IMPACT OF LAND LEVELING AND CUT-OFF IRRIGATION ON COTTON YIELD AND WATER PRODUCTIVITY IN NORTH MIDDLE NILE DELTA REGION

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Received: Dec. 12 , 2020 Accepted: Dec. 31 , 2020

ABSTRACT: A field trial was conducted through successive the two summer growing seasons 2018 and 2019 at Sakha Agricultural Research Station Farm, Kafr-El-Sheikh Governorate. The objective of this current study was to investigate the impact of three land leveling levels and three irrigation treatments on some water relationships, cotton yield and also some its components. The experiments were designed as split plot with three replications. The main plots were occupied by land leveling with three levels namely; traditional leveling farmers practices (L1), Dead level (0.0%) slope (L2) and 0.10% ground surface slope (L3). while sub plots were devoted t cut-off irrigation with three level namely, cut-off at 100% of furrow length (I1), cut-off irrigation at 90% of furrow length (I2) and cut-off irrigation at 80% furrow length(I3).

The main results can be summarized as follows:

Land leveling and cut-off irrigation treatments have highly significant effect on increasing the cotton yield. its components and fiber technological properties. The interaction between the two factors resulted in the highest values of cotton yield i.e.

The highest mean values of seed cotton yield, boll weight, leaf area, plant height, lint percentage, lint index and seed index were obtained under I_3 and L_3

The highest mean values of fiber fineness, fiber strength, length 2.5%, length 50% and uniformity index were obtained from interaction between I_3 and L_3 .

Cut-off irrigation at 80% from furrow length (I_3) and 0.1%ground surface slope (L_3) decreased seasonal applied water, water consumptive use and water stored in the effective root zone by 20.11, 12.11 and 10.90%, respectively compared with cut-off irrigation at 100% of furrow length (I_1) and L_1 (traditional land leveling). Also, the highest mean values of water application efficiency, water consumptive use efficiency (71.65, 67.84%) respectively were obtained with I_3 and L_3 treatments.

The highest mean values of water productivity (WP) and productivity of irrigation water (PIW) were recorded under the I_3 and L_3.

Key words: Irrigation, land leveling, cotton.

INTRODUCTION

Today, agriculture sector in Egypt is facing a complex challenge of producing more food with less water the demand for food is driven primarily by population growth which expected to increase from 92 m^3 billion in 2016 to 150 billion in year 2050 water is already a limiting factor for agriculture production climate change is likely to enhance the water requirements due to temperature increase whish will in turn amplify the water scarcity thus there will not be enough water to produce the food needed it is therefore imperative to develop and promote water saving practices on large scale in agriculture to

cope with water scarcity. (Amer et al 2017). 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; e.g. soil practices and irrigation management.

Management of irrigation water and improving soil productivity in Egypt become necessary in order to face water shortage as well as increasing population. New techniques and innovations must be found out to save irrigation water and increase crop production among of these in novation are land leveling and cut-off irrigation.

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, use efficiency will vary from locality to another. In areas where water is scarce and costly, available water should be used carefully.

Precision land leveling recorded 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 21.5% than surrounding field under traditional leveling.

Semaika and Rady (1987) recommended that precision land leveling program in Egypt increased irrigation efficiencies. Saied (1992) concluded that water consumptive use and amount of irrigation water applied was decreased by 0.1% ground surface slope and irrigation discharge of 1.0 m^3 / min. 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.

Aiad (2007) found that, the 0.1% ground sur ere face slope resulted in increasing the cotton yield and its components by 27.43% compared with traditional land leveling. El-Sanat (2018) stated that the ground surface slope of 0.1% and 0.05% and dead land leveling lead to increasing the seed cotton yield by 21.8, 15.12 and 5.15% compared to traditional land leveling. Precision land leveling using laser assisted land leveler equipped with drag scrapper is a process of smoothing the land surface within +_2 cm of its average micro-elevation. It is contemplated that laser levelers may play a significant role in improving resource use efficiency under surface irrigated system. Improvement in operational efficiency (Rajput *et al.* 2004), weed control efficiency (Jat *et al* 2004) reported as a result of precision land leveling when compared to traditional practice of land leveling. Significant increase in water use efficiency (WUE) on laser level fields has been reported by several researchers under different soil and climatic conditions (Jat *et al.* 2011).

Enhancement in irrigation practices lead to more uniform water distribution, soil and water conservation and economic viability of irrigated agriculture.Thus efficient on farm irrigation methods is 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, the maximum value of seed cotton yield was (1846.3 kg fed^{-1}) was achieved by using gated pipes under furrow length treatments Mohamed *et al.* (2017). The highest seed cotton yield (5707 kg ha^{-1}), was reached with 130% ETC and 210 kgN ha^{-1}. The maximum N agronomic efficiency was achieved at 140 kgN ha^{-1}. The treatments of 10% ETC showed significant benefits in terms of

irrigation water savings with 0.587kg m^{-3} (Zonta *et al.* 2016).

Cotton production is adversely affected by water stress (Pettigrew, 2004; Dagdelen *et al.* 2006; Basal *et al.* 2009). On the other hand, over-irrigation of cotton can cause undesired excessive vegetative growth which may reduce cotton yields (Karam *et al.* 2006) knowing the optimum water requirement of irrigated cotton is essential to achieving a balance between vegetative and reproductive growth in cotton.

The main objectives of this present study were to

1- **Investigate the impact of levels of land leveling on cotton yield, yield components and some technological characteristics.**

2- **Study the impact of land leveling on some water relationships.**

3- **Study the influence of cut off irrigation treatments on cotton yield its components some technological characteristics and some water relationships.**

MATERIALS AND METHODS

A field investigation was conducted at Sakha Agricultural Research Station farm Kafr El-Sheikh Governorate, Egypt during two consecutive summer seasons (2018 and 2019). The site lies at 134 km North Cairo and has an elevation of about 6 meters above mean sea level with coordinates of 31° 07 N Latitude 30° 57 E longitude. The objective was to study the effect of three land levels; traditional (L1), dead level (L2) (0.0%) slope and 0.1% ground surface slope and three irrigation treatments; traditional irrigation like practice by local farmers (I1, traditional practice), 90% (I_2) and 80% (I_3) from furrow length on some water relations, as well as cotton yield and its components.

An experiment was conducted in a split plot design, with three replications. The plot area was 2000 m^2 (20 x 100m^2) for land level treatments, while it was 600m^2 (6 x 100m) for cut-off irrigation treatments. The main plots were assigned to land leveling, with three levels namely L_1, L_2 and L_3. while the sub-plots were devoted to cut-off irrigation with three levels namely I_1 , I_2 and I_3.

Cotton (*Gossypium barbadebse*) Var. Giza 86 cotton seeds were planting in April, 25, 2018 and picked in sept. 30, 2018, while in the 2nd season 2019 the planting date was April, 20 and picking was in Oct. 10, 2019 respectively. Nitrogen, phosphorus and potassium fertilizers were added according to the recommended doses for the crop and area of study. Nitrogen fertilizer was applied in the form of urea (46%N) at the rate of 75 kg/fed. in two equal doses, the first one before the first post planting irrigation and second one at before the second irrigation. Phosphorus fertilizer in the form of calcium superphosphate (15.5% P_2O_5) was added at the rate of 200 kg/fed. in one dose before planting during land preparation. Potassium fertilizer in the form of potassium sulphate (48% K_2O) at the rate of 50 kg/fed. was added before planting. The agrometeorological data during the two growing seasons were obtained from Sakha Station as presented in Table 1.

Before performing treatments, soil samples at three depths up to 60 cm were randomly collected and analyzed for pH, EC according to page *et al.* (1982). Soil bulk density was determined according to (Blake and Hartage, 1986). Particle size distribution was determined according to Piper, (1950). Some chemical and physical properties of the studied soil are shown in Tables 2 and 3).

Table 1. Some meteorological data at Kafr El-Sheikh area during the two growing seasons.

Months	Temperature C			Relative humidity%			Wind velocity (km/24h)	Pan-evaporation (cm day^{-1})	Rain mm/month
	Max	Mini	Mean	Max	Mini	Mean			
	1st season (2018)								
Apr.	27.8	20.0	23.9	80.9	43.9	62.4	74.0	0.532	-
May.	31.2	23.8	27.5	75.6	43.9	59.8	95.8	0.634	-
Jun.	32.6	25.3	29.0	75.5	48.0	61.8	98.6	0.771	-
Jul.	34.2	25.4	29.8	82.6	51.0	66.8	89.5	0.737	-
Agus.	33.9	25.2	29.6	82.4	51.4	66.9	76.0	0.642	-
Sept.	32.8	23.5	28.2	83.1	48.3	65.7	68.7	0.498	-
Oct.	29.5	20.6	25.1	8.5	49.6	67.6	57.9	0.324	3.5
	2nd season (2019)								
Apr.	25.1	21.3	23.2	80.8	48.9	64.9	44.8	0.370	3.9
May.	31.9	25.4	28.7	76.4	37.9	57.2	68.4	0.683	-
Jun.	33.0	28.0	30.5	81.5	50.0	65.8	103.0	0.846	-
Jul.	33.5	28.4	31.0	85.2	54.4	69.8	83.8	0.808	-
Agus.	34.2	28.9	31.6	89.7	55.6	72.7	68.7	0.682	-
Sept.	32.4	27.9	30.2	83.4	52.9	68.2	76.9	0.590	-
Oct.	30.3	26.7	28.5	87.3	54.3	70.8	56.6	0.384	57.3

Table 2. Some chemical properties of the soil before cotton cultivation.

Depth (Cm)	EC (dsm^{-1})	pH	SAR	Soluble cation meg/L				Soluble anion meg/L			
				Ca^{+2}	Mg^{+2}	Na^{+}	K^{+}	Co_3^{-2}	HCO_3	Cl^{-}	So_4^{-2}
0-20	2.78	7.86	8.28	6.8	3.5	18.8	0.5	-	1.5	14.8	13.3
20-40	3.36	8.05	9.16	7.3	5.1	22.8	0.7	-	2	17.6	16.3
40-60	4.68	8.35	10.78	9.8	7.6	31.8	0.9	-	2.5	25.4	22.2
Mean	3.61		9.41	7.97	5.40	24.47	0.70	-	2.00	19.27	17.27

Table 3. Some physical properties and some water constants of the soil before cotton cultivation.

Depth (cm)	Particle size distribution (%)			Textural class	Bulk density (Mgm^{-3})	Soil moisture constant (%)		
	Sand	Silt	Clay			Field capacity	Wilting point	Available water
0-20	16.38	30.85	52.77	Clayey	1.23	43.15	23.86	19.29
20-40	15.65	30.48	53.87	Clayey	1.25	41.46	22.25	19.21
40-60	15.12	29.76	55.12	Clayey	1.33	39.25	20.18	19.09
Mean	15.72	30.36	53.92	Clayey	1.27	41.29	22.1	19.2

The studied characters were

-Plant height (cm)

-leaf area (cm^2)

-Seed cotton yield in kentar (157.5 Kg) / feddan($4200m^2$): Estimated as the weight of seed cotton yield in kentar/ fed.

- **Boll weight:** The average boll weight in grams of twenty-five bolls picked at random from each treatment.

- **Lint percentage (%):** The percentage weight of lint attained from a given weight of seed cotton samples:

Lint percentage = (weight of cotton lint / cotton seed weight) x 100.

Seed index: The weight of 100 seeds in grams.

Lint index= (seed index x lint percentage) / 100 – lint percentage.

Earliness percentage = (yield of the first pick / total yield) x 100.

Cotton fiber technological properties:

Fiber fineness, Fiber strength, Length 2.5 %, Length50% and uniformity

Some water relationships:

Applied water (AW): Submerged flow orifice with fixed dimension was used to convey and measure the applied water, as the following equation (Michael, 1978).

$$Q = CA\sqrt{2gh}$$

Where:

Q = Discharge through orifice ($cm^3\ Sec^{-1}$)

C = Coefficient of discharges (0.60)

A = Cross sectional area of orifice (cm^2)

g = Acceleration due to gravity (980 cm / Sec^{-2})

h = Pressure head over the orifice center (cm).

-Soil moisture percentage: Soil samples were taken from each 20 cm depth up to 60 cm before and after the irrigations to determine moisture content and to calculate the amount of consumed water and stored for each irrigation.

-Water consumptive use (WCU): Was calculated as $m^3\ fed^{-1}$ using the following equation (Hansen *et al.* 1979).

$$WCU = \sum_{i=1}^{i=n} \{(\frac{\theta 2-\theta 1}{100}) \times Dbi \times Di \times 4200\}$$

Where:

Θ_2: Soil moisture % after irrigation with 48 hours in the 1^{th} layer

Θ_1: Soil moisture % before next irrigation in the 1^{th} layer

Dbi: Bulk density in g / cm^3 of other 1^{th} layer

i: No of soil layers

n: No of irrigation and

Di: Soil layer depth (20 cm)

- Stored water was calculated using the following equation: (Hansen et.al, 1979).

$$WCU = \sum_{i=1}^{i=n} \{(\frac{\theta 2-\theta 1}{100}) \times Dbi \times Di \times 4200\}$$

Where

Θ_2: Soil moisture % after irrigation with 48 hours in the 1^{th} layer

Θ_1: Soil moisture % before the same irrigation in the 1^{th} layer

Dbi: Bulk density in g / cm^3 of other 1^{th} layer

-Irrigation application efficiency (Ea): It was calculated as described by (Downy, 1970) according to the following equation:

$$Ea = (\frac{Sw}{Aw}) \times 100$$

Where:

Ea = water application efficiency (%)

Sw = stored water in the root zone

Aw = applied water to the field plot

-Consumptive use efficiency (CUE), %: It was calculated according to (Doorenbos and Pruitt, 1975) as follows:

$$CUE = (\frac{ETc}{IWA}) \times 100$$

Where:

ETC: Water consumptive use, and IWA: irrigation water applied to the field ($m^{-3}\ fed^{-1}$) during the irrigation.

Water productivity (WP): It was calculated according to Ali *et al.* (2007).

$$WP = \frac{CSY}{ET}$$

Where
WP = water productivity (kg m-1),
CSY = cotton seed yield (kg fed-1) and
ET = total water consumption of the growing season (m3 fed-1).

Productivity of irrigation water (PIW, kg/m3): Was calculated according to (Ali et al. 2007) as follows:

$$PIW = \frac{CSY}{I}$$

Where
CSY: cotton seed yield (kg fed^{-1}) and
I: irrigation applied water m^3 fed^{-1}

Statistical analysis:

The data were analyzed statistically by a general linear model procedure and 2-way analysis of variance (ANOVA) using Cohort Computer Program according to the method of Gomez and Comez, (1984). Mean separation procedure was performed using LSD's test at a 0.05 and 0.01 level of significance.

RESULTS AND DISCUSSION

Seed cotton yield:

The results in Table (4) showed that the seed cotton yield (average of two growing seasons) was significantly affected by land leveling and cut-off irrigation. The interaction between land leveling and cut-off irrigation was significant. The maximum values of seed cotton yield (9.54 kentar fed^{-1}) was obtained with L_3) and (9.48 kentar fed^{-1}) was recorded under I_3. While the lowest value of seed cotton yield (8.16 kentar fed^{-1}) was obtained with L_1 and (8.27 kentar fed^{-1}) was recorded under I_1irrigation, respectively. The interaction between land leveling and cut-off irrigation had high significant effect on seed cotton yield, respectively. The highest value of seed cotton yield (10.13 kentar fed^{-1}) was produced from interaction between cut-off irrigation at 80% of furrow length and L_3 (0.1% ground surface slope). The results are in a great harmony with those obtained by El-Shahawy (2014), Aiad, (2001), Zanta et al. (2016), Mohamed et al. (2017) and El-Sanat (2018) their results revealed that the ground surface slope of 0.1 % , 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. It was noticed that the seed cotton yield was increased with decrease cut-off irrigation treatments under land leveling (I2 and I3).

Boll weight in (gm):

The results in Table (5) show that boll weight was significantly affected by land leveling and cut-off irrigation (the average of the two growing seasons). Data also showed that the interaction between land leveling and cut-off irrigation have significant effect on boll weight. The maximum values of boll weight (3.13 and 3.02 gm) were recorded under L_3 (0.1% ground surface slope) and I_3 (cut-off irrigation at 80% of furrow length, respectively. The interaction between land leveling and cut-off irrigation had high significant effect on boll weight, the highest values of boll weight (3.37 gm) was obtained with I_3 (cut- off irrigation at 80% of furrow length) under L_3 (0.1 % ground surface slope). The results are in a great harmony with those obtained by Mohamed *et al.* (2017) and El-Sanat (2018).

Plant height and leaf area

The results in Table (4) show that the plant height and leaf area were significantly affected by land leveling and cut-off irrigation in (the average of two growing seasons). Data also showed that the interaction between land leveling and cut-off irrigation had insignificant on plant height and leaf area. The maximum values of plant height and leaf area (155.22 cm and 173.71 cm^2 were obtained with L_3 and (156.55 cm and 176.43 cm^2) were recorded under I_3, respectively. The highest values of plant height (159 cm)

and leaf area (177.43 cm^2) were recorded with I_3 (cut-off irrigation at 80% of furrow length) under L_3 (0.1 % ground surface slope).

Table 4. Seed cotton yield and its components as affected by land leveling and cut-off irrigation treatments (average of two growing seasons.

Treatments	Seed cotton yield (kentar fed^{-1})	Boll weight (gm)	Leaf area (cm^2)	Plant height (cm)	Lint percentage (%)	Seed index (gm)	Lint index
Land leveling (L)							
L1	8.16 c	2.61 c	171.59 c	149.33 c	36.73 c	8.24 c	4.81 c
L2	8.97 b	2.85 b	172.86 b	153.66 b	37.20 ab	8.58 b	5.07 b
L3	9.54 a	3.13 a	173.71 a	155.22 a	38.34 a	8.81 a	5.22 b
F test	**	**	**	**	**	**	**
L.S.D. 0.05	0.024	0.030	0.020	1.000	0.810	0.102	0.070
L.S.D. 0.01	0.04	0.05	-	1.67	1.35	0.17	0.11
cut-off irrigation (I)							
I1	8.27 c	2.72	169.38 c	149.33 c	36.82 c	8.17 c	4.96 c
I2	8.92 b	2.85	172.36 b	152.33 b	37.19 b	8.58 b	5.08 b
I3	9.48 a	3.02	176.43 a	156.55 a	38.25 a	8.89 a	5.33 a
F test	**	**	**	**	**	**	**
L.S.D. 0.05	0.013	0.030	0.203	1.100	0.590	0.103	0.090
L.S.D. 0.01	0.02	0.05	-	1.54	0.83	0.04	0.12
Interaction (L*1)							
	**	**	Ns	Ns	ns	**	**

Table 5. Cotton fiber technological properties as affected by land leveling and cut-off irrigation treatments (average two growing seasons).

Treatments	Fiber fineness	Fiber strength	Length 2.5 %	Length 50%	uniformity
Land leveling (L)					
L1	2.866 c	9.347 c	29.281 c	15.362 b	52.46
L2	3.508 b	9.979 b	30.359 b	15.924 a	52.421
L3	4.266 a	10.453 a	31. 48 a	16.594 c	52.743
F test	**	**	**	**	Ns
cut-off irrigation (I)					
I1	3.074 c	9.309 c	28.916 c	15.278 c	52.829
I2	3.46 b	9.94 b	30.469 b	15.901 b	52.188
I3	4.104 a	10.53 a	31.736 a	16.702 a	52.608
F test	**	**	**	**	Ns
Interaction (L*1)					
1	2.467 f	8.907	28.25 f	14.813	52.437
2	2.67 f	9.48	28.967 e	15.147	52.287
3	3.46 de	9.653	30.627 c	16.127	52.657
4	3.147 e	9.227	28.767 e	15.107	52.513
5	3.53 cd	9.96	30.82 c	15.973	51.827
6	3.847 bc	10.75	31.49 b	16.693	52.923
7	3.62 cd	9.793	29.73 d	15.913	53.537
8	4.18 b	10.38	31.62 b	16.583	52.45
9	5.007 a	11.187	33.09 a	17.287	52.243
F test	*	Ns	**	Ns	Ns

Lint percentage, lint index and seed index

Presented data in Table (4) clearly showed that values of lint percentage, lint index and seed index were significantly affected by land leveling and cut-off irrigation. The highest values of lint percentage, lint index and seed index (38.34%, 5.22 and 8.81 gm) were recorded under L_3 and (38.25 %, 5.33 and 8.89 gm) were achieved under I_3, respectively. The interaction between land leveling and cut-off irrigation had insignificant effect on lint percentage since it had high significant effect on lint index and seed index. The highest values of lint percentage (39.10%), lint index (5.94) and seed index (9.15gm) were obtained with I_3 (cut-off irrigation at 80% of furrow length) under L_3 (0.1 % ground surface slope).

Cotton fiber technological properties:

Presented data in Table (5) clearly showed that the values of cotton fiber technological properties which were affected by land leveling and cut-off irrigation.

Fiber fineness and fiber strength

The results in Table (5) showed that the fiber fineness and fiber strength high significantly affected by land leveling and cut-off irrigation. The maximum values of fiber fineness and fiber strength (4.266 and 10.453) were recorded under L_3 (0.1% ground surface slope) and (4.104 and 10.53) were achieved with I_3 (cut off irrigation at 80% of furrow length) respectively. The interaction between land leveling and cut-off irrigation had significant effect on fiber fineness and while it had insignificant effect on fiber strength. The highest values of fiber fineness (5.007) and fiber strength (11.187) were obtained with I_3 (cut-off irrigation at 80% of furrow length) under L_3 (0.1 % ground surface slope).

Length 2.5 %, length 50% and uniformity index:

The results in Table (5) indicated that the Length 2.5 %, length 50% and uniformity index highly significantly affected by land leveling and cut-off irrigation.

Some water relations:

Amount of seasonal applied water:

Presented data in Table (6) clearly showed that the values of cotton seasonal applied water were affected by land leveling and cut-off irrigation (as the average of two growing seasons). The highest values of seasonal water applied (4200 m^3 fed^{-1}) were recorded under L_1 (traditional land leveling) and cut-off irrigation at 100% of furrow length, (traditional) respectively. It was noticed that the seasonal water applied was decreased with increasing cut off irrigation treatments under land leveling (I_2 and I_3).

In comparison with cut-off irrigation at 100 % of furrow length (no cut-off) under land leveling treatments. The highest values of water saving (810 m^3 fed^{-1} (20.71 %)) were obtained with cut-off irrigation at 80% of furrow length and L_3 (0.10 %ground surface slope). Based on the highest crop yield, water saving could be used for irrigating more crops and horizontal expansion in agriculture. The results are in a great harmony with those obtained by Abd-El-Fatah (2011), El-Ramady *et al.* (2013), Moursi *et al.* (2014), El-Hadidi *et al.* (2016), Zoghdan *et al.* (2019) and Kanannavar *et al.* (2020).

The maximum value of water saving was achieved in case of using gated pipes irrigation system under laser land leveling (0.1 % slope) combined cut off irrigation at 80% of furrow length.

Table 6. Seasonal applied water and water saving as affected by land leveling and cut-off irrigation treatments (average of two growing seasons).

Treatments		Seasonal water applied		Water saving	
Land leveling	Cut-off irrigation	cm fed^{-1}	m^3 fed^{-1}	% cm fed^{-1}	m^3 fed^{-1}
L1	I1	100	4200	-	-
	I2	94.88	3985	5.12	215
	I3	92.26	3875	7.74	325
Mean		95.71	4020	6.43	270
L2	I1	92.6	3889	7.4	311
	I2	85.95	3610	14.05	590
	I3	82.14	3450	17.86	750
Mean		86.9	3650	13.1	550
L3	I1	86.3	3625	13.69	575
	I2	81.19	3410	18.8	790
	I3	79.29	3330	20.71	870
Mean		82.26	3455	17.73	745

Seasonal water consumptive use (Cu):

The seasonal crop water consumptive use had the same trend as that of seasonal applied water. The mean values of seasonal water consumptive use are a direct function of the soil water status which already are affected by the amount of irrigation water applied.

Presented data in Table (6) showed that the highest mean values of seasonal water consumptive use (2588 m^3 fed^{-1} (61.62 cm)) were recorded under L_1 (traditional land leveling) and cut-off irrigation at 100 % of furrow length (as the average two growing seasons), respectively, compared with other treatments. Meanwhile, the lowest water consumptive use values (2259 m^3 fed^{-1} (53.79 cm)) were achieved with L_3 (ground surface slope 0.1 %) and cut-off irrigation at 80 % of furrow length (I_3 treatment), respectively. It was observed that the values of seasonal water consumptive use were decreased with increasing cut-off irrigation under L2 and L3 treatments (dead level and ground surface slope 0.1 %), respectively. These results are in agreement with those obtained by Abd-El-Fatah (2011), El-Ramady *et al.* (2013), Moursi *et al.* (2014), El-Hadidi *et al.* (2016), Mohamed, *et al*. (2017), Zoghdan *et al*. 2019 and Kanannavar *et al.* (2020).

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

The values of water stored in the effective root zone are presented in Table (7) revealed that the mean values of water stored in the effective rhizosphere were decreased by 3.34 and 6.92 % with precision land leveling and ground surface slope 0.1 % compared to traditional land leveling, while the lowest values was recorded with I_3 (cut-off irrigation at 80 % of furrow length since it was (2386 m^3 fed^{-1}) under 0.1 % ground surface slope.

Table 7. The seasonal water consumptive use and consumptive use efficiency as affected by different treatments (average two growing seasons).

Treatments		Water consumptive use m^3 fed^{-1} Soil depth, cm 0 – 20	20 – 40	40 - 60	Total m^3 fed^{-1}	Consumptive use efficiency (%)
L1	I1	1047	954	578	2588	61.62
	I2	1016	934	554	2504	62.84
	I3	986	914	544	2444	63.06
Mean		1016	934	559	2512	62.5
L2	I1	996	923	551	2470	63.48
	I2	953	898	533	2384	66.05
	I3	918	873	518	2309	66.87
Mean		956	898	534	2388	65.47
L3	I1	954	863	529	2346	64.54
	I2	914	848	519	2281	66.89
	I3	901	843	515	2259	67.84
Mean		923	851	521	2295	66.42

While, the highest value is obtained from cut-off irrigation at 100 % of furrow length which it was (2678 m^3 fed^{-1}) under traditional land leveling. Results are in convenience with those achieved by Mohamed, *et al* 2017, Zoghdan *et al.* 2019 and Kanannavar *et al.* (2020).

Irrigation efficiencies

Water application efficiency (Ea%)

Data in Table (8) showed that the highest value of water application efficiency (71.69 %) was achieved from cut-off irrigation till 80 % of furrow length underground surface slope 0.1 % (the average two growing seasons), respectively, followed by cut-off irrigation at 90 % of furrow length under the dead level (precision land leveling).

While, the lowest value of water application efficiency (63.76 %) was resulted from cut-off irrigation at 100 % of furrow length under L_1 (traditional land leveling), respectively. Also, it was noticed that the mean values of water application efficiency were increased with cut-off irrigation at 90 % and 80 % of furrow length under dead level (precision land leveling and ground surface slope 0.1 %. These results are some what agreed with those obtained by Mohamed, *et al* 2017, Zoghdan *et al.* 2019 and Kanannavar *et al.* (2020).

Water consumptive use efficiency (Ecu, %)

Water consumptive use efficiency is a parameter which indicates the capability of plants to utilize the soil water stored in the effective root zone. Date in Table (7) showed that the highest value of Ecu (67.84 %) was recorded under cut-off irrigation at 80 % of furrow length combined with ground surface slope 0.1 %. On the other hand, the lowest value of Ecu (61.62 %) was achieved from cut-off irrigation at 100 % of furrow length under traditional land leveling. This finding is somewhat agreed with those obtained by Mohamed, *et al* 2017, Zoghdan *et al.* 2019 and Kanannavar *et al.* (2020).

Water productivity (WP) and productivity of irrigation water (PIW) (kg m^{-3}):

Data in Table (9) showed the effect of land leveling and cut-off irrigation on water productivity and productivity of irrigation water; whereas the highest values for WP and PIW (0.655 and 0.435 kg m^{-3}) were achieved underground surface slope 0.1 % (L_3) compared with L_1 and L_2, respectively. The highest values of WP and PIW 0.639 and 0.420 kg m^{-3} were achieved from cut-off irrigation at 90 and 100% of furrow length, respectively.

These results are in the same line with those obtained by Mohamed, *et al* (2017), Zoghdan *et al.* (2019) and Kanannavar *et al.* (2020).

Table 8. Stored water, water application efficiency and water distribution efficiency as affected by different treatments (average of two growing seasons).

Treatments		Stored water (m^3 fed^{-1})				Water application efficiency(Ea%)
Land leveling	Cut-off irrigation	Soil depth, cm			Total m^3 fed^{-1}	
		0 - 20	20 – 40	40 – 60		
L1	I1	1102	979	597	2678	63.76
	I2	1037	949	584	2570	64.5
	I3	1032	946	581	2559	66.03
Mean		1057	958	587	2602	64.76
L2	I1	1067	960	588	2615	67.23
	I2	1014	925	571	2510	69.52
	I3	969	895	557	2421	70.18
Mean		1017	927	572	2515	68.98
L3	I1	997	915	564	2476	68.14
	I2	962	890	554	2406	70.43
	I3	950	886	550	2386	71.65
Mean		970	897	556	2423	70.07

Table 9. Effect of land leveling and cut-off irrigation on cotton water productivity (WP, kg m^{-3}) and productivity of irrigation water (PIW kg m^{-3}) (as average two seasons).

Treatments	Seed cotton yield kentar / fed^{-1}	Water applied m^3 fed^{-1}	Water consumptive use m^3 fed^{-1}	Productivity of irrigation water (PIW kg m^{-1})	Water productivity (WP kg m^{-1})
L1	8.16	4020	2512	0.32	0.512
L2	8.97	3650	2389	0.387	0.591
L3	9.54	3455	2295	0.435	0.655
I1	8.27	3905	2468	0.334	0.528
I2	8.92	3668	2390	0.383	0.588
I3	9.48	3552	2337	0.42	0.639

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تاثير تسوية التربة وطول جبهة الري علي محصول القطن وانتاجية وحدة المياه بمنطقة شمال وسط دلتا النيل

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الملخص العربى

اجريت تجربة حقلية في الموسمين الزراعيين 2018 و2019 في مزرعة محطة البحوث الزراعية بسخا محافظة كفرالشيخ . وكان الهدف من هذه الدراسة تقييم تاثير ثلاث معاملات من تسوية التربة تسوية تقليدية وتسوية دقيقة بدون ميول وتسوية بميول 0,1% وثلاث معاملات الري: ايقاف سريان المياه عند 100% من طول الخط (ري عادي) و90% و80% من طول الخط (طول الخط 100متر) علي بعض المقاييس المائية ومحصول القطن ومكوناته وقد صممت التجربة في قطع منشقة مرة واحدة مع ثلاث مكررات حيث مثلت معاملات التسوية القطع الرئيسية بينما معاملات ايقاف سريان المياه وضعت في القطع الشقية.

ويمكن تلخيص اهم نتائج كما يلي :

- كان لمعاملات التسوية ومعاملات ايقاف سريان مياه الري تاثيرا عالي المعنوية علي زيادة محصول القطن ومكوناته علي خواص الالياف التكنولوجية.
- أمكن الحصول علي أعلي القيم لمحصول بذرة القطن ووزن اللوزة ومساحة الورقة وطول النبات ونسبة الشعر ودليل الشعر ودليل البذرة بإيقاف سريان المياة عند 80% من طول الخط والتسوية بميول 0,1% .
- تم الحصول على أعلي القيم لنعومة التيلة ومتانة التيلة وطول التيلة عند 2.5% و50% ودرجة انتظام الشعيرات من ايقاف سريان المياة عند 80% والتسوية بميول 0.1% .
- تشير نتائج التفاعل بأن إيقاف سريان المياه عند 80% مع التسوية بميول 0,1% قد أدى إلي نقص الماء المضاف الموسمي والاستهلاك المائي والماء المخزن في منطقة الجذور الفعالة بنسب 20,11- 12,11- 10,9 % علي الترتيب بالمقارنة بايقاف سريان المياه عند 100% من طول الخط مع التسوية التقليدية .
- أمكن الحصول على أعلي القيم لكفاءة الري التطبيقية وكفاءة تغطية الاستهلاك المائي (71,65% و 67,84%) من معاملة التفاعل بين ايقاف سريان المياة عند 80% مع التسوية بميول 0,1% .
- سجلت اعلي القيم للانتاجية المائية وانتاجية مياه الري بالتفاعل بين ايقاف سريان المياة عند 80% من طول الخط والتسوية بميول 0,1% .

السادة المحكمين

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