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Effect of Different Leveling Methodes on Roughness Condition of Soil Surface

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ABSTRACT

The main objective of this research is to determine the most appropriate ways of land leveling methods, which is working to reduce the resistance to water flow and the impact on irrigation efficiencies. Three different treatment methods and two experiments were carried out in Gemiza, El-Gharbia government,(clayley soil) during two successive agricultural seasons of winter (wheat) 2014/2015, and summer (corn) 2015. The study showed the decrease of coefficient of water resistance, and water applied with laser land leveling comparing hydraulic scraper, and rotary tiller. The percentage of decrease of coefficient of water resistance were (54%, and 79%), (79%, and 92%) and (56%, 86%) at Manning's roughness coefficient(n), chezy's roughness coefficient(C), and Darcy-Weisbach roughness coefficient,($\sqrt{f}$) respectively at hydraulic scraper, and rotary tiller at first season. The percentage of decrease at water applied was (20%, and 22%) with laser land leveling comparing hydraulic scraper, and rotary tiller at first season. The percentage of decrease of coefficient of water resistance at second season were (51.75%, and 67.61%), (51.76%, and 93.4%) and (51.75%, and47.15%) at Manning's roughness coefficient(n), chezy's roughness coefficient(C), and Darcy-Weisbach roughness coefficient,($\sqrt{f}$) respectively at hydraulic scraper, and rotary tiller. The percentage of decrease at water applied was (17.97%, and 19.99%) with laser land leveling comparing hydraulic scraper, and rotary tiller at second season. The study showed the increase of irrigation efficiencies with laser land leveling comparing hydraulic scraper, and rotary tiller. The percentage of increase of irrigation efficiencies were (15.44%, and 20.61%), (4.83%, and 7.81%), (1.4%, and 3.36%) and (36.95%, and 62.99%) at application efficiency, distribution efficiency, low-quarter efficiency, and water productivity at hydraulic scraper, and rotary tiller at first season. The percentage of increase of irrigation efficiencies were (23.24%, and 22.23%), (1.23%, and 4.68%), (11.17%, and 3.06%) and (43.75%, and 45.26%) at application efficiency, distribution efficiency, low-quarter efficiency, and water productivity at hydraulic scraper, and rotary tiller at second season.

INTRODUCTION

Roughness is one of the major parameters controlling overland flow. The overall roughness effects depend on the scales of the processes involved. For mm to cm scales, soil roughness reduces flow velocity and the roughness effect is usually incorporated in a friction term such as Darcy–Weisbach's, Manning's or Chezy's coefficients (Baird et. al., 1992; Grayson and Moore, 1992; Scoging *et al*., 1992). Laser land leveling is the important measure of improve irrigation efficiency and facilitating more uniform distribution of irrigation water. The sensitivity of the operating system 10 to 50 times more accurate than manual hydraulic system compared to conventional land leveling methods (Walker, 1992). (Clemmens *et al*. 2001) State that the Manning N has also been show to vary with time during irrigation as the soil is smoothed by the flowing water. Thus estimates of manning N based on the advance curve may vary substantially from those on measured water depth. In appropriate selection of equation or parameter values for one (infiltration or roughness) can lead to unrealistic parameter values for the other. The infiltration capacity concept can be described using the concept of maximum water storage (S_{max}). Although, in reality the water storage is highly variable due to different soil and land –uses in catchment scale, S_{max} allows the direct comparison of different soil/land –use units. (Abo-Habaga, 2003) Indicated, the traditional land leveling (Scraper) are conservation soil physical properties more than the precision leveling (LASER). Declining water table and degrading soil health are the major concerns for the current growth rate and sustainability of agriculture. Thus, proper emphasis is being given on the management of irrigation water usage for adequate growth of agriculture. Keeping in view, the need for judicious use of our natural resources, concerted are being made to enlighten the farmers for efficient use of irrigation water at farm level (Kaur *et al*., 2012). After five irrigations experiment the highest averages percentage of change of soil bulk density was observed under precision land leveling 0.03% treatment. The averages percentages of change of soil bulk density were 1.87, 2.35%, 2.8%, 3.2%, and 3.5% at 0-15 cm depth respectively. While the lowest change were under Rotary tiller treatment. The averages percentages of change of soil bulk density were 0.63%, 0.91%, 1.1%, 1.4%, and 1.4% at 0-15 cm depth respectively (El-Samra *et al*., 2013). (Naresh, *et al*., 2014) Indicated, the LASER land leveling, farmers could save irrigation water 21%, energy by 31% and obtained 6.6%, 5.4% and 10.9% in rice, wheat and sugarcane higher yields. The total irrigation duration and applied water depth was reduced to 10.9%, 14.7% in rice; 13.7%, 13.3% in wheat and 13.5%, 20.3% in sugarcane as compared to traditional leveled field.

MATERIALS AND MEHODS

This investigation aimed to deduct the empirical relationship. So as to account for raising irrigation applied efficiency via soil water flow resistance explain saving irrigation water due to three landlevlling treatments were evaluated versus the main evaluating parameters of water movement in the field. Field experimenters were carried out at Elgemaza Research Station, EL-Gharbia Governorate. 1.2 Fed with area of divided nine different plots each was 6m width x 80m length and one meter between every plots. The soil texture was (clayley soil). The experiments were carried out through two seasons. The first one was planted Wheat at winter 2014/2015, and the second season was planted Maize at summer 2015. All crops were plant in flat soil. Experimental design was to irrigate by surface – border irrigation.

The land leveling treatments included: precision land leveling (by LASER equipment of slopes 0.00% (L1); convention land leveling(by hydraulic scraper(L2)) and land smoothing (by rotary tiller(L3)).The experimental are wire tilled by tow perpendicular paths by chisel plough. Measured surface irrigation efficiency and its components.

Material:

The tractor as power units was used, the New Holand TM-150 of 120hp (85.7KW).The chisel plow of 9 shanks with plow width 2.25m and 225kg weight. LASER land leveler with pneumatic 4 tires (16x 650/6), cutting depth scraper was changed by the hydraulic cylinder, working width, 300 cm, and total weight was 770 kg was used. The mounted hydraulic scraper with cutting depth was changed by the tractors hydraulic system. working width,250 cm and total weight was 467 kg was used. The rotary plow specifications were 35 tines the plow depth, max 15cm was working width, 210 cm, 540 rpm p.t.o shaft speed and 846 kg total weight.

Methods:

The experimental design was random complete block the experimental are divided into four plots each repeated three times.

Measurements:

1- **Manning coefficient of roughness,(N).** It was calculated according to Hart *et al*, (1980) as follows:

N= {(60 $S_o^{0.5\ 0.6}$ √LS_y)/ Q_o- IL} (3)

Where; S_o =Soil surface slope, %., S_y=Water surface slope at the station where the measurements were taken,%., L = the length at the station were the measurements were taken, m., Q_o=Input discharge, L/sec/m width., and I= actual infiltration rate, mm/min.

2-Flow resistance formulas: (Michael, 1993) reported that the Flow resistance coefficients computing from the following equations:

a- Chezy's formula (V=C√RS),

b-Manning's formula (V= ($R^{2/3}S^{1/2}$)/N), and

c-Darcy-Weisbach formula (V=√8gRS/f).

In which (R=hydraulic radius, meters), (g= acceleration due to gravity, meters/sec²), (c=chezy's roughness coefficient, $L^{1/2}$ /T), (n= Manning's roughness coefficient, L^1/6), and (f= Darcy-Weisbach roughness coefficient or friction factor, dimensionless).

The resistance coefficients, C, N and f can be related to each other as follows: (C/√g= √8/√f= R^1 /6 / N √g) (Michael, 1993).

3- Irrigation evaluation parameters:

a- Irrigation application efficiency,(EA),%. It was calculated according to Michale (1993) as follows: $$Ea=\frac{Ws}{Wf}X100 \quad (5)$$

Where; Ws=Stored water in the root zone, cm, and Wf=water delivered to each treatment, cm,.

b- Water distribution efficiency,(DU),%. It was calculated according to Burt *et al*.(1977)as follows:

$$DU=(1-\frac{Y}{dr})X100 \quad (6)$$

Where; d_r = Average depth of soil water stored along the run during the irrigation, cm, and Y= Average numerical deviation from d_r, cm.

c- The low-quarter distribution uniformity,(DU_{Lq}),%. It is computed according to Burt *et al*.(1977) as follows:

$$DU_{Lq}=\frac{Z\,avg\,Lx}{Zr}X100 \quad (7)$$

Where; Z_{avg} L_x= average depth of water stored in the low-quarter of the border length, cm, and Z_r = average depth of water accumulated in all elements, cm.

4- water productivity: Water productivity analysis physical accounting of water with yield or economic output to assess how much value is being obtained from the use of water (Molden *et al*., 2003), (Abdullaev *et al*.,2007),and (Bouman *et al*.,2008). Physical water productivity was calculated by:

WP=Output/Q.

Where WP is the productivity of crop in $Kg.m^{-3}$, Output is the mass of crop in kilograms and Q is water resource applied and depleted(m^3)

RESULTS AND DISCUSSION

To study the effect of soil land leveling equipments on change of water movement parameters, coefficient of flow resistance were minorities in terms of the state of the soil plowing before. Four irrigated were applied during wheat growth, first season and six irrigated were applied period according to 1.5L/Sec Per meter of width. Two field experiments were carried out in Gemiza, El-Gharbia government. Winter 2014/2015, and summer 2015 were two successive agriculture seasons. The land leveling treatments included: precision land leveling by LASER equipment of slopes 0.00% (L1); convention land leveling by hydraulic scraper(L2) and land smoothing by rotary tiller(L3).The experimental are wire tilled by two perpendicular paths by chisel plough.

Table(1) showed that the effect of land leveling treatments on coefficient of flow resistance with Average Total water applied at first season. The average values of coefficient of flow resistances were 0.03412, 0.07338,and 0.24201 at Manning 's coefficient of flow resistance(N), 0.03287, 0.15296, and 0.46380 at Chizey's coefficient of flow resistance (C), and 0.269288, 0.579142, and 1.91003 at Darcy- wesbach's coefficient of flow resistance(√ʃ) at L1, L2, and L3 land leveling treatments respectively. The greatest values was 0.24201, 0.46380, and 1.910033 with L3 treatment at Manning 's coefficient of flow resistance(N), Chizey's coefficient of flow resistance (C), Darcy- wesbach's coefficient of flow resistance(√ʃ) respectively and the Average Total water applied (q_t) l/m/cm was a higher 3243.391 comparing the smallest values was 2516.973 l/m/cm with L1 treatment. And the average values of coefficient of flow resistances were 0.03412, 0.03287, and 0.269288 at Manning 's coefficient of flow resistance(N), Chizey's coefficient of flow resistance (C), Darcy- wesbach's coefficient of flow resistance(√ʃ) respectively with L1 land leveling treatment at first season.

Table 1. The effect of land leveling treatments on coefficient of flow resistance with Average Total water applied at first season .

Average Total water applied (q_t) l/m/cm	Treatments	Average values of Manning's coefficient of flow resistance (N)	Average values Chizey's coefficient of flow resistance (C)	Average values Darcy- wesbach's coefficient of flow resistance (√ʃ)
2516.973	L1	0.03412	0.03287	0.269288
3184.115	L2	0.07338	0.15296	0.579142
3243.391	L3	0.24201	0.46380	1.910033

Table(2) showed that the effect of land leveling treatments on coefficient of flow resistance with Average Total water applied at second season. The average values of coefficient of flow resistances were 0.06822, 0.14139,and 0.19208 at Manning 's coefficient of flow resistance(N), 0.060777, 0.125964, and 0.114979 at Chizey's coefficient of flow resistance (C), and 0.538331, 1.115724, and 1.0118584 at Darcy-wesbach's coefficient of flow resistance(√ʃ) at L1, L2, and L3 land leveling treatments respectively. The greatest values was 0.19208, and 0.114979, with L3 treatment at Manning 's coefficient of flow resistance(N), and Chizey's coefficient of flow resistance (C), respectively. And the greatest values was 1.115724 at Darcy- wesbach's coefficient of flow resistance(√ʃ) with L2 treatment and the Average Total water applied (q_t) l/m/cm was a higher 1944.99 at L3 treatment comparing the smallest values was 1556.70 l/m/cm with L1 treatment. And the average values of coefficient of flow resistances were 0.06822, 0.060777,and 0.538331at Manning 's coefficient of flow resistance(N), Chizey's coefficient of flow resistance (C), Darcy- wesbach's coefficient of flow resistance(√ʃ) respectively with L1 land leveling treatment at second season. Increasing the average values of coefficient of flow resistances on the soil surface as a result of the inaccuracy of the use of hydraulic scraper result of dependence on the human factor, While the rotary tiller work to smoothness soil surface without modification soil surface levels

Table 2. The effect of land leveling treatments on coefficient of flow resistance with Average Total water applied at second season

Average Total water applied (q_t) l/m/cm	Treatments	Average values of Manning's coefficient of flow resistance (n)	Average values Chizey's coefficient of flow resistance (C)	Average values Darcy- wesbach's coefficient of flow resistance (√ʃ)
1556.70	L1	0.06822	0.060777	0.538331
1896.93	L2	0.14139	0.125964	1.115724
1944.99	L3	0.19208	0.114979	1.018584

Table (3) showed that the effect of land leveling treatments on efficiencies of irrigation at every irrigation and the average total efficiencies. (L1), comparing with the (L2), and (L3), application efficiency, (AE%) values at every irrigation at two season were increased . The percentage of increase was 7.35%, 6.98%, 25.99%, and 31.39% at four irrigations at first season resp, and 26.69%, 12.6%, 22.68%, 24.34%, 38.33%, and 24.33% at six irrigations at second season resp, and 34.78%, 16.39%, 25.98%, and 12.31% at for irrigations at first season resp, and 38.11%, 21.97%, 23,26%, 16.33%, 26.56%, and 20.42% at six irrigations at second season resp comparing with (L2), and (L3) treatments resp. distribution efficiency, (DU%) values at every irrigation at first season were increased with LASER equipments . The percentage of increase was 3.14%, 6.87%, 3.7%, and 6.18% at four irrigations at first season resp, and distribution efficiency,(DU%) values at first, and second irrigations at second season were decreased with LASER equipments. The percentage of decrease was -0.083%, and -2,36%, at first irrigation, and -0.083%, and-0,031% at second irrigation, comparing (L2),and (L3), resp at second season.

Table 3. The effect of land leveling treatments on irrigation efficiencies with every irrigation and total irrigation efficiencies at two season 's

Irrigation No	Treatments	Irrigation efficiencies: Irrigation application efficiency (AE)%		Water distribution efficiency, (DU)%		Low-quarter distribution uniformity(DU_{Lq})	
		Wheat	Corn	Wheat	Corn	Wheat	Corn
Average	L1	80.998	89.91	95.48	95.62	62.79	62.91
	L2	70.228	72.95	90.98	95.45	61.10	59.47
	L3	67.153	72.55	88.57	94.17	60.75	59.36

As a result of the use of laser equipment for the second straight season happened to demolish gatherings soil and the heterogeneity of the distribution of soil moisture content resulting in a decline in the efficiency of distribution of moisture from the rest of the another treatments. The process of cultivation soil down did not affect the efficiency of water distribution with laser leveling in the four following irrigations fluctuated between high efficiency and low values. The investigators must work for future studies on repeat laser leveling for more than a season and its impact on soil properties. (L1), comparing with the (L2) and (L3), low-quarter distribution uniformity efficiency,(DU_{lq}%) at every irrigation at two season were increased . As a general Land leveling by LASER equipments (L1) the achievement of higher values for total irrigation efficiencies have results were (80.998%, and 89.91%), (95.48%, and 95.62%), and (62.79%, and 62.91%) at two seasons at application efficiency, (AE%) , distribution efficiency,(DU%), and low- quarter distribution uniformity efficiency, (DU_{lq}%) respectively. And the lowest values for irrigation efficiencies were (67.15%, and 72.55%), (88.57%, and 94.17%), and (60.75%, and 59.36%), with treatment by rotary tiller (L3), at two seasons at application efficiency, (AE%) , distribution efficiency, (DU%), and low- quarter distribution uniformity efficiency, (DU_{lq}%) respectively. The percentages of increase was (15.44%, and 20.06%), and (23.25%, and 23,93%) with L1 treatment comparing L2,and L3 at application efficiency, (AE%), at first and second seasons respectively, (4.95%, and 7.8%), and (0.18%, and 1.54%) at distribution efficiency,(DU%), at first and second seasons respectively, and (2.77%,and 3.36%), and (5.78%, and 5.98%) at low- quarter distribution uniformity efficiency, (DU_{lq}%), at first and second seasons respectively.

Table 4. The effect of land leveling treatments on water productivity (kg/m^3) at two season's.

Treatments	Total applied water (m^3/fed)		Water productivity (kg/m^3)	
	Wheat	**Corn**	**Wheat**	**Corn**
L1	2507.66	3527.55	1.0958	1.1906
L2	3183.33	3688.51	0.8001	0.9624
L3	3303.17	3784.56	0.6724	0.9512

Table(4) showed that the total applied water, and water productivity at two seasons after land leveling treatments. the smallest values for total applied water was 2507.66 m^3/fed with L1 treatment comparing 3183.33, and 3303.17 m^3/fed with L2,andL3 treatments resp. and the highest values for water productivity was 1.0958 kg/m^3 with L1 treatment comparing 0.8001, and 0.6724, kg/m^3 with L2, and L3 treatments resp at first season. At second season the smallest values for total applied water was 3527.55 m^3/fed with L1 treatment comparing 3688.51, and 3784.56 m^3/fed with L2,andL3 treatments resp, and the highest values for water productivity was 1.906 kg/m^3 with L1 treatment comparing 0.9624, and 0.0.9512, kg/m^3 with L2, and L3 treatments resp. Minute settlement using a laser equipment worked on the uniformity of germination and increase the rate of germination to increase productivity and slashing to the values of the amount of applied water to raise the productivity per unit of water values while leveling manual control of hydraulic scraper which depend on the efficiency of the tractor driver reduced the tropical surface accuracy which affected the germination of the crop and increase the amount of applied water, thereby reducing the productivity per unit of water, while the values of the use of rotary tiller has depended on the degree of tropical soil surface before treatment and thus the productivity of the unit depends on the degree of accuracy leveling soil surface before treatment.

CONCLUSION

The study was showed the decrease of values of all coefficient of water resistance with land leveling by LASER equipments comparing with land leveling by hydraulic scraper and rotary tiller. The percentage of decrease of coefficient of water resistance were 54%, and 79%, 79%, and 92% and 56%, 86% at Manning's roughness coefficient(n), chezy's roughness coefficient (C), and Darcy-Weisbach roughness coefficient,($\sqrt{f}$) respectively at hydraulic scraper, and rotary tiller at first season. The percentage of decrease of coefficient of water resistance at second season were 51.75%, and 67.61%, 51.76%, and 93.4% and 51.75%, and47.15% at Manning's roughness coefficient(n), chezy's roughness coefficient(C), and Darcy-Weisbach roughness coefficient,($\sqrt{f}$) respectively at hydraulic scraper, and rotary tiller. And the increase of irrigation efficiency with laser land leveling comparing hydraulic scraper, and rotary tiller. The percentage of increase of irrigation efficiencies were 15.44%, and 20.61%, 4.83%, and 7.81%, 1.4%, and 3.36% and 36.95%, and 62.99% at application efficiency, distribution efficiency, low-quarter efficiency, and water productivity at hydraulic scraper, and rotary tiller at first season. The percentage of increase of irrigation efficiencies were 23.24%, and 22.23%, 1.23%, and 4.68%, 11.17%, and 3.06% and 43.75%, and 45.26% at application efficiency, distribution efficiency, low-quarter efficiency, and water productivity at hydraulic scraper, and rotary tiller at second season.

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تأثير نظم التسوية المختلفة علي حالة خشونة سطح التربة

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أجريت التجارب الحقلية بمحطة بحوث الجميزة محافظة الغربية لموسمين زراعيين موسم شتوي (قمح) 2015/2014 وموسم صيفى(ذرة) 2015 الهدف من هذا البحث هو دراسة جميع معاملات حساب مقاومة سريان المياة علي سطح التربة لتحقيق اقل معاملة تسوية في معاملات حساب مقاومة السريان لتقليل كمية المياة المضافة وتأثيرها علي كفاءات الري تم استخدام ثلاث مستويات من التسوية :- - التسوية الدقيقة باستخدام اجهزة الليزر عند مستوي الصفر L1 - التسوية بإستخدام القصابية الهيدروليكية L2 - إستخدام المحراث الدوراني L3 وذلك بعد الحرث بالمحراث الحفار في اتجاهين متعامدين وقسمت التجربة الي ثلاث مكررات لكل معاملة مساحة كل مكرر 6مX80م. بالإضافة الي واحد متر بين المعاملات للفصل بينها وكانت المساحة الكلية للتجربة 1.2فدان وقد حققت التجربة النتائج التالية:- 1- كانت معاملة التسوية الدقيقة بأستخدام أجهزة الليزر أقل قيم لمعاملات مقاومة سريان المياة علي سطح التربة مقارنة بمعاملات التسوية الأخري وقد كانت القيم أقل بنسبة 54% و 79% لمعامل ماننج لحساب مقاومة المياة علي سطح التربة وأقل بنسبة 79% و92% لمعامل شيزي لخشونة سطح التربة وأقل بنسبة 56% و 86% لمعامل دارسي ويسباش لمعامل خشونة سطح التربة وذلك مقارنة بالتسوية بالقصابية الهيدروليكية والمعاملة بإستخدام المحراث الدوراني علي التوالي وذلك في الموسم الأول. كما كانت معاملة التسوية الدقيقة بإستخدام أجهزة الليزر اقل قيمة فى كمية المياة المضافة بنسبة 20% و 22% وذلك مقارنة بالتسوية بالقصابية العادية والمعاملة بإستخدام المحراث الدوراني على التوالي وذلك فى الموسم الأول. 2- كانت معاملة التسوية الدقيقة بإستخدام أجهزة الليزر أقل قيم لمعاملات مقاومة سريان المياة علي سطح التربة مقارنة بمعاملات التسوية الأخري وقد كانت القيم أقل بنسبة 51.75% و 67.61% لمعامل مانتج لحساب مقاومة المياة علي سطح التربة وأقل بنسبة 51.76% و93.4% لمعامل شيزي لخشونة سطح التربة وأقل بنسبة51.75% و 47.15% لمعامل دارسي ويسباش لمعامل خشونة سطح التربة وذلك مقارنة بالتسوية بالقصابية الهيدروليكية والمعاملة بإستخدام المحراث الدوراني علي التوالي وذلك في الموسم الثاني. كما كانت معاملة التسوية الدقيقة بإستخدام أجهزة الليزر اقل قيمة فى كمية المياة المضافة بنسبة 17.97% و 19.99% وذلك مقارنة بالتسوية بالقصابية العادية والمعاملة بإستخدام المحراث الدوراني على التوالي وذلك فى الموسم الثاني. 3- حققت كفاءات الري مع استخدام المعاملة L1 زيادة في قيمها مقارنة بالمعاملتين L2, L3 فقد كانت نسب ازيادة 15.44% و20.61% لكفاءة الأضافة و 4.83% و 7.81% لكفاءة التوزيع و 1.4% و3.36% لكفاءة التوزيع في الربع الأخيرو 36.95% و62.96% لكفاءة انتاجية وحدة المياة وذلك في الموسم الأول. 4-حققت كفاءات الري مع استخدام المعاملة L1 زيادة في قيمها مقارنة بالمعاملتين L2, L3 فقد كانت نسب ازيادة 23.24% و 22.23% لكفاءة الأضافةو 1.23% و 4.68% لكفاءة التوزيع و 11.17% و3.6% لكفاءة التوزيع في الربع الأخير و 43.75% و45.26% لكفاءة انتاجية وحدة المياة وذلك في الموسم الثانى.