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Improving Irrigation Efficiencies through Different Methods of Land Leveling and Irrigation Discharge under Using Gated Pipes at North Delta

El-Sanat, G. M. A.
Soils, Water and Environment Res. Inst., ARC, Giza, Egypt

ABSTRACT

A field trial was conducted through summer season of 2016 at Sakha Agricultural research Station Farm, Kafr El-Sheikh Governorate. The purpose of the study was to investigate the effect of four methods of land leveling (traditional land leveling, precision land leveling, ground surface slope of 0.05% and 0.1% as main plots and three irrigation water discharge (2.0, 2.5 and 3.5 L.Sec^{-1} m^{-1}) as sub plots on cotton yield and its components, some water relations and irrigation efficiencies. The results revealed that the ground surface slope of 0.1% and 0.05% and precision land leveling lead to increasing the seed cotton yield by 21.8, 15.12 and 5.15% compared to traditional land leveling, respectively. Also, irrigation water discharge at 2.5 and 3.5 L.Sec^{-1} m^{-1} raised seed cotton yield by 11.61 and 5.13% compared to 2.0 L.Sec^{-1} m^{-1}. The achieved results indicated that the land leveling of ground surface slope of 0.1% and irrigation 2.5 L.Sec^{-1} m^{-1} were the best treatment in increasing the boll weight and earliness percentage. Respecting to irrigation water saving, data demonstrated that the land leveling at 0.1% and 0.05% ground surface slope saved irrigation water by 33.57% and 21.93% compared to traditional land leveling. Data indicated that the interaction between land leveling and 0.1% ground irrigation water discharge at 3.5 L.Sec^{-1} m^{-1} obtained the highest values of water distribution efficiency, water application efficiency, consumptive use efficiency, water productivity and productivity of irrigation water.

Keywords: cotton, crop water productivity, irrigation discharge, land leveling, vertisol.

INTRODUCTION

Irrigation water management is very important in Egypt due to shortage in water resources as well as the expansion of agriculture in newly reclaimed lands. Water supply in Egypt is limited to the average annual share of the Nile water at Aswan 55.5 billion cubic meter plus some minor quantities of ground water and rainfall. Much water is wasted and the irrigation efficiency is very low.

Numerous studies were carried out to enhance irrigation efficiencies to achieve the proper economic use of water. The good design of gated pipes with precision land leveling may improve the water distribution uniformity and save irrigation water by about 12 to 29% in cotton and wheat respectively (Osman, 2000,Abo Soliman, *et al*., 2008 and Abdel Reheem, 2017).

Enhancement in irrigation practices lead to more uniform water distribution, soil and water conservation (sustainability), and economic viability of irrigated agriculture. Thus efficient On-Farm irrigation methods are necessary for increasing crop production per unit of water applied (Streilkoff *et al*., 1999; Bautista *et al*., 2009; Morris *et al*., 2015 and Anwar *et al*., 2016).

To improve the performance of most surface irrigation systems through the implementation of optimal management practices such as using gated pipes, different precision land leveling and selection of correct inflow rates (Hassan and Elwan, 2016).

Many authors and investigators i.e. Saied (1992), El-Mowelhi *et al*. (1995), Meleha (2000) and El-Shahawy (2004) stated that the 0.1% ground surface slope seemed to be more efficient than traditional land leveling in increasing the cotton yield and its components. The using gated pipes technique increased wheat yield by 6.5% when compared with the traditional one. Thus may be due to good condition of plant growth by regulating and controlling of water application to affect the soil water balance (Hassan, 2004).

Application efficiency can be raised substantially, and deep drainage losses decreased equally substantially by the application of simple inexpensive irrigation management practices involving increased furrow flow rates and reduced irrigation time. Substantial reduction in deep drainage are possible by ensuring that irrigation applications do not exceed the soil moisture deficit (Smith *et al*., 2005).

The aim of this research is to study the effect of different land leveling and irrigation discharge under gated pipes technique on cotton yields and irrigation efficiencies at North Nile Delta.

MATERIALS AND METHODS

1. Location of the studied area:

A field experiment was carried through summer season 2016 at Sakha Agricultural Research Station which situated at 31^{o}07' N Latitude and 30^{o}57' E longitude, middle Northern part of the Nile Delta region. It has an elevation by 6 meters above the sea level. The soil has a clayey texture; the average textural for this soil is 19.37% sand, 27.48% silt and 53.15 % clay Table 1. The purpose of this work is to study the effect of different precision land leveling and irrigation water discharge under gated pipes technique on cotton yields and irrigation efficiencies at North Nile Delta.

2. Soil characteristics:

Soil samples were taken before planting of cotton from four depths namely: 0-15, 15-30, 30-45 and 45-60 cm, respectively, air dried, grounded, sieved and stored for physiochemical analysis. Mechanical analysis of soil was carried out using the pipette method to obtain soil texture. Soil bulk density and total porosity were measured using the core sampling technique as described by Campbell (1994). Infiltration rate (IR) cm hr^{-1} was determined by blocked furrow infiltration before planting. Soil moisture constants i.e. field capacity (FC) and permanent wilting point (PWP) were determined by using pressure cooker method at 0.33 and 15 atmosphere (Klute, 1986). Soil reaction (pH) was determined in 1:2.5 soil water suspension and salinity (EC, dS m^{-1}) was determined in soil paste extract according to Page *et al*. (1982). Some physical and chemical properties of the experiments soil are shown in Tables 1 and 2.

Table 1. Some physical properties of the studied soil.

Soil depth (cm)	Particle size distribution % Sand	Silt	Clay	Texture grade	Basic IR cm hr^{-1}	Bulk density mg m^{-3}	Total porosity %	Soil moisture contents % FC	PWP	AW
0-15	15.49	25.69	58.82	Clayey		1.16	56.23	46.5	25.1	21.4
15-30	22.50	26.19	51.31	Clayey		1.20	54.72	39.9	21.5	18.4
30-45	18.89	29.46	51.65	Clayey	0.7	1.25	53.83	38.5	20.8	17.7
45-60	20.57	28.62	50.81	Clayey		1.30	50.94	36.4	19.6	16.8
Mean	19.37	27.48	53.15	Clayey		1.23	53.93	40.33	21.75	18.58

Table 2. Some chemical properties of the studied soil

Soil depth (cm)	EC dSm^{-1}	Soluble cations meq L^{-1} Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Soluble anions meq L^{-1} $CO_3^{=}$	HCO_3^{-}	Cl^{-}	$SO_4^{=}$	pH 1:2.5
0-15	2.00	4.00	2.00	14.80	0.10	-	3.50	5.50	11.90	8.26
15-30	2.20	4.00	2.50	15.00	0.20	-	3.50	5.50	12.70	8.00
30-45	2.30	4.20	2.30	16.00	0.20	-	3.30	5.80	13.60	8.35
45-60	2.60	4.50	2.50	18.20	0.20	-	3.00	6.50	15.90	8.40
Mean	2.28	4.18	2.33	16.00	0.18	-	3.33	5.83	13.53	8.25

3. Experimental layout:

The current examination aimed to study the effect of different land leveling and irrigation discharge using gated pipes technique on cotton yields and irrigation efficiencies. The experiment was designed in a split plot with three replicates, where different land leveling (precision land leveling, 0.05%, 0.1% ground surface slope and traditional land leveling) were assigned to main plots, while water discharge occupied the sub plots; three water discharges (2.0, 2. 5 and 3.5 L. Sec-1 m-1of furrow width).

4. Description of gated pipes:

The aluminum pipes were used for the gated pipes system with length of 6 meter, 152 mm diameter, the orifice diameter is 37 mm and the space between each orifice is 0.75 m and the average pressure head ranging from 35 to 50 cm.

5. Studied parameters:

Giza 86 variety was used and cotton seeds were sown on April 10, 2016 and picked on Sept. 20, 2016.The different agricultural practices were done as recommended.

a. Boll weight (g):

The mean boll weight in grams of twenty five bolls were picked at random from each treatment.

b. Seed index:

The weight of 100 seeds in grams.

c. Earliness percentage:

Yield of the first pick/total yield x 100.

d. Lint percentage:

The ratio of lint to seed cotton expressed as a percentage using the following formula:

$$\text{Lint percentage} = \frac{\text{mass of lint cotton}}{\text{mass of seed cotton}} x100$$

e. Seed cotton yield (kentar per feddan):

Estimated as the weight of seed cotton yield in kentar/fed.

- The yield of each treatment picked and the average yield per plant was multiplied by number of plants per feddan.
- All the allocated data for the yield and its components were exposed to the statistical analysis according to Snedecor and Cochran (1967). Treatments means and significance of differences were calculated and presented using LSD according to Duncan (1955).

6. Water measurements:

- **Actual water consumptive use:** Calculated according to the following equation as described by Israelson and Hansen (1962):

$$CU = \sum_{i=1}^{i=n} \frac{\theta_2 - \theta_1}{100} x\ Bd\ x\ D\ x\ 4200$$

Where:

CU: Water consumptive use (m^3 m^{-1})
$_2$: Soil moisture percent after irrigation in the i^{th} layer
$_1$: Soil moisture percent before the next irrigation in the i^{th} layer
Bd: Bulk density g/cm^3 of the i^{th} layer of the soil.
D : Depth of the i^{th} layer of the soil, cm.
i : Number of soil layer sampled in the root zone depth (D)
n : Number of irrigation

- **Amount of irrigation water applied:**

The discharge through an orifice was determined from the following equation as described by Brater and King (1976).

$$Q = CA(2GY)^{1/2}$$

Q : Discharge (m^3 sec^{-1})
C : Discharge coefficient ranges from 0.6 to 0.8
A : Ares of orifice opening (m^2)
G : Accelerating of gravity (9.8 m sec^{-2})
Y : The head causing free flow where y is the upstream head measured from the center of orifice opening.

- **Irrigation efficiencies:**

Irrigation application efficiency was attained by dividing the water stored in the effective root zone on the irrigation water applied (Downy, 1970).

- **Water distribution efficiency:**

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

$$Ed = (1-Y/d) \times 100$$

Where:

Ed: Water distribution efficiency (Ed)
d: Average depth of soil water stored along the furrow during the irrigation.
Y: Average numerical deviation from d.

- **Consumptive use efficiency:**

It was calculated according to Doorenbos and Pruitt (1977) as follows:

$$Ecu = ETc/IWA \times 100$$

Where:

Ecu : Consumptive use efficiency (%)

Etc : Water consumptive use
IWA : Irrigation water applied to the field m^3 fed^{-1}.

- Crop water productivity:

Water productivity as defined by Bos (1980)

$$Wp = Y/CU$$

Where:

Wp : Water productivity (kg m^{-3} water consumed)
Y : Marketable yield (kg) for cotton seed yield.

- Productivity of irrigation water:

Was calculated according to Ali *et al.* (2007).

$$PIW = Y/Wa$$

Where:

PIW : Productivity of irrigation water applied (kg m^{-3})
Y : Yield of cotton (kg fed^{-1})
Wa : Water applied (m^3 fed^{-1})

RESULTS AND DISCUSSION

Effect of precision land leveling and irrigation discharge on yield and its components:

- Seed cotton yield:

Effect of different precision land leveling and irrigation discharge on seed cotton yield (kentar per feddan) is presented in Table 3.

Seed cotton yield was highly significantly pretended by all treatments. The obtained results show that ground surface slope 0.1%, slope 0.05%, and precision land leveling lead to increasing the seed cotton yield by 21.80, 15.12 and 5.15% compared to traditional land leveling, respectively.

Table 3. Cotton seed yield and its contributing variables and influenced by land leveling and irrigation discharge in growing seasons.

Treatments	Boll weight (g)	Earliness (%)	Seed cotton yield kentar fed^{-1}	Lint yield ($kgfed^{-1}$)	Seed index (g)	Lint (%)
Land leveling						
Traditional land leveling	3.04	63.69	9.13	52.94	10.37	34.73
Precision land	3.16	68.07	9.6	56.78	10.55	35.86
Ground surface slope 0.05%	3.26	69.53	10.51	59.38	10.77	36.37
Ground surface slope 0.1%	3.3	70.93	11.12	60.43	11.05	36.52
Mean	3.19	68.06	10.09	57.38	10.69	35.87
F. test	**	**	**	**	**	**
LSD 0.05	0.114	1.2	0.322	2.56	0.18	0.46
LSD 0.01	0.17	1.82	0.49	3.13	0.28	0.69
Irrigation discharge L sec^{-1} m^{-1}						
2.0	3.14	66.86	9.56	56.40	10.54	35.78
2.5	3.31	68.19	10.67	60.25	10.72	36.30
3.5	3.12	69.12	10.05	55.50	10.79	35.53
Mean	3.19	68.06	10.09	57.38	10.68	35.87
F. test	**	**	**	**	NS	NS
LSD 0.05	0.109	0.54	0.28	0.75	-	-
LSD 0.01	0.150	0.74	0.39	1.03	-	-
Interaction	NS	NS	NS	NS	NS	NS
Land leveling x irrigation	-	-	-	-	-	-
F. test	-	-	-	-	-	-

Concerning the irrigation water discharge treatments, data clear that irrigation water discharge had significant increase in seed cotton yield. The increase in seed cotton yield under 2.5 L. Sec^{-1} m^{-1} and 3.5 L. Sec^{-1} m^{-1} were 11.61 and 5.13% compared to 2 L. Sec^{-1} m^{-1}, respectively. The interaction between land leveling and irrigation water discharge did not induce a significant effect on seed cotton yield. These results cod be maintained by those found by El-Mowelhi *et al.* (1995b), Meleha (2000), El-Shahawy (2004) and Sonbol *et al.* (2007).

These results may be due to the good distribution of irrigation water along the furrows.

- Yield components:

The obtained results in Table 3 show that land leveling and irrigation water discharge had highly significant effect on boll weight, earliness percentage, lint yield, seed index and lint percentage in the growing season ground surface slope 0.1% was the best treatment which resulted in the highest average values for boll weight (3.3 g), earliness percentage (70.93%), lint yield (60.43 kg fed^{-1}), seed index (11.05 g) and lint percentage (36.52%), respectively. While, traditional land leveling resulted in a significant decrease in yield components compared to ground surface slope 0.1%, 0.05% and precision land leveling. These results are in agreement with those of Sonbol *et al.* (2007).

Data reveal that, the highly significant effect tend to irrigation water discharge on boll weight, earliness percentage and lint yield. While, there is insignificant effect on seed index and lint percentage. The relative increase in boll weight (3.31 g) under irrigation water discharge at 2.5 L. Sec^{-1} m^{-1}, earliness percentage (69.12%) under 3.5 L.Sec^{-1} m^{-1}, lint yield (60.25 kg/fed.) under 2.5 L. Sec^{-1} m^{-1}, seed index (10.79 g) under 3.5 L. Sec^{-1} m^{-1} and lint percentage (36.30%) under 2.5 L. Sec^{-1} m^{-1} compared to traditional land leveling, respectively.

It can be concluded that, the interaction effect between land leveling and irrigation water discharge are presented in Table 3.

Data indicated that the all yield and its components were not affected significantly by different treatments.

These results could be confirmed by those obtained by Sonbol *et al.* (2007).

Some water relations:

- Amount of irrigation water applied:

The average amount of irrigation water delivered to each treatment is presented in Tables 4 and 5. The ground surface slope 0.1% decreased the amount of water applied and slope 0.05% compared to traditional land leveling. Also, irrigation water discharge at 3.0 L. Sec^{-1} m^{-1} is the less amount of water applied compared with 2.0 and 2.5 L. Sec^{-1} m^{-1}. It is clear from data obtained that the water requirements for cotton plant ranged between (2467 to 4286 m^3 fed^{-1}). The lowest values were recorded from irrigation water discharge 3.3 L. Sec^{-1} m^{-1}(2675 m^3 fed^{-1}) under 0.1% ground surface slope. While, the highest value is obtained from irrigation water discharge 2 L.Sec^{-1} m^{-1} was (4495 m^3fed^{-1}) under traditional land leveling. The results indicated that the 0.1% and 0.05% ground surface slope saved irrigation water by 33.57% and 21.93% compared to traditional land leveling. The results are in harmony with those obtained by El-Mowelhi *et al.* (1995b), El-Shahawy (2004) and Sonbol *et al.* (2007).

- Water consumptive use (WCU) m^3 fed^{-1}:

Data in Tables 4 and 5 show that the mean values of water consumptive use were decreased with ground surface slope 0.1% and 0.05%.

Table 4. Effect of land leveling and irrigation water discharge on water applied, water stored and water consumptive use in growing season

Treatments: Land leveling	Treatments: Irrigation discharge L.Sec^{-1} m^{-1}	Water applied m^3 fed^{-1}	Water stored m^3 fed^{-1}	Water consumptive use m^3 fed^{-1}
Traditional	2.0	4495	2735.80	2721
	2.5	4210	2642.42	2690
	3.5	4152	2648.82	2677
Mean		4286	2675.68	2696
Precision land leveling	2.0	3775	2684.97	2681
	2.5	3582	2627.30	2665
	3.5	3392	2582.30	2612
Mean		3583	2631.52	2653
Ground surface slope 0.05%	2.0	3498	2622.20	2590
	2.5	3341	2521.50	2564
	3.5	3198	2447.63	2402
Mean		3346	2530.44	2519
Ground surface slope 0.1%	2.0	3042	2301.43	2249
	2.5	2825	2223.90	2194
	3.5	2675	2184.95	2175
Mean		2847	2236.76	2206

Table 5. Mean values of water applied, water consumptive use, water saving, water productivity and water productivity of irrigation water to different treatments

Treatments	Water applied m^3 fed^{-1}	Water consumptive use m^3 fed^{-1}	Water saving %	Water productivity kg m^{-3}	Water productivity of irrigation water kg m^{-3}
Land leveling					
Traditional	4286	2696	-	0.534	0.336
Precision land leveling	3583	2653	16.40	0.569	0.423
Ground surface slope 0.05%	3346	2519	21.93	0.638	0.480
Ground surface slope 0.1%	2847	2206	33.57	0.788	0.611
Irrigation water discharge L.Sec^{-1} m^{-1}					
2.0	3703	2560	-	0.594	0.418
2.5	3490	2528	5.75	0.656	0.485
3.0	3354	2467	9.42	0.645	0.488

The highest mean value of WCU (2696 m^3 fed^{-1}) was recorded under traditional land leveling. On the other hand, the lowest mean value (2206 m^3 fed^{-1}) was recorded under ground surface slope 0.1%. Generally, seasonal water consumptive use decreased as soil available water amount decreased. These results are in friendship with those found by El-Shahawy (2004), El-Mowelhi *et al.* (1995), Sonbol *et al.* (2007) and Hassan and Elwan (2016).

- Water stored in the effective root zone (m^3fed^{-1}):

Also, data in Table 6 reveal that, mean values of water stored in the effective rhizosphere were decreased by 16.40% and 5.43% with ground surface slope 0.1% and 0.5% compared to precision land traditional land leveling, while the lowest values was recorded from irrigation water discharge at 3.5 L.Sec^{-1} m^{-1} since it was (2465.93 m^3fed^{-1}) under 0.1% ground surface slope. While, the highest value is obtained from irrigation water discharge at 2 L.Sec^{-1} m^{-1} which it was (2586.10 m^3fed^{-1}) under traditional land leveling. Results are in convened with those achieved by El-Mowelhi *et al.* (1995), Meleha (2000), El-Shahawy (2004) and Sonbol *et al.* (2007).

- Water application efficiency (%):

Presented data in Table 6 show that the mean values of water application efficiency were affected by land leveling with regard to irrigation discharge, the highest value was achieved with 0.1% ground slope.

The highest percentage (81.68%) was obtained from irrigation water discharge 3.5 L. Sec^{-1} m^{-1} under 0.1 ground surface slope, respectively. While the lowest percentage 60.86% was recorded with irrigation water discharge at 2 L. Sec^{-1} m^{-1} under traditional land leveling

- Water distribution efficiency (%):

Data presented in Table 6 show that the mean values of water distribution efficiency were greatly affected by land leveling and irrigation water discharge. The highest percentage (83%) was realized with irrigation water discharge at 2.5 L. Sec^{-1} m^{-1} under 0.1% ground surface slope, respectively. Also, the lowest percentage (74%) was recorded with irrigation water discharge at 2 L. Sec^{-1} m^{-1} under traditional land leveling.

- Water productivity (WP) and productivity of irrigation water (kgm^{-3}):

Data in Table 6 show the different land leveling and irrigation water discharge on water productivity and productivity of irrigation water. The mean values for WP and PIW were increased under ground surface slope at 0.1% and 0.05% and irrigation discharge at 2.5 L. Sec^{-1} m^{-1}. The increasing for WP and PIW might be due to the decrease in the amount of water consumption use and water applied under traditional land leveling and irrigation water discharge at 2 L. Sec^{-1} m^{-1}, respectively.

Table 6. Water application efficiency, water distribution, consumptive use efficiency, water productivity and water productivity of irrigation water during growing seasons.

Treatments: Land leveling	Treatments: Irrigation discharge L.Sec^{-1} m^{-1}	Water application efficiency (ET%)	Water distribution efficiency (Ewd, %)	Consumptive efficiency (Ecu%)	Water productivity WP (kgm^{-3})	Productivity of irrigation water kgm^3 (PIW)
Traditional	2.0	60.86	74.0	60.53	0.508	0.307
	2.5	62.77	76.0	63.89	0.563	0.359
	3.5	63.79	76.0	64.47	0.530	0.342
Mean		62.47	75.33	62.96	0.534	0.336
Precision land leveling	2.0	71.13	78.0	71.02	0.535	0.380
	2.5	73.35	79.0	74.40	0.614	0.457
	3.5	76.13	79.0	77.00	0.560	0.431
Mean		73.54	78.67	74.14	0.569	0.423
Ground surface slope 0.05%	2.0	74.96	80.0	74.04	0.606	0.448
	2.5	75.47	83.0	76.74	0.616	0.473
	3.5	76.54	82.0	75.11	0.692	0.519
Mean		75.66	81.67	75.30	0.638	0.480
Ground surface slope 0.1%	2.0	75.66	80.0	73.93	0.728	0.538
	2.5	78.72	83.0	77.66	0.836	0.649
	3.5	81.68	82.0	81.31	0.799	0.647
Mean		78.69	61.25	77.63	0.788	0.611

- Consumptive use efficiency (CUE, %):

Consumptive use efficiency is a parameter which indicate the capability of plants to utilize the soil water stored in the effective root zone. Data tabulated in Table 6 show that the highest values of 81.31% was recorded irrigation discharge 3.5 L. Sec^{-1} m^{-1}under ground surface slope 0.1%. Therefore, by reducing the applied water, the higher amount of irrigation water could be beneficially used by growing plants. On the opposite, the lowest values of ECU 60.53% was achieved by irrigation discharge 2 L. Sec^{-1} m^{-1} under traditional land leveling. It is noticeable that from the obtained data values of ECU increased with increasing both of water discharge and ground surface slope 0.05 and 0.1%. This finding is somewhat agreed with those obtained by El-Mowelhi *et al.*(1995), Sonbol *et al.* (2007) and Abo Soliman, *et al.*, (2008).

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تحسين كفاءات الرى من خلال طرق التسوية المختلفة ، تصرفات مياه الرى باستخدام المواسير المبوبة فى شمال الدلتا

جمال محمد عبد السلام الصناط
معهد بحوث الأراضى والمياه والبيئة - مركز البحوث الزراعية - الجيزة - مصر

أجريت تجربة حقلية فى الموسم الزراعى الصيفى 2016 فى مزرعة محطة البحوث الزراعية بسخا وكان الهدف هو دراسة تأثير أربعة طرق من التسوية (معاملات التسوية التقليدية ، التسوية الدقيقة بالليزر (صفر ميول) ، تسوية بالليزر بميول 5 سم/100 متر ، 10 سم /100 متر (معاملات رئيسية) وثلاثة تصرفات من مياه الرى 2 ، 2.5 ، 3.5 لتر/ثانية/متر من عرض خطوط الرى(معاملات شقية) على محصول القطن ومكوناته ، بعض العلاقات المائية وكفاءات الرى المختلفة. وأشارت النتائج أن التسوية بالليزر بميول 10سم/100 متر ، 5 سم/100 متر والتسوية الدقيقة (صفر ميول) أدى إلى زيادة محصول القطن الزهر بنسب 21.8% ، 15.12% ، 5.15% بالمقارنة بالتسوية التقليدية على التوالي. وأيضا الرى عند 2.5 ، 3.5 لتر/ثانية/متر من عرض الخطوط أدت إلى زيادة محصول القطن الزهر بحوالى 11.61% ، 5.13% بالمقارنة بمعاملة الرى عن 2 لتر/ثانية/متر من عرض الخطوط. أوضحت النتائج المتحصل عليها أن معاملة التسوية بميول 10سم/100 متر والرى عند 2.5 لتر/ثانية/متر كانت أفضل المعاملات فى زيادة وزن اللوزة ونسبة التفتيح للوز وبالاشارة إلى نسبة توفير مياه الرى فإن النتائج أوضحت أن معاملة التسوية بميول 10 سم ، 5 سم/100 متر أدت إلى توفير مياه الرى بنسبة 33.57% ، 21.93% بالمقارنة بمعاملة التسوية التقليدية. وكذلك أوضحت النتائج أن التفاعل بين معاملة التسوية بالليزر بميول 0.1% والرى عند تصرف 3.5 لتر/ثانية/متر من عرض خطوط الرى حققت أعلى القيم لكفاءة الرى التطبيقية ، كفاءة التوزيع ، كفاءة الاستهلاك المائى ، الانتاجية المائية لمحصول القطن ، والإنتاجية المائية لمياه الرى المضافة فى منطقة شمال الدلتا.