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EFFECT OF SURFACE IRRIGATION METHODS AND LAND LEVELING PRACTICES ON COTTON YIELD AND IRRIGATION PERFORMANCES AT NORTH DELTA

Sonbol, H.A. *; E.M. El Hadidl*; M.M. Saied and M.A. El-Faiad****
*** Soils, Dept., Fac. of Agric., Mansoura Univ.**
**** Soils, Water and Environment Res. Inst.**

ABSTRACT

Two field trials were conducted at Sakha Agricultural Research Station during the two successive growing seasons 2004 and 2005 to study the impact of three methods of surface irrigation which are: 1 Short furrows, 2- Long furrows and 3- border irrigation, also during present work three land leveling practices were used as, traditional dead level (precision leveling) and ground surface slope of 10 cms/100 m (0.1% slope) on Egyptian cotton (*Gossypium branadenese*L.), variety Giza 86, and irrigation performances. The experimental design which used in this study was split plot with four replicates, where the main plots were assigned to surface irrigation methods and the sub plot were devoted to land leveling methods.

Results revealed that, the short furrows irrigation combined with 0.1% ground surface slope significantly affected the seed cotton yield, and all growth parameters. Data also revealed that 0.1% ground surface slope and dead level received the less amounts of irrigation water in the two studied seasons. Also, water application efficiency increased under short furrows irrigation and 0.1% ground surface slope. Compared to long furows and border irrigation. The data showed that the highest values of crop and field water use efficiencies were achieved with short furrows irrigation and 0.1% ground surface slope.

INTRODUCTION

Irrigation is generally defined as the application of water to soil for the purpose of supplying the moisture essential for plant growth. Efficient use of irrigation water is an obligation of each user. However, efficiency of use will vary from locality to another. In areas where water is scarce and costly, available water should be used carefully.

Cotton is considered the main cash profitable crop and represents the back bone of agricultural economy as it is the main exported crop as well as its demanded for local industrial uses. Cotton productivity is affected by several factors; soil practices and irrigation management.

Precision land leveling record a positive effect on seed cotton yield (El-Mowelhi *et al.*, 1996). Eid *et al.* (1988) showed that, land leveling with 0.1% slope increased seed cotton yield by 21.5% than surrounding fields under traditional methods.

Semaika and Rady (1987) recommended that precision land leveling programme in Egypt increased irrigation efficiencies.

Saied (1992) concluded that water consumptive use and amount of irrigation water applied was decreased with 0.1% ground surface slope and irrigation discharge of 0.1 m^3/min. Also, Abd El-Rahman (1985) concluded

that water application, distribution and water use efficiencies increased as the flow rate increased and soil slope increased.

In this connection, El-Mowelhi *et al.* (1990) and Saied (1992) pointed out that the water requirement of cotton was from 3200 m^3 to 3900 m^3, the water consumptive use were 52.89 cm to 58.42 cm and the water application efficiencies as 63 to 74% according to the land leveling method and irrigation water discharge.

El-Mowelhi *et al.* (1995) showed that the highest amount of water consumed by cotton was 3048.9, while it was 2236.8 m^3/fed. for cotton and maize under traditional methods. On the other hand, the lowest values for 0.1% ground surface slope treatment (2129.8 and 1841.3 m^3/fed.) for cotton and maize.

El-Shahawy (2004) concluded that the highest value of actual water consumptive use (2900.0 m^3/fed.) was obtained from irrigation of all furrows under traditional land leveling. Also, the highest values of all furrows under traditional land leveling and the highest values of crop and field water use efficiencies (0.352 and 0.37 kg/m^3) were achieved with alternative furrow irrigation under precision land leveling. While the lowest values were obtained when all furrows were irrigated with traditional land leveling.

MATERIALS AND METHODS

Two field experiments were conducted at Sakha Agricultural Research Station during 2004 and 2005 summer seasons using Egyptian cotton (*Gossypium barbadense* L.), variety Giza 86). The soils of the two experimental sites were clayey in texture and saline. Some chemical and hydrological parameters of soils are shown in Table (1).

Table (1): Some soil chemical and physical properties of the experimental site.

Depth cm	*pH 1: 2.5	**ECe dSm^{-1} at 25°C	SAR	Particle size distribution			Texture class	Soil moisture characteristics			Bulk density g/cm^3
				Sand %	Silt %	Clay %		F.C. %	P.W.P. %	Ava. water	
	First season										
0-20	7.47	6.02	10.32	16.44	24.87	58.69	Clayey	41.75	20.25	21.50	1.18
20-40	7.85	5.02	10.23	17.55	26.75	55.70	Clayey	39.47	19.10	20.37	1.21
40-60	8.04	3.96	10.6	17.31	23.5	59.19	Clayey	37.82	18.62	19.20	1.26
60-80	8.06	3.83	9.8	17.05	27.62	55.33	Clayey	36.15	17.54	18.61	1.31
Mean	7.86	4.70	10.24	17.10	25.68	57.22	Clayey	38.79	18.87	19.92	1.24
	Second season										
0-20	7.78	6.75	11.19	15.86	26.46	57.68	Clayey	42.10	21.63	20.98	1.15
20-40	7.87	5.68	10.93	16.94	25.16	55.90	Clayey	40.15	20.51	19.64	1.19
40-60	7.84	4.85	10.34	17.52	24.25	58.23	Clayey	38.75	20.25	18.5	1.23
60-80	7.97	4.37	10.59	15.65	28.17	56.18	Clayey	37.50	18.91	18.59	1.26
Mean	7.85	5.41	10.74	17.01	26.01	58.98	Clayey	39.75	20.32	19.43	1.20

* Suspension ** Soil past extract.

The experimental design was split plot with four replicates. The main plots were devoted to three surface irrigation methods, which are: 1- Short furrows irrigation (SF), 2- long furrows irrigation (LF) and 3- border (6 m x 90

m) irrigation (B), where the sub plots were assigned to the three land leveling practices; traditional (T), dead leveling (D) (precision and leveling) and ground surface slope of 10 cms/100 m (0.1% slope) (S).

Giza 86 cotton seeds were sown in April, 3, 2004 and pi ked in Sept. 23, 2004. While in the 2nd season 2005 the sowing date was March, 30 and picking was in Oct. 2.

The studied characters were:

1. Plant height in (cm).
2. Seed cotton yield in kentar/feddan: Estimated as the weight of seed cotton yield in kentar/fed.
3. Boll weight: The average boll weight in grams of twenty five bolls picked at random from each treatment.
4. Lint percentage (%): The percentage weight of lint attained from a given weight of seed cotton samples:
   L.P. = (weight of cotton lint/cotton seed weight) x 100
5. Seed index: The weight of 100 seeds in grams.
6. Lint index = (seed index x lint percentage)/100-lint percentage.
7. Earliness percentage = (yield of the first pick/total yield) x 100.

Water measurements:

1. Water consumptive use was calculated according to the following equation described by Israelsen and Hansen (1962).

$$Cu = \sum_{i=1}^{i=n} \frac{\theta_2 - \theta_1}{1000} \times Bd \times \frac{60}{100} \times 4200$$

Where:

Cu = Water consumptive use (m^3/fed.)
N = Number of irrigation
θ_2 and θ_1 = Soil moisture content (%) after irrigation and before the next irrigation, respectively.
Bd = Bulk density (g/cm^3).

2. Amount of irrigation water applied as measured by cut-throat flue (30 x 90 cm) calculated as m^3/fed. (Early, 1975).
3. Crop water use efficiency was calculated in kg/m^3 according to Abd El-Rasool *et al.* (1971) as follows:

$$W.U.E. = \frac{\text{Yield (kg/fed.)}}{\text{Water consumptive use } (m^3/\text{fed.})}$$

4. Field water use efficiency by the following formula:

$$\frac{\text{Yield (kg/fed.)}}{\text{Water applied } (m^3/\text{fed.})}$$

RESULTS AND DISCUSSION

Effect of surface irrigation methods and land leveling practices as:

1. Seed cotton yield:

Seed cotton yield and growth parameters as influenced by short furrows, long furrows and border irrigation method are shown in Tables 2 and

3 from the obtained results it is clear that surface irrigation methods had high significant effect on seed cotton yield and growth parameters.

The highest average value (6.610, 7.087 kentar/fed.) for seed cotton yield under short furrow in the first seasons and border irrigation in the second season, (154.5, 155.833 cm) for plant height, (3.025 and 3.042 gm) for boll weight (38.702 and 38.628%) for lint percentage under short furrows, in 1st and 2 and seasons (8.923 and 9.364 gm) for seed index under Border irrigation in 1st season and short furrows in 2nd season, (12.165 and 12.131 gm) for lint index under SF in the 1st and 2nd seasons and (71.731 and 70.748%) for earliness percentage under short furrows and border irrigation in the 1st and 2nd seasons.

Effect of land leveling on seed cotton yield and growth parameters during the two growing seasons are presented in Tables 2 and 3. Land leveling exhibited high significant influences on seed cotton yield and growth parameters. The highest average value (7.279, 7.627 kentar/fed.) For seed cotton yield (157.917, 159.5 cm) for plant height, (3.25, 3.239 gm) for boll weight in 1st and 2nd seasons, respectively were obtained by 0.6% ground surfaces (38.027, 38.648%) for lint percentage under radiational land leveling in the first season and 0.1% ground surface slope, (9.349, 9.745 gm) for seed index, (12.587, 12.608 gm) for lint index in 1st and 2nd under 0.1% ground surface slope and (71.266, 74.465%) fro earliness percentage under dead level and 0.1% ground surface slope in 1st and 2nd seasons.

Table (2): Cotton seed yield and growth parameters as affected by different treatments in the first growing seasons.

Treatments	Seed cotton yield kentar/fed.	Plant height (cm)	Boll weight (gm)	Lint percentage %	Seed index (gm)	Lint index (gm)	Earliness percentage (%)
Surface irrigation methods							
SF	6.610	154.500	3.025	38.702	8.801	12.165	71.731
LF	6.203	152.917	2.919	37.340	8.385	11.589	69.291
B	6.563	154.500	2.966	37.179	8.923	11.75	71.365
F-test	**	**	NS	**	**	**	**
L.S.D. 0.05	0.281	21.011	NS	0.392	0.257	0.292	0.335
0.01	0.403	2.785	NS	0.556	0.373	0.423	0.479
Land leveling							
T	5.712	150.833	2.693	38.027	7.939	11.305	70.522
D	6.383	153.167	2.968	37.31	8.825	11.648	71.266
S	7.279	157.917	3.250	37.863	9.344	12.587	70.599
F-test	**	**	**	**	**	**	**
L.S.D. 0.05	0.243	2.318	0.235	0.383	0.203	0.229	0.303
0.01	0.333	3.176	0.322	0.525	0.278	0.314	0.415
Interaction							
S x L	**	NS	NS	**	**	**	**

T = traditional D = Dead leveling S = 0% ground surface slope.

In contrast the traditional land leveling (T) resulted in the lowest seed cotton yield and growth parameters during the two growing seasons as shown in Tables 2 and 3. The obtained results are in agreement with those obtained by Saied (1992), El-Mowelhi (1990), Meleha (2000) and El-Shahawy (2004).

Table (3): Cotton seed yield and growth parameters as affected by different treatments in the second growing seasons.

Treatments	Seed cotton yield kentar/fed.	Plant height (cm)	Boll weight (gm)	Lint percentage %	Seed index (gm)	Lint index (gm)	Earliness percentage (%)
Surface irrigation methods							
SF	7.013	155.833	3.042	38.628	9.364	12.131	70.661
LF	6.355	154.167	2.933	38.443	8.650	11.673	69.769
B	7.087	155.583	3.003	36.494	9.215	11.884	70.748
F-test	**	*	*	**	**	**	**
L.S.D. 0.05	0.315	2.126	0.164	0.279	0.245	0.241	0.733
0.01	0.447	2.970	0.229	0.389	0.343	0.337	1.017
Land leveling							
T	6.076	151.917	2.723	37.796	8.303	11.444	66.848
D	6.752	154.167	3.016	37.121	9.181	11.635	69.866
S	7.627	159.500	3.239	38.648	9.745	12.608	74.465
F-test	**	**	**	**	**	**	**
L.S.D. 0.05	0.306	2.318	0.183	0.306	0.265	0.260	0.835
0.01	0.419	3.176	0.250	0.419	0.363	0.357	1.144
Interaction							
S x L	**	*	NS	**	**	**	**

Some water relations:

1. Water consumptive use:

Values of water consumptive use by cotton plants as affected by different treatments. Surface irrigation methods and land leveling practices in the two seasons are presented in Table (4). It can be noted that the seasonal water consumptive use increased with border irrigation method under traditional land leveling in both seasons.

The highest value of actual consumptive use (2811.06 m^3/fed.) was obtained from traditional land leveling under border irrigation methods in the second season.

While, the lowest value (2352.72 m^3/fed.) was obtained from 0.1% ground surface slope (S) under short furrows irrigation (SF) in the first season.

2. Amount of irrigation water applied:

The average amounts of irrigation water delivered to each treatment is presented in Table (4). The short furrows irrigation (SF) the decreased the amount water applied more than long furrows and border irrigation. Also, 0.1% ground surface slope (S) is the less amount water applied compared with dead leveling (D) and traditional land leveling (T).

It is clear from data obtained that the water requirements for cotton plants range between (2915.64 to 3676.26 m^3/feddan). The lowest value was recorded from 0.1% ground surface slope (S) under short furrows (SF) irrigation method in the first and second season. While the highest value is obtained from traditional land leveling (T) under border irrigation methods (B) in the first and second season.

Table (4): Water consumptive use, amount of water applied and efficiencies as affected by different treatments in the first and second season.

Treatments		Seed cotton yield (kg/fed.)	Water consumptive use (m^3/fed.)	Water applied (m^3/fed.)	Water application efficiencies (%)	Crop W.U.E. kg/m^3	Field W.U.E. kg/m^3	Water distribution efficiency (%)
Surface irrigation methods	Land leveling							
First season								
SF	T	882.0	2700.18	3590.16	68.57	0.33	0.25	66.74
	D	1083.6	2654.40	3268.86	73.29	0.41	0.33	77.20
	S	1157.63	2352.72	2915.84	79.26	0.49	0.39	83.30
Mean		1041.07	2569.10	3258.22	73.70	0.41	0.32	75.45
LF	T	869.09	2715.72	3645.18	65.39	0.32	0.24	65.50
	D	930.83	2563.86	3320.52	72.30	0.36	0.28	74.80
	S	1130.85	2391.06	3131.44	75.26	0.47	0.36	83.10
Mean		976.92	2556.88	3365.71	70.98	0.38	0.29	74.46
B	T	948.15	2762.76	3676.26	63.43	0.34	0.26	64.40
	D	1001.7	2593.50	3399.06	71.04	0.39	0.30	73.50
	S	1151.01	2456.58	3192.00	74.39	0.46	0.36	79.90
Mean		1033.62	2604.28	3422.44	69.62	0.39	0.30	72.60
Second season								
SF	T	94.85	2731.68	3533.04	67.72	0.34	0.26	65.20
	D	1120.29	2694.30	3290.70	73.37	0.42	0.34	75.30
	S	1251.34	2489.34	3105.90	75.15	0.50	0.40	81.30
Mean		1104.49	2638.44	3309.88	72.08	0.42	0.33	73.92
LF	T	879.95	5807.70	3592.26	64.13	0.31	0.24	64.07
	D	974.93	2603.58	3320.80	72.84	0.37	0.29	73.50
	S	1147.86	2519.16	3208.38	73.91	0.46	0.35	80.10
Mean		1000.91	2643.49	3373.81	70.29	0.38	0.29	72.56
B	T	1048.95	2811.06	3583.02	65.72	0.37	0.29	63.02
	D	1095.09	2633.40	3346.98	72.69	0.41	0.32	72.20
	S	1204.40	2551.08	3230.64	74.21	0.47	0.37	78.50
Mean		1116.15	2665.18	3386.88	70.87	0.41	0.31	71.24

3. Water application efficiency:

Data presented in Table (4) show that water application efficiency values were increased when cotton was irrigated by short furrows irrigation (SF) more than long furrows (LF) and border irrigation (B) methods. Also, the 0.1% ground surface slope (S) increased water application efficiency compared than dead level (D) and traditional land leveling (T).

The highest value of water application efficiency (79.26%) was obtained by 0.1% ground surface slope (S) under short furrows (SF) irrigation methods. While, the lowest value (63.43%) was recorded with the traditional land leveling under (T) border irrigation method (B).

4. Crop and field water use efficiencies:

Crop and field water use efficiencies were determined for the different treatments and the values are presented in Table (4). The highest values of crop and field water use efficiencies (0.50 and 0.40 kg/m^3) were achieved with 0.1% ground surface slope (S) under short furrow irrigation (SF) in the second season while the lowest values were (0.33 and 0.25 kg/m^3) was obtained when the traditional land leveling (T) under short furrows (SF) irrigation methods.

The higher values of crop and field water use efficiencies may be due to the high yield obtained and less amount of water consumed and water applied.

5. Water distribution efficiency:

Data of Table (4) indicate that the water distribution efficiency increases with the short furrows irrigation and 0.1% ground surface slope.

The highest values of water distribution efficiency was 83.30 and 81.30% obtained with 0.1% ground surface slope (S) under short furrows (SF) irrigation. The lowest value of WDE was (64.40 and 63.02%) obtained from traditional land leveling under border irrigation method in the first and second season.

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تأثير طرق الرى السطحى والتسوية على محصول القطن وكفاءة الرى فى شمال الدلتا

حسين أحمد سنبل* ، السيد محمود الحديدى* ، محمود محمد سعيد** و محمود أبوالفتوح عياد*

* قسم الأراضى ــ كلية الزراعة ــ جامعة المنصورة

** معهد بحوث الأراضى والمياه والبيئة ــ مركز البحوث الزراعية

أقيمت تجربتان حقليتان بمزرعة محطة البحوث الزراعية بسخا خلال الموسمين الزراعيين ٢٠٠٤ ، ٢٠٠٥م لدراسة تأثير طرق للرى السطحى على محصول القطن وكفاءة الرى المختلفة وكمانت طرق الرى السطحى هى:

١-الرى فى الخطوط القصيرة.

٢-الرى فى الخطوط طويلة.

٣-الرى فى الشرائح وثلاثة ممارسات للتسوية وهى التسوية التقليدية والتسوية الدقيقة والتسوية ٠,١% انحدار لسطح الأرض على محصول القطن وكان التصميم المستخدم فى هذه التجربة هو القطع المنشقة فى أربع مكررات.

وأوضحت النتائج أن طريقة الرى فى الخطوط مع التسوية ٠,١% انحدار لسطح الأرض أدت إلى زيادة فى محصول القطن الزهر بالإضافة إلى مدلولات النمو الأخرى (طول النبات ، وزن اللوزة ، نسبة التصافى ، معامل البذرة ، معامل الشعر ، ونسبة التبكير).

وكان هناك تأثير معنوى على جميع القياسات المحصول. وأعطت معاملة الرى فى الخطوط القصيرة مع التسوية ٠,١% انحدار عن سطح الأرض أعلى القيم لمحصول القطن زهر وطول النبات والقياسات الأخرى. بينما كان المعاملة الرى فى الشرائح مع التسوية التقليدية أعطيت أقل القيم بالنسبه لمحصول القطن الزهر وقياسات الأخرى.

ومن جهة أخرى حدث انخفاض فى كمية مياه الرى باستخدام طريقة الرى فى الخطوط القصيرة مع استخدام التسوية ٠,١% انحدار عن سطح الأرض من خلال موسمى الدراسة. كذلك أدت إلى رفع كفاءة الرى التطبيقية وكفاءة استخدام المحصول للمياه وكذلك كفاءة الاستخدام الحقلى للمياه. وأيضا انخفاض قيمة الاستهلاك المائى بواسطة نبات القطن. وكانت كفاءة التوزيع أعلى بمقارنة للطرق الأخرى.