_f$ = Density of fuel , kg / L (for solar fuel = 0.85 kg/l) .

L.C.V = Lower calorific value of fuel , kCal / kg (average 10000).

ζ_{th} = Thermal efficiency of the engine , (about 40% for D.E).

ζ_m = Mechanical efficiency of the engine , (about 80% for D.E).

427 = Thermo – mechanical equivalent kg.m / k Cal.

b)Specific fuel consumption (S.F.C)

$$S.F.C = \frac{\text{Fuel consumption , L/h}}{\text{Power consumed, kW}} \quad L/kW.h \quad \text{.....(5)}$$

c) Field capacity :

The effective field capacity (E.F.C) was calculated as follow.

$$E.F.C = \frac{1}{\text{Effective total time in hours required per feddan}}, \text{ fed./h.... ....(6)}$$

The field efficiency(ζ_f) was calculated as follows.

$$\zeta_f = \frac{E.F.C}{T.F.C} \times 100, \% \quad \dots\dots\dots\dots\dots\dots(7)$$

d) The percentage of slip (S_t):

The slip percentage determined by using the following formula:

$$S_t = \frac{D_1 - D_2}{D_1} \times 100, \% \quad \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots$$

(8)

Where:

D_1= Distance without –load, m and

D_2 = Distance with – load , m.

4- Machinery cost analysis:

Machinery costs are classified into two groups **(Hunt, 1979**). The first group is fixed costs including on depreciation , interest on investment, taxes, shelter and insurance . The second group is variable cost divided into repairs and maintenance , fuel, oil and labor.

Cost of implements per feddan:

The cost of ploughing on feddan for each individual type of the ploughs used in the study was calculated.

Determination of soil volume disturbed :

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

$$V = 4200\ F_c\ d \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots(9)$$

Where:

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

F_c =Field capacity , fed / h and

d= Plowing depth, m.

5- Water measurements:

a)Water consumtive use:

was calculated according to the following equation**(Israelsen and Hansen(1962)**

$$CU = \frac{\theta_2 - \theta_1}{100} \mathrm{X}\, DB\, \mathrm{X} \frac{60}{100} \mathrm{X}\, 4200 \quad \dots\dots\dots\dots\dots\dots..(10)$$

Where:

CU = Water consumptive use, m^3/fed.

θ_1 = Soil moisture content,% after irrigation.

θ_2 = Soil moisture content,% before the next irrigation.

DB = Bulk density in, g/cm^3.

b) Amount of irrigation water applied:

Was measured cutthroat flum (20x90 cm) and calculted as m^3/ fed.

c) Field water use efficiency:

The water utilization efficiency was calculated as **(Michael, 1978)**

FWUE=seed flax yield (kg) / Water delivered to the field (m^3), kg/m^3…..(11)

d) Crop water use efficiency:

Was computed by dividing the yield (kg of seed cotton) on evapotranspiration expressed as cubic meters of water **(Abd EL – Rasooletal. 1971).**

e) Water application efficiency:

Was calculated according to the following equation **(Micheal, 1978).**

$$\frac{\text{Water stored in the effective root zone}}{\text{Amount of water applied}} \times 100 \quad .....(12)$$

RESULTS AND DISCUSSION

The results and discussion dealing with the present study will be arranged under the following headings .

1- Field performance characteristics:

a) Effective field capacity :

Fig .1 illustrates the effect of seedbed preparation machines on the effective field capacity in fed/h. The obtained values of field capacity were found to be 3.39, 1.56, 1.93 and 2.28 fed/h for disc harrow , chisel plough one –pass, chisel plough two-passes and subsoiler, respectively.

It is clear that the chisel plough gave the minimum values of effective field capacity , while the disc harrow gave the maximum values. This trend is due to the ploughing width of the disc harrow is the more than the other treatments.

The analysis of variance showed that the disc harrow was highly significant effect on the effective field capacity.

b)Field efficiency:

Fig.2 shows the effect of seedbed preparation machines on the field efficiency . Field efficiency values were 73.98, 65.0 78.89 and 92.0% for disc harrow , chisel plough one-pass , chisel plough two-passes and subsoiler , respectively.

It is apparent that the minimum values of field efficiency were given with the chisel plough one – pass 65.0% , followed by disc harrow 74.0%. On the other hand. The sub-soiler plough gave the maximum field efficiency 92.0%.

The analysis of variance showed that the subsoiler were highly significant effect on the field efficiency and seedbed preparation machines.

c) The percentage of Slip:

Fig .3 demonstrate the effect of seedbed preparation machines on the slip ratio. The values of slip ratio were 4.54, 6.51 ,7.44 and 13.06% when disc harrow , chisel plough one –pass, chisel plough two-passes and subsoiler were used , respectively .

It is evident that the lowest values of slip ratio were obtained with the disc harrow , while the highest values were recorded with the subsoiler .

The analysis of variance showed that there highly significant differences between all seedbed preparation machines.

d) Fuel consumption rate:

The effect of seedbed preparation system on the fuel consumption rate are shown in Fig.4. The obtained values for the five treatments use were 7.0 ,11.0 18.0 , 21.0 and 28.0 L / h for disc harrow , chisel once + disc harrow , chisel twice + disc harrow , chisel once + subsoiler +disc harrow , chisel twice +subsoiler + disc harrow , respectively.

It is obvious that the fuel consumption rate increases with the use of more than one type of treatments .Treatment of disc harrow alone consumed the least fuel 7.0 L/h and the consumption increased gradually until it reached the maximum of 28.0 L/h for treatment chisel twice + subsoiler +disc harrow .

The analysis of variance showed that highly significant effect on the fuel consumption rate and between seedbed preparation treatment.

e) Power requirements:

The effect of seed bed preparation system on power requirement in kW is presented in Fig 5 . The obtained values of power requirement were 22.12 , 34.76 , 56.88 , 66.36 and 88.48 kW for the same above mentioned treatments ,respectively .

It is obvious that the minimum values of power requirement were obtained when the disc harrow was used . Required power increases to the maximum value when the treatment chisel twice + subsoiler + disc harrow was used . These results agree with those obtained by **Abernathy et al . (1975)**.

The analysis of variance showed that the highly significant effect on the power requirements and between seedbed preparation treatment.

f) specific fuel consumption (S.F.C) L / kW. h:

The effect of seedbed preparation system on the (S.F.C.) are shown in Fig 6 . It is obvious that the minimum values of S.F.C were , obtained when the disc harrow was used , while the maximum values of S.F.C were 0.341 L/kW.h for treatment (chisel twice +subsoiler + disc harrow) .

2- Cost of tillage machine per feddan:

Fig. 7 indicate the effect cost of tillage machines per fed. The obtained values of the operation cost were found to be 8.00, 15.50, 12.25 and 23.00 L.E / fed . for disc harrow , chisel plough one – pass , chisel plough two – passes and subsoiler , respectively .It is clear that the disc harrow gave the minimum cost per fed. 8.00 L.E /fed . This trend maybe due to the high actual field capacity, while the subsoiler plough gave the maximum cost per fed. 23.00 LE /fed .These results agree with those obtained by **EL-Ansary and EL-Mallah (1986)** .

The analysis of variance showed that there highly significant difference between all four type of machines.

3-Plant and Yield characters :

i) **Number of open bolls per plant :**

The number of open bolls picked up per plant at maturity was recorded for each seedbed preparation treatment . The average numbers of open bolls are presented in Fig. 8. The treatment (chisel twice + disc harrow) gave the highest number of open bolls per plant 15.0 . The lowest number was 12.0 was produced from (chisel twice + subsoiler +disc harrow) .

ii) Boll mass (g) :

The average boll weights in g, illustrated in Fig. 9. The differences between treatment were highly significant. Treatment (chisel once + disc harrow) gave an average boll mass of 2.89 g . The analysis of variance showed that there were significant difference between all seedbed preparation treatment.

iii) Cotton yield (Qentar / feddan) :

Data of seed cotton yield (kg/fed) is presented in Table3. Seed cotton yield in kentars per feddan was computed from the amount of seed cotton produced in kg / plot. Data indicated that the highest value of seed cotton yield produced with (chisel once + subsoiler + disc harrow) followed by (chisel twice +subsoiler + disc harrow) as the top yielders .While treatment (disc harrow) gave the lowest yield . These results agree with those obtained by **EL-Ansary and EL-Mallah (1986).**

The analysis of variance showed that there were significant difference between all seedbed preparation treatments

4- Water relations :

a)Values of amount water applied m^3 /fed., for different tillage Systems are shown in Table3. The amount of water applied were 3033, 3185, 3205, 3319 and 3591 m^3 /fed. for treatments A, B, C,D and E, respectively. Also, the values of water consumptive use were 2216,2345,2405,2462 and 2574 m^3 /fed. for the same above mentioned treatments. These results are in agreement with those obtained by **(Helmy et al.(2001).**

b) The values of field water use efficiency, also are illustrated inTable3. Concerning water use efficiency which considered as the parameter of the capability of consumed water by plants in producing crop yield. The highest valuse of 0.31kg/ m^3 for treatment D, while the lowest value of 0.22 kg/ m^3 for treatment A.

Table3: Water measurements for cotton as affected by different tillage system.

Treatments	Amount of water applied (m^3/fed.)	yield (kg/fed.)	Field water use efficiency (kg/m^3)	Water consumptive use (m^3/fed.)	Crop water use efficiency (kg/m^3)
A	3032.82	675.7	0.22	2215.5	0.30
B	3184.86	814.3	0.26	2344.86	0.35
C	3205.02	908.8	0.28	2404.5	0.38
D	3318.84	1031.6	0.31	2462.04	0.42
E	3591.0	1001.7	0.28	2546.46	0.39

1 Qentar of cotton yield = 157.5 kg C = chisel twice + disc harrow
A = disc harrow D = chisel once + subsoiler + disc harrow
B = chisel once + disc harrow E = chisel twice + subsolier + disc harrow

The rate of disturbed soil volume is shown in Fig. 10. The volume unit values of disturbed soil were 2847.6 , 1310.4 , 2026.5 , 3830.4 and 4788.0 , m^3/h for A, B, C, D, and E, respectively . Chisel plough one – pass at 20 cm depth gave the lowest values of the disturbed soil volume .Whilest , the subsoiler plough at 50 cm depth gave the highest volume value of the disturbed soil volume unit .

CONCLUSION

The results revealed the following :

1-Effective field capacity (fed/h) : Chisel plough one or two – passes gave the minimum values 1.56 and 1.93 fed./h, while the disc harrow gave the maximum values 3.39 fed./h.

2-Field efficiency (%) : Chisel plough one- pass was effective in lowering field efficiency to about 65%, while the subsoiler plough gave the maximum field efficiency 92.0 %.

3-The percentage of slip (%) : The disc harrow proved the best with 4.54% compared to 13.06 % for the subsoiler plough .

4-Rate of fuel consumption (L/h) : Logically , the rate increased gradually and significantly with the increase of number of machines from 7.0 L/h of treatment A to 28.0 L/h of treatment E.

5-Power requirements (kW) : The same trend was obtained with disc harrow giving the lowest value 22.12 kW and chisel plow two – passes + disc harrow + subsoiler giving the highest value 88.48 kW.

6-Cost of seedbed preparation (L.E/fed) : The disc harrow gave the lowest cost 8.0 L.E/fed , while the highest cost of 23.0 L.E/fed. came from using the subsoiler .

7-Number of open bolls/ plant: Treatment C giving the highest number 15.0 bolls and the lowest 12.0 bolls from treatment E.

8- Boll mass (g): Treatment B giving the heaviest bolls 2.8 g and treatment E giving the lightest bolls 2.4 g .

9- Seed cotton yield (Qentars/feddan): The treatments D and E were significantly the highest yielder , 6.55and 6.36 Qent./fed, compared to 4.29 Qent./fed for treatment A.

10-Amount of water applied (m^3/fed.):The total applied water were 3033,3185,3205,3319 and 3591 m^3/fed for treatments A,B,C,D, and E, respectively.

11-Field water use efficiency (kg/m^3): The heighest value was 0.31 kg / m^3 for the treatment D. While the lowest value was 0.22 kg / m^3 for the treatment A.

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الملخص العربي

تأثير انظمة الحرث المختلفة على بعض الاحتياجات المائية والإنتاجية لمحصول القطن

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يهدف هذا البحث إلى دراسة تأثير معاملات أعداد مرقد البذرة باستخدام خمسة طرق لإعداد مرقد البذرة على الاحتياجات المائية و الإنتاجية لمحصول القطن بغرض اختيار الأسلوب الأمثل للخدمة و الذي يحتاج أقل كمية من الماء و يعطى أعلى إنتاجية و بأقل تكلفة .

و قد تم استخدام خمسة أنواع من المعاملات و كانت كالتالي:

أ- المشط القرصي فقط .

ب- المحراث الحفار في اتجاه واحد+المشط القرصي .

جـ- المحراث الحفار في اتجاهين متعامدان + المشط القرصي .

د- المحراث الحفار في اتجاه واحد + محراث تحت التربة + المشط القرصي .

هـ- المحراث الحفار في اتجاهين متعامدان + محراث تحت التربة + المشط القرصي .

و تبع التخطيط جميع المعاملات.

و قد أقيمت التجربة في محطة البحوث الزراعية بسخا - محافظة كفر الشيخ .

و تتلخص النتائج الرئيسية لهذا العمل كالآتي :

١- أعطى المحراث الحفار وجه واحد أو وجهين أقل قيمة للسعة الفعلية و كانت(١,٥٦- ١,٩٣ فدان/ساعة) بينما أعطى المشط القرصي أعلى قيمة كانت ٣,٣٩ فدان / ساعة .

٢- اعطى المحراث الحفار وجة واحد تخفيض الكفاءة الحقلية إلى حوالي ٦٥٪ مقارنة بمحراث تحت التربة الذي أعطى ٩٢٪ كفاءة حقلية .

٣-أتضح أن المشط القرصي أحسن معاملة فقد أعطى نسبة انزلاق ٤,٥٤٪ بينما أعطى المحراث تحت التربة ١٣,٠٦ %.

٤- أوضحت النتائج أن قيم استهلاك الوقود زادت تدريجيا كما هو متوقع و ذلك بزيادة عدد الآلات المستخدمة من ٧ لتر/ساعة للمعاملة (أ) إلى ٢٨ لتر /ساعة فى (هـ).

٥- كذلك القدرة المطلوبة أخذت نفس الاتجاه السابق ذكره حيث كانت ٢٢,١٢ كيلو وات للمعاملة (أ) بينما كانت ٨٨,٤٨ كيلو وات للمعاملة (هـ) .

٦- أعطى المشط القرصي أقل قيمة ٨ جنيه /فدان بينما أعطى المحراث تحت التربة ٢٣جنيه /فدان.

٧- أعطت المعاملة (د،هـ) أعلى محصول ٦,٥٥ ، ٦,٣٦ قنطار /فدان على التوالي بالمقارنة بالمعاملة (أ) التى أعطت أقل محصول ٤,٢٩ قنطار / فدان .

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٨- كمية المياه المضـافة لكل معاملـة كانـت ٣٣٣ ،٣١٨٥ ، ٣٢٠٥، ٣٣١٩، ٣٥٩١ م٣ /فدان للمعاملات أ ، ب ، جـ ، د ، هـ.

٩- أوضحت النتائج أن أعلى قيمة لكفاءة استخدام المياه كانـت ٣١, كـج / م٣ للمعاملـة (د) بينمـا كانت أقل قيمة حصل عليها للمعاملة (أ) و هي ٢٢, كج / م٣ .

١٠- أظهرت النتائج أن قيم درجة تنعيم التربـة كانـت ٧٤,٦ – ٧٣,٧ – ٧٢,٠ – ٧٠,٤ و ٦٩ ./. و ذلك للمعاملات ا، ب، جـ ، د ، هـ على التوالى.