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EFFECT OF LASER LAND LEVELING AND WIDTH BETWEEN FURROWS ON WATER USE EFFICIENCY AND YIELD OF SOYBEAN CROP

*** El Tantawy, M.T. ** El Sharkawy, A.F **Abo ElNour, M.N.**

ABSTRACT

A field trial was conducted at Gemmiza Agricultural Research Station during (2004-2005) growing season to study the effect of land leveling and distance between furrows on soybean yield, some aspects of water management, irrigation efficiency. Split plot design with four replicates was used. The land leveling treatments (0.05%, 0.03% surface slope and traditional land leveling) with the main plots. The distances between furrows were (0.5m with sown on one side of the ridge and 1.0 m width between furrows sown on two sides of the ridge) treatments occupied the subplots.

The results showed that the Laser land leveling treatments were 0.03 %, 0.05 %surface slopes, generally in both two furrows width (0.5, 1.0 m) and specially under surface slope 0.05 % compared with traditional method recorded positive effect as follows:

1. *Decreasing the advance and recession times with ratio percentage about 25.55 %& 11.36 % in case of 0.5 m width and 25.0 % & 9.52 % in case of 1.0 m width respectively and the same trend with opportunity time.*
2. *Decreasing mean infiltration rate and cumulative infiltration depth with ratio percentage about 30.0% and 27.0 % in both two widths (0.5 m and 1.0 m) respectively.*
3. *Saving the applied water with a percentage about19.42 %and 29.74% in both two widths (0.5 m and 1.0 m) respectively.*
4. *Increasing water application efficiency with a percentage about 18.21% and 16.15% in both two widths (0.5 m and 1.0 m) respectively.*
5. *Increasing consumptive water with a percentage about 5.53% and 7.96% respectively*
6. *Increasing soybean yield with a percentage about 29.0% and 30.2% respectively.*
7. *Increasing water use efficiency with percentage about 6.0% and 8.0%in both widths (0.5m and 1.0 m) respectively.*

***Kaywords**:* Soybean, advance, recession and opportunity times, laser land leveling infiltration rate, applied water, water consumptive use, water application and use efficiencies.

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* ** S. Res and Res, Agric. Eng. Instit. Dokki, Giza.

INTRODUCTION

Soybean is one of the most important crops in Egypt, and represents significantly value in the agricultural income. Water resources in Egypt are limited to the country's share of the Nile water, which is fixed according to international agreements 55.5 billion m^3 and some minor quantities of ground water and rain fall. Surface irrigation is the most widely irrigation method in Egyptian old land. A problem which one of the major problems concerns a lower application efficiency of surface irrigation system which causes the loss of water. So, many researches have been carried out aiming to improve its effectiveness throughout different manners. Land smoothing, land leveling with proper slope to improve surface irrigation effectiveness, increase the field water use efficiency and save water needed.

El-Yazal and Ismail (1986) stated that the leveled land showed significant water savings over unleveled land, by about 1000 m^3/fad. While yield increased by about 8%. **El-Yazal and wissa (1988**) reported that sugar cane yield increased with about 46% in addition to 28% irrigation water reduction due to precision land leveling.

Morcos et al. (1996) reported that soil surface slope, furrow length and discharge rate are effective engineering elements for proper water management. **Kassem and El-khatib (2000)** found that the opportunity time decreased by increasing the discharge rate and the soil surface slope while it increased by increasing the furrow length. The same trend was shown for the depth of infiltrated water. **Abd El –Hafez et al. (1996**) found that, both the advance and recession times for irrigation water were increased under the traditional method of land leveling .While in case of dead level and 0.2%slope laser land leveling shortened this time .The lowest was achieved at 0.2% ,and land leveling at dead level or 0.2% slope improved water application efficiency to reach 74% and saved the irrigation water by 17-.30 % compared with the traditional land leveling treatment. El- **Mowelhi et al (1999)** found that, water consumption of wheat; maize and sunflower were slightly high with traditional method of land leveling. The lowest values were with ground surface slope of 0.1%. **EL-Mowelhi and Abou baker (1995)** found that 0.1 % ground surface slope significantly increased the yield of maize comparing with that of dead level and the traditional method of land leveling

Attia et al (1999) stated that, the irrigation every 14 day of soybean with 90 cm between rows, reduced amount of applied irrigation water by 19.7 and 18. 8 % in the two growing seasons, respectively, and the same treatment saved about 20.6, 41.9 and 38.5 % of the time needed for sowing, thinning and irrigation respectively when it was compared with the treatment

irrigation every 14 days with 60 cm between rows **.El-Sherbeny et al (1997)** stated that, water advance and recession time increase for traditional furrow irrigation and opportunity time decreases under alternate irrigation technique. There is no high difference for yield between the alternate technique and traditional furrow irrigation system .The water use efficiency increased with alternate irrigation technique .Alternate furrow irrigation method received lowest amounts of irrigation water with saving 22 to 28 %. **El-Mowelhi et al (1996)** reported that the precession land leveling treatments ,dead level and 0.1% ground surface slope recorded a positive effect on seed cotton yield ,crop water use and water consumptive use efficiencies **Abd El-Rahman (1985)** concluded that water opportunity intake time and infiltration depth were decreased as both the flow rate and soil slope increased. While, water application efficiency in general increased as the flow rate increased and also as soil slope increased. So one of the main objectives of this work was to study the soil surface slopes and furrow width on the advance time ,the recession time ,the opportunity time , the amount of the applied water ,water consumptive ,water application efficiency ,the crop yield of soybean and water use efficiency

MATERIALS AND METHODS

The field experiments were performed at Gemmeza Agricultural Research Station Farm (Gharbeia Government) in 2004-2005 to study the effect of the precision surface slope the row width on the advance time , the recession time , the opportunity time , the amount of the applied water , the water application efficiency , the crop yield of the Soybean and water use efficiencies .A split plot design with four replicate was used ,the plot size was 300 m² (6 rows * 0.5 width * 100 m length)and (3 rows * 1m width * 100 m length)

Soybean was planted in June 20 and received six irrigations after planting. All of the agronomic practices were done as usual for soybean crop grown at the zone soybean was harvested on October 20. The soil mechanical analysis and soil moisture contents of the studied soil illustrate in table (1).

Table (1:) Mechanical analysis and some soil moisture contents of the studied soil experimental.

Depth cm	Fine sand %	Coarse sand %	Silt %	Clay %	Soil texture	F C.%	W.P. %
0-15	3.7	20.3	26.3	49.7	Clay	42.50	21.10
15-30	3.6	20.55	27.30	48.45	Clay	42.90	20.70
30-45	3.65	20.55	28.25	47.55	Clay	43.60	21.90
45-60	4.25	20.75	28.45	46.55	Clay	44.00	22.30

Experimental design

Six treatments were performed with three slope traditional land

leveling, 0.03 % and 0.05% laser land leveling under two widths of the furrows 0.5 m between furrows sown on one side of the ridge and 1 m width between furrow sown on two sides of the ridge.

Characters the studied

1- Determination of parameters advance and recession times of water irrigation. The irrigation run of each plot was divided into with stations equal distances 20 meters apart. Times of advance (t_1) and recession (t_2) of irrigation water were recorded at the stations along the irrigation run.

2-Opportunity time (t_o):

-The opportunity time was calculated according to the relation of ($t_o = t_2 - t_1$).

3- Infiltration rate of the soil were determined in the field using double ring (cylinder infiltrometer). .Cumulative infiltration and average infiltration rates were calculated according to **Garcia (1978).**

4- The irrigation water was conveyed through an orifice and its quantity was measured using submerged orifice .The quantity was determined by the following formula according to **James (1988)**

$$Q = 0.61 * A * 0.443*H^{0.5}$$

Where,

Q: Orifice discharge, 1/sec.

A Cross -section area of the orifice, cm².

H: Effective water head, m.

5-The consumptive use of water in each irrigation was estimated for the 60 cm soil depth according to **Israelsen and Hansen (1962).**

$$Wc = ((\theta 2 - \theta 1) / 100) * D * \beta d * 4200.$$

Where,

W_c : Amount of the water consumptive use (m³).

θ_2 : Soil moisture percent after irrigation.

θ_1 : Soil moisture percent before irrigation.

D : Depth of soil 60 cm.

β_d : Bulk density gm/cm³.

6-The values of irrigation application efficiency of each treatment were obtained by dividing the total consumptive use of water on the applied irrigation water.

$$Ea = (W_c / W_d) *100$$

Where,

E_a : Efficiency of the water applied.

W_c : Consumptive use of water.

W_d : Applied irrigation water delivered to the field plot.

7- The water use efficiency is weight units of marketable crops produced per

unit volume of water consumed by plant. It was computed by dividing the yield (kg of seed) over consumptive use of water (m3) according to the equation of **Vites (1965).**

$$WUE = \frac{\text{Seed Soybean yield (kg/ fed.)}}{\text{Consumptive use of water (} m^3 / \text{ fed).}}$$

8- Pan equation.

$$E_{to} = K \cdot E_o$$

Where

E_{to} : evapotransperation (mm/day).
K : pan coefficient.
E_o : pan evaporation (mm/ day).

9- Crop coefficient for every irrigation under different treatments were calculated as . followes .

$$K_c = E_{ta} / E_{to}$$

Where

K_c : Crop coefficient.
E_{ta} : Actual consumptive use (mm).
E_{to} : Potential evapotranspiration (mm).

RESULTS AND DISCUCTION

1-Advance, recession and opportunity times.

The advance and recession times are shown in Fig.(2) for different treatments. It is obvious that both of the advance and recession time increased under the traditional method of land leveling compared with the laser land leveling treatments 0.03% and 0.05% precision slope. On the other hand 0.05% precision slope treatment recorded the lowest values were 67 and 195 minutes. These results may be due to the effect of compaction caused by equipments used for laser. The data with slope 0.03 % were 77 and 206 minutes while the values under traditional land leveling were 90 and 220 minutes these results under width of furrows 0.5 m. In case of the distance between irrigation furrows 1 m, the times of advance and recession decreased and the values were 80 and 210 minutes with traditional land leveling ,70 and 195 minutes with 0.03% slope and the lowest values were (60 and 180 minutes) with 0.05% slope .It may notice that ,the values of advance time decreased under width between furrows 1 m . This trend may be due to increase of flow rate as a result for decreasing the number of furrows under distance between furrows 1.0 m. Recession time values had the same trend. This result may be due to increasing of water irrigation with movement horizontal direction.

Data of the opportunity time in minutes are shown in Fig. (2).It has been noticed that the opportunity time increased under the traditional land leveling compared with the other two treatments, while 0.05% slope

treatment recorded the lowest values .As the distance between furrow increased from o.5 to 1 m the opportunity time decreased and vice versa.

Generally the laser land leveling treatments 0.03 %, 0.05 % slope in both two furrows width (0.5, 1.0 m) and specially under surface slope 0.05% compared with traditional methods recorded a positive effect while decreased the advance and recession times with ratio percentage about 25.55% & 25.0 % and 11.36 % & 9.52 % respectively and same trend with opportunity time.

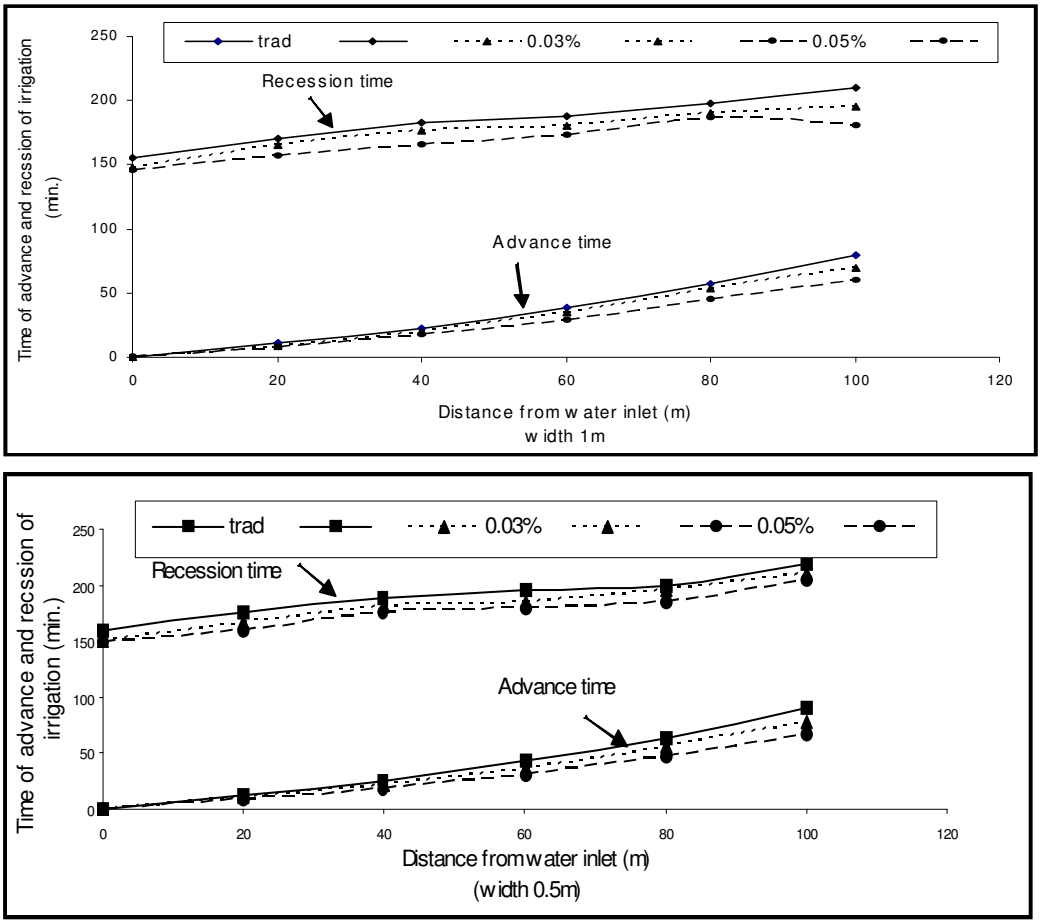

Fig.(2): Advance and recession times of the different land leveling treatments.

2-Infiltration rate and cumulative infiltration:

Values of infiltration rate (cm/hr) and cumulative infiltration (cm) as affected by the different treatments are shown in Fig. (3).Both the 0.03 % and 0.05 % surface slope treatments decreased the infiltration rate and the cumulative infiltration depth in comparison with the traditional treatment. This may be due to the effect of compaction caused by equipments used for

land leveling practices. Basic infiltration rate was found to be, 1, 0.8 .and 0.7 cm /h for traditional, 0.03 % and 0.05 % respectively.

Cumulative infiltration found to be 8.9, 7.5 and 6.5 cm for traditional (0.03% and 0.05 %) respectively and having the same trend of the basic infiltration rate.

Generally the laser land leveling treatments (0.03 %, 0.05 %, surface slope) in both two furrows width (0.5, 1.0 m) and specially under surface slope 0.05 % compared with traditional methods recorded positive effect while decreased infiltration rate and cumulative infiltration depth with percentage about30.0% and 27.0%respectively

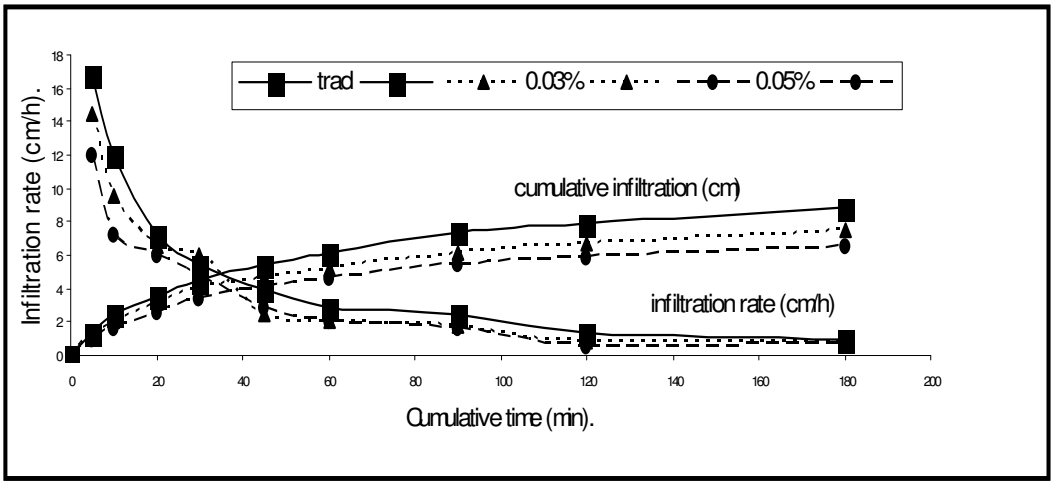

Fig. (3): Cumulative infiltration and infiltration rate of different treatments.

3- Crop coefficient (K_c)

The factors affecting on the value of the crop coefficient Kc, where $K_c = (E_{ta} / E_{to})$ are mainly the crop characteristics ,or sowing date ,rate of crop development ,length growing season .The Fig. (4). illustrate, the values of K_c for soybean. The values increased from sowing to flowering stage then decreased to ripening stage of all treatments, the values of Kc in case of width 0.5 m between furrows increased from 0.37 to 1.09. while decreased to 0.46 in traditional treatment ,the values increased from o.37 to 1.03 then decreased to 0.43 for 0.03 % surface slope .For o.o5 % slope the values were increased from o.36 0 to 1.03 then decreased to 0.42 .Also ,the same trend with width between furrows 1 m ,the values of Kc increase from 0.36 to 1.04 then decreased to 0.42 with traditional land leveling .The data with 0.03

% increased from 0,34 to 0.98 then decreased to 0.36 while the values of 0.05 %slope were increased from 0.33 to 0.97 then it decreased to 0.35.

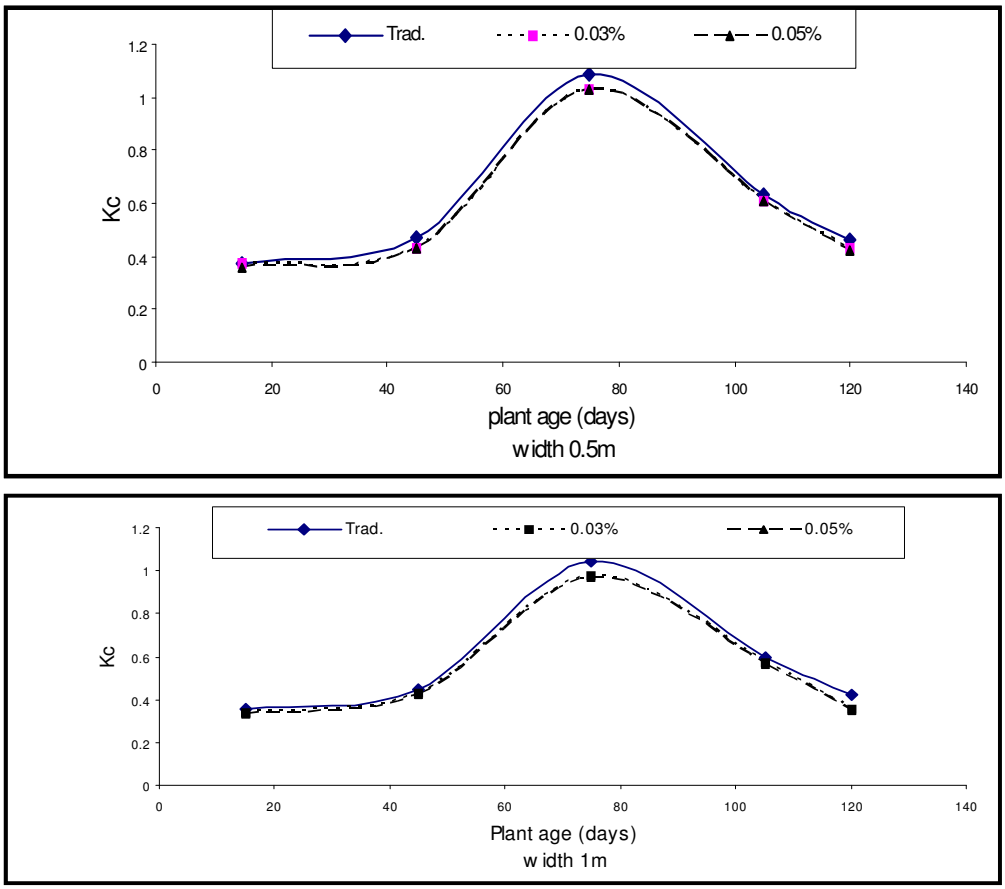

Fig.(4): Seasonal evaluation of (K_c) for different treatment during soybean growth stages.

4. Applied water:

Soybean received six irrigations after planting irrigation, the amount of irrigation water delivered to each plot and treatment. It was recorded for each irrigation and the cumulative amount added to the crops through the growing season was also recorded. The data in Table (2) illustrate, the traditional land leveling which received the highest amount of irrigation water. The width between furrows 0.5 m the value was 2733.5 m^3/fed. For laser lands leveling the values were 2206.3 m^3 /fed and 1920.5 m^3 /fed. for 0.03 % and 0.0 5% slope respectively .By using laser land leveling , the water irrigation saved by 19.28 % and 29.74 % for 0.03 % and 0.05 % slope respectively .When increase distance between furrows to 1.0 m with planting two rows

decreased applied water ,the values were 2338.3 ,1890 and 1650.4m^3/fed.for traditional land leveling, 0.03% slope and 0.05% slope respectively. The percentage of saved water by using laser land leveling were 19.17 % and 29.42 % for 0.03 % and 0.05 % .On the other hand, at using width between furrows 1.0 m compared with 0. 5 m, it decreased the applied water; the average applied water was from 2286.63 m^3/fed. to1959.57 m^3 /fed i.e decreased about (14.31%).

Generally The laser land leveling treatments (0.03 %, 0.05 %surface slope)in both two furrows width (0.5, 1.0 m) and specially under surface slope 0.05 % compared with traditional method recorded positive effect which saved the applied water with ratio percentage about19.42 % and 29.74% respectively.

Table (2): Effect of different land leveling and distance between furrow irrigation on the applied water and water application efficiency

Treatments	Distance of furrow	Applied water m^3/fed.	Consumptive water m^3 /fed.	Water applied efficiency %
Traditional	0.5 m	2733.5	1460.8	53.44
0.03 % slope	0.5 m	2206.3	1388.6	62.94
0.05% slope	0.5 m	1920.5	1380.0	71.86
Mean m^3/fed.	0.5 m	2286.77	1409.80	61.65
Traditional	1.0 m	2338.3	1395.3	59.67
0.03 % slope	1.0 m	1890.0	1307.6	69.19
0.05% slope	1.0 m	1650.4	1284.3	77.82
Mean m^3/fed	1.0 m	1959.57	1329.1	67.82

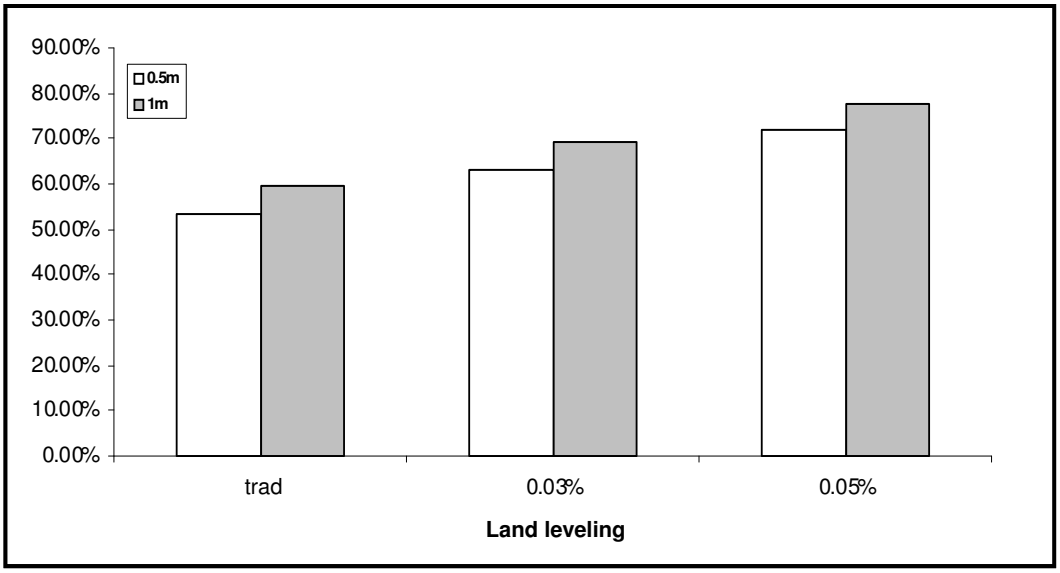

Fig.(5):Effect of different land leveling and distance between furrows on water application efficiency

5-Water application efficiency:

The amount of seasonal water applied and seasonal water consumptive use of soybean was determined. Water application efficiency was calculated for the different treatments and the values are shown in table (2) and fig.(5).The values of water application efficiency under distance between furrow 0.5m with planting one side row were about 53.44, 62.94 and 71.86 % for traditional ,0.03 %and 0.05% slope respectively .Meanwhile ,the values of water application efficiency under the distance between furrow 1m with two rows were about 59.67 ,69.19 and 77..84 % for traditional treatment , 0.03 % and 0.05 % slope respectively. Average values of water application efficiency increase by using laser in both two furrows width (0.5& 1.0 m), the highest value was 74.84 % of 0.05 % slope and the lowest value was 56.56 % under traditional treatment.

Generally, the laser land leveling treatments (0.03 %, 0.05 %surface slope)in both two furrows width (0.5, 1.0 m) and specially under surface slope 0.05 % compared with traditional methods recorded positive effect which increasing water application efficiency with percentages about 18.21%.and 16.15% respectively.

6-Seed soybean yield.

Values of seed soybean yield as effected by different treatments are shown in Table (3), and Fig.(6). The data under distance between furrow 0.5m with planting one side ridge indicated that seed soybean yields among land leveling treatments 0.05% surface slope treatment resulted the highest seed yield (1500 kg/fed.),followed by the 0.03 %slope treatment (1347 kg /fed., while the traditional land leveling (1162 kg /fed.) recorded the lowest yield. By using laser leveling. Seed soybean yield, increased with percentage 15.92 % and 29.09 % for 0.03 % and 0.05 % respectively compared with traditional treatment values of seed soybean yield as effected by different treatments are present in Table (3), and Fig.(6).

The data under distance between furrows .0.5m with planting one side ridge indicated that seed soybean yields among land leveling treatments 0.05% surface slope treatment resulted the highest seed yield (1500 kg/fed.),followed by the 0.03 %slope treatment (1347 kg /fed.) ,while the traditional land leveling recorded the lowest yield (1162 kg /fed) By using laser leveling .Seed soybean yield increased with percentage 15.92 % and 29.09 % for 0.03 % and 0.05 % compared with traditional treatment.

Data under distance between furrow 1.0 m with planting two side ridge, the same trend of values for yield by the different treatments, 0.05% surface slope treatment resulted the highest seed Soybean yield (1575 kg/fed.), followed by the 0.03 % surface slope treatment (1420 kg/fed.), while the traditional land leveling recorded the lowest yield (1209 kg/fed.)

.increasing by 17.45 % and 30.2 % for 0.03 % and 0.05 %compared with traditional land leveling.

On the other hand, due to using width 1.0m between furrows increased the seed Soybean. Average seed Soybean yield were 1336.33 kg/fed and 1393 kg/fed. for width of furrow 0.5 m with planting one side ridge and width 1.0 m with planting two side ridge ,the percentage of increasing was 4.24 % .

Table (3): Effect of different treatments on yield and water use efficiencies

treatments	Width of furrow	yield (kg/fed.)	Applied water (m^3/ fed.)	Consumptive water(m^3/fed)	WU E (kg/m^3)
Traditional.		1162	2733.5	1460.8	0.80
0.03%slope	0.5 m	1347	2206.3	1388.6	0.97
0.05%slope		1500	1920.79	1380	1.09
Mean	0.5 m	1336.33	2286.86	1409.8	0.95
Traditional		1209	2338.69	1395.3	0.87
0.03%slope	1.0 m	1420	1890.00	1307.6	1.09
0.05%slope		1575	1650.01	1284.3	1.22
mean	1.0 m	1493	1959.57	1329.07	1.06

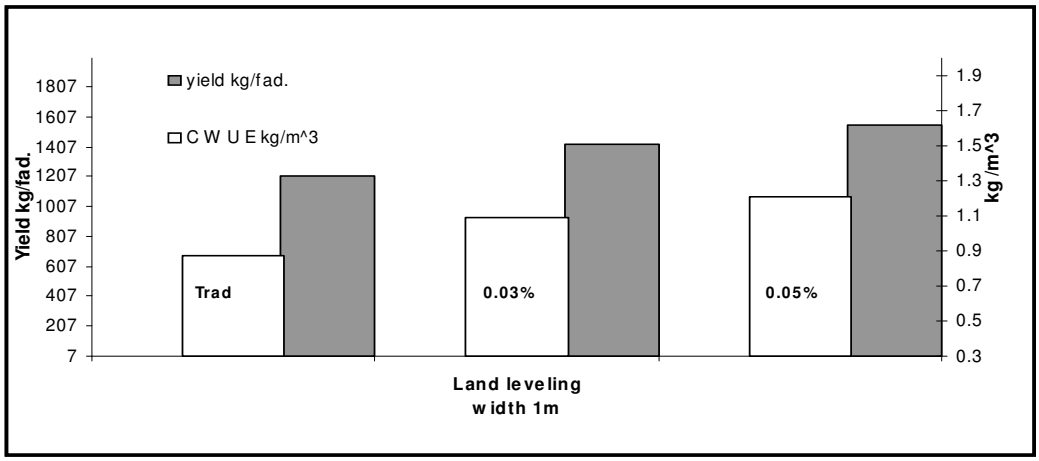

Fig.(6):Effect of different land leveling on soybean yield and water consumptive use Efficiency.

7-Crop water consumptive use efficiency

The water use efficiency is expressed as kg of Soybean yield / m^3 of consumed water. The water use efficiency has been used to evaluate different irrigation treatments in producing maximum yield per unit of water consumed by the crop plants. the average values of water consumptive use

are shown in Table (3).The values increased by using laser land leveling for both width of furrow 0.5 m and 1.0 m. The highest value was 1.09 kg/m^3 in case of 0.05% surface slope, while the lowest value was 0.80 kg/m^3 in case of traditional land leveling and the value with 0.03 % was 0.97 for width 0.5 with planting one row. Due to used laser land leveling increased the water consumptive use efficiency increased by 21.25 %and 36.25 % for 0.03 % and 0.05 % compared with traditional treatment.

Mean while, in case width of furrow 1 m with planting two rows the highest value with 0.05% surface slope was 1.22 kg/m^3. The lowest value with traditional land leveling 0.87 kg/m^3.For 0.03 % slope was 1.09kg /m^3, the percentage of increasing were 25.29 % and 39.08 % for 0.03 % and 0.05 %.

On the other hand the effect of two width furrow practices, average of crop consumptive use efficiency was 0.95 and 1.06 kg/ m^3 of distance between furrow 0.5m with planting one side ridge and distance between furrows 1 m with planting two ridge .The percentage of increasing was 11.58 %.

SUMMARY AND CONCLUSIONS

The main results in the present work can be summarized and concluded in he following points:

1- The laser leveling was effects on both of the applied water and Soybean yield. The highest saving applied water percentage was 29.74 o/oat lasers leveling with 0.05o/o slope. Meanwhile, the highest percentage value of Soybean yield was30.2% at laser leveling with 0.05% slope and width 1.0 m comparing with the traditional leveling.

2- Water use efficiency was the highest value about 1.22 kg/m^3 at the laser leveling with 0.05% slope and 1.0 width between furrows sown on two sides of the ridge

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الملخص العربي

تأثير التسوية بأشعة الليزر والمسافة بين الخطوط علي كفاءة استخدام مياه الري والإنتاجية لمحصول فول الصويا

د .مجدي توفيق الطنطاوي* د .أمال فتوح الشرقاوي* * د .نصر محمد أبوالنور**

نفذت تجربه حقليه بالمزرعة البحثية لمحطة البحوث الزراعية بالجميزة موسم ٢٠٠٤-٢٠٠٥ لدراسة تأثير التسوية بأشعة الليزر و المسافة بين الخطوط علي أنتاج محصول فول الصويا ،كفاءة الري وبعض العلاقات المائية . أستخدم تصميم القطع المنشقة وتم تنفيذ التجربة باستخدام أربع مكررات حيث كانت معاملات التسوية (٠,٠٣%، ٠,٠٥%، انحدار مقارنة بالتسوية التقليدية) القطع الرئيسية ،بينما كانت معاملتا المسافة بين الخطوط (٠,٥ متر مع الزراعة علي ريشه واحده و ١,٠٠ متر مع الزراعة علي الريشتين) تمثل القطع المنشقة

وكان لمعاملة التسوية بالليزر بميل ٠,٠٣% ، ٠,٠٥% لمعاملتا المسافة بين الخطوط (٠,٥ متر مع الزراعة علي ريشه واحده و ١,٠٠ متر مع الزراعة علي الريشتين تأثير ايجابي وخاصة التسوية بميل ٠,٠٥ % مقارنة بالتسوية التقليدية وكانت النتائج كالتالي :

١. نقص زمن تقدم وانحسار المياه بنسب (٢٥,٥٦%، ١١,٦٣%، ٢٥% ٩,٥٢%) علي الترتيب لمسافة بين الخطوط ٠,٥ ، ١,٠متر وكذلك زمن بقاء المياة.
٢. نقص معدل الرشح ومعدل الرشح التجميعي بنسب (٣٠%، ٢٧%) علي الترتيب تحت تسوية ٠,٠٥%
٣. توفير المياه المضافة بنسب (١٩,٤٢% ، ٢٩,٧٤%) علي الترتيب لكل من المسافة بين الخطوط ٠,٥ ، ١,٠متر.
٤. زيادة إنتاجية المحصول بنسب (٢٩% ، ٣٠%) لكل من المسافة بين الخطوط (٠,٥ ، ١,٠ متر).
٥. زيادة المياه المستخدمة بنسب ٥,٣٥% ٧,٩٦% و كفاءة الاستخدام المائي بنسبة ٦,٠٠%، ٨,٠٠% لكل من المسافة بين الخطوط (٠,٥ ، ١,٠ متر).

٦. بالتالي فأن معاملة التسوية بميل ٠,٠٥% والمسافة بين الخطوط ١ متر مع الزراعة علي الريشتين أعطيا أفضل النتائج تحت ظروف منطقة الجميزة

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*، **باحث أول و باحث- معهد بحوث الهندسة الزراعية - مركز البحوث الزراعية - وزارة الزراعة .