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WATER MANAGEMENT FOR COTTON YIELD IN NORTH DELTA

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ABSTRACT

Two field experiments were conducted at the farm of El-Karada water management research station-Kafr El-Sheikh Governorate. (Water management and Irrigation System Research Institute National water research center Egypt) during 2007 and 2008 season for cotton crop. The experiment was arranged in split-plot design with four replicates. The main plot represented two methods of planting : 1- Furrow and Bed methods, while, the sub-plot treatments represented water applied methods e.g. 1) irrigate at F.C% 2) irrigated at F.C +10%, 3) irrigate at F.C - 10% 4) irrigate at F.C- 15% and 5) irrigate at F.C - 20% . The results indicated that under furrow cultivation method received more amount of water consumptive use, seed cotton yield, while, bed cultivated method was opposite. Also, data revealed that water applied methods was significant effect of traits under study, where as, F.c + 10% water applied treatment received more amount of water, water consumptive use, seed cotton yield, but it gave sufficient water stored, crop water use efficiency and field water use efficiency, while, F.C-20% water applied was opposite. The Bed cultivated method achieved the highest value of water saving (20.21 %). This results led to recommend to use Penman-Month equation for estimating water consumptive use for seed cotton yield in North delta. Interactions between planting methods and water applied treatment was significantly. Where as, the high values observed by furrow

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cultivate method with F.c + 10% and F.c treatments particularly net income for irrigation water unit (L.E/m3).

INTRODUCTION

Productivity of cotton plant depends on a large number of environmental effects as well as crop management. Water management is one of the factors affecting the productivity of cotton. An amount of irrigation water of 4000 m^3 and 4700m^3 per fed. has been recommended by Ministry of water resources and irrigation for lower and upper Egypt, respectively. On the other hand, Ministry of Agriculture in their publications (1961 up till now) devoted farmers to schedule cotton irrigation to be every 15 and 10 days for lower and upper Egypt, respectively. Irrigation water which became more available after constructing the high dam. Taking into consideration insufficient and inefficient drainage systems the situation has become more difficult where high ground water babble has been established. This, resulting in increasing the salt affected soils area from one side and creates poor soil aeration condition from the other side by which cotton yield has been negatively affected. Cotton yield is dependent upon the production and retention of bolls, both of which can be decreased by water stress (Guanine and Money, 1984). Additionally, income produced by cotton depends on yield and its value based on fiber physical properties. However, even short periods of water stress during susceptible stages could cause shorter and less-developed cell walls in bolls (Ramey, 1986). To reduce the enormous impact of yield reduction during these drought periods, many cotton grower's consider irrigation. Rijks (1965) stated that cotton plants grown with low water supply, produced fewer bolls and yield. Under weather conditions of Middle Egypt, water use for cotton was reported to be 73.0-80.7 cm (El-Shal, 1966), 81.0 cm (Khalil *et al*. 1969), and 98.8 cm (Chaudry, 1969).

The number of open bolls per plant and seed cotton yield per feddan were reported to decrease by delaying the sowing date (Ragab, 1985). Yasean *et al*. (1989), reported that highest number of open bolls per plant and seed cotton yield per fed. were obtained by 21-28 days as time of first post sowing irrigation. Mohamed *et. al*. (1994) indicated that highest seed cotton yield for Dandarah cotton variety

grown in upper Egypt is to be achieved by applying irrigation at 10 days abort till Flower stage and then at 20 days apart till harvesting . This treatment is followed by 10 days interval all over the cotton growing season. From the economic point of view, the best irrigation regime may be achieved by applying the irrigation every 10 days till flowering and than 20 days until harvesting due to its maximum water use efficiency. Bishr et al. (1994) found that in the case of absence of the ground water table (Free of water table) the higher seed cotton yield was observed from the shorter irrigation intervals. Cotton water consumptive use was found to be higher at more frequent irrigation (shorter irrigation intervals. Delaying to be 21 days apart caused 90% higher in water use efficiency than that scheduled every 14 days. This was due to the higher yield and less irrigation requirements resulted in irrigating cotton every 21 days in 60 to 70 cm (ground water table) field. In case of no GWT, an amount of 3400m3/Fed. May be devoted under irrigation regime of 18 days apart.

MATERIALS AND METHODS

The present investigation was conducted at EL-Karada Agricultural Research Station, Kafer El-Sheikh, Governorate Egypt, during 2007 and 2008 seasons.

The soil of the experimental area was clay loam in texture. Mechanical and chemical analysis of soil samples were determined a cording to the standard methods that outlined by **Black (1983), Klute (1986) and Westerman (1990)** are given in Table (1).

Table (1): Chemical analysis of the tested soil.

Soil depth,cm	PH 1:2.5	Ec mmhos/cm	Cation meq/L				Anion meq/L			
			Ca^{++}	Mg^{++}	Na^{+}	K^{+}	Co^{3}--	Hco^{3}-	cl-	So^{4}--
0-20	8.0	1.90	6.4	5.3	9.0	0.34	-	3.5	10.4	7.14
20-40	8.1	2.10	5.2	4.1	12.4	0.35	-	5.6	11.6	4.85
40-60	8.1	2.30	5.0	5.5	12.7	0.34	-	5.2	12.4	5.94

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Monitoring soil moisture:

Soil samples were collected before and two days after each irrigation from 3 layers (20cm each) to determine soil moisture constants which presented in Table (2).

Table (2): Soil moisture constants for the experimental site.

Soil depth,cm	Field capacity (F.C)%	Permanent wilting point (Pwp),%	Available water (Aw), cm	Bulk density, g/cm^3
0-20	45.00	24.30	20.70	1.08
20-40	37.20	21.20	16.00	1.20
40-60	34.10	18.50	15.00	1.31

Egyptian cotton Giza variety (Gossypium L.) was planted on March 21, 2007 and on March 26, 2008 seasons. The land was ridged at 60 cm spacing. Four seeds were sown in each hill and the hills were spaced 20 cm a part. The first irrigation was after 35 days from planting. The hills were thinned to the desired stand before the second irrigation. Nitrogen were applied to the second irrigation after 17 days from the first. The experiment was arranged in split-plot design with 4 replicates .the main- plot represented seedbed cultivate methods: 1- Furrow and methods. 2- Bed cultivate while, the sub-plot treatments represented irrigation applied reign, e.g.,

1- Irrigate to F.C % only (A)
2- Irrigate to F.C + 10% (B)
3- Irrigate to F.C – 10% (c)
4- Irrigate to F.C– 15% (D)
5- Irrigate to F.C – 20% (E)

Climatologically elements:

Values of the climatologically elements in Table (3) were obtained from the meteorological station at El-Karada, Kafer El-sheish, Governorate, situated at 30° 47 N F atitude and 31° E longitude and 15 m ltitude. It represents the circumstances and conditions of the North Delta. Average values of temperature, air relative humidity (RH%) and wind speed (m/s) were recorded daily during the two years.

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Table (3) Average meteorological data for two seasons.

Month	Ave. of air Tem. C°	Ave. of R H, %	Ave. of wind velocity, Km/day
March	16.20	63.6	89.50
April	19.20	60.00	106.9
May	20.8	58.00	108.00
June	24.3	65.30	119.00
July	25.8	67.00	103.00
August	26.7	67.70	86.10
Sept.	25.10	96.49	99.60
Oct.	26.30	72.00	90.20

Estimation of the potential evapotranspiration (ETP):

Estimated ETP were made simultaneously for a period of about 8 months from March until October only in both seasons and used

1- Penman – Monteith Method

The form of the penman-Monteith equation for estimating ETP recommended by the FAO (1990). Expert consultation held in May 1990 is as follows:

$$ET_p = \frac{0.408\Delta(Rn - G) + yu2(ea - ed)\dfrac{900}{Tc + 273.15}}{\Delta + y(1 + 0.34u2)} \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Where:

ET_p= Reference Evapotranspiration (grass) (mm/d)

R_n= Net radiation at crop surface (’Mg/m^2/d))

G= Soil heat flux (MJ/m^2/d)

T_c= Average temperature (C°)

U_2= Wind speed at 2m height (m/s)

e_a= Saturation vapour pressure (kpa)

e_d= (actual vapour pressure (kpa)

A= Slope of the saturation vapour pressure curve at mean air temperature

y= Psychometrics constant (kpa/c)).

2 - Modified penman:

.ETo = c {(W. R_n + (1-w). f (u). (ea – ed)} **(FAO, 1977)**…(2)

Where:

ETo =Potential crop Evapotranspiration in mm/day.

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W =Temperature – related weighting factor.
R_n =Net radiation in equivalent evaporation in mm/day.
f (u) =Wind – related function
(ea – ed) =Difference between the saturation vapour pressure at mean air temperature and the mean actual vapour pressure of the air, both in mbar.
C =Adjustment factor to compensate for the effect of day and night weather condition.

3-Modified Blaney & Criddle equation:

Blaney and Criddle (1955) observed that the amount of water consumptive used by crop during the growing seasons was closely correlated with means monthly temperature and day light hours.

$$ET_p = C \{p (0.64T + 8.13)\} \quad \ldots\ldots\ldots\ldots(3)$$

Where:
ET_p =Potential evapotranspiration in mm/day.
T =Mean daily temperature in C.
P =Mean daily percentage of total annual day time hours for given month and Latitude.
C =Adjustment factor which depends on minimum relative humidity, sunshine hours and daytime wind estimate.

4-Radiation method :

$$ET_p = C \times (W.R_s.) \ldots\ldots\ldots\ldots\ldots\ldots(4)$$

Where:
ET_p = Potential crop Evapotranspiration in mm/day.
Rs = The solar radiation expressed in equivalent evaporation in m/day.
W = Weighting factor which depends on temperature and altitude.
C = Adjustment factor which depends on mean humidity and daytime wind conditions.

5- Pan evaporation method :

Potential Evapotranspiration (ET_p) can be obtained from the following Equation:

$$ET_p = Kp.\ E_{pan}\ (mm/day) \ldots\ldots\ldots\ldots(5)$$

Where:
K_p = Pan Coefficient depends on type of pan condition of humidity, wind speed And pan environmental conditions

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E_{pan} = Pan evaporation in mm/day and represent the mean daily value of the period considered.

6- Estimation of crop coefficient (kc):

Crop coefficient was estimated by **(FAO, 1990)** as Follows:

Etc= Etp X Kc ……..(6)

Where:

Etc = Actual evapotranspiration, mm/day

Etp= Potential evapotranspiration calculated by the modified penman equation, mm/day, and

Kc= Crop coefficient, dimensionless

7- Soil – Water relationships:

1- 1- Applied water (Wa):

Discharge measurements were made by using a fixed crested weir using its Empirical equation a cording to **(Masoud, 1967**) as follows:

$$Q = C\ L\ H^{3/2} \text{.....(7)}$$

Where:

Q = Discharge in cubic meter per minuet.

L = Length of the crest in meter.

H = Water head in meter,

C = Discharge coefficient.

2- Water consumptive use :

Soil moisture content was determined before and after irrigation to calculate water consumptive use accordion to **lesraelsson and Hansen (1979).**

$$Cu = \frac{\Theta 2 - \Theta 1}{100} \times \mathbf{B.\ d} \times \mathbf{D} \text{ x A} \quad \text{…… …….(8)}$$

Where:

Cu = Water consumptive use in ache irrigation (m^3).

$\Theta 2$ = Soil moisture percent after irrigation. (%,)

$\Theta 1$ = Soil moisture percent before irrigation. (%,)

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B d = Soil Bulk density
D = Depth of soil layer of the soil. (m).and
A = Irrigation area (= 4200 m^2)

3- Water saving (m3/Fed.):

difference between the water applied in furrow and bed cultivate methods

$$Ea = \frac{\text{Water stored in the root sone}}{\text{Amount of applied water}} \times 100 \quad \text{.....(10)}$$

4- Crop water use efficiency, (CWUE)

It was calculated according to **Hansen et al. (1980)** by the following equation:

$$\text{CWUE, } (Kg/m^3) = \frac{\text{Yield (Kg/Fed)}}{\text{Water consumptive use } (m^3/Fed)} \quad \text{.....(11)}$$

5- Field water use efficiency, (FWUE):

It was calculated by **Michael (1978)** the following equation:

$$\text{FWUE, } (Kg/m^3) = \frac{\text{Yield (Kg/Fed)}}{\text{Applied water } (m^3/Fed)} \quad \text{.....(12)}$$

6- Net benefit of irrigation water unit =

$$\frac{\text{net benefit of seed cotton yield (Kntar/Fed)}}{\text{Applied water } (cm^3/fed)} \quad \textbf{.....(13)}$$

Data of the two seasons were statistically analyzed using the IRRISTAT computer program **(IRRI, 1991),** and the treatment means were compared according to Duncans multiple range test **(Duncan, 1954).**

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RESULTS AND DISCUSSION

1- Amount of water applied (m^3/Fed.) and water consumptive use:

The results in Table (4) indicate that irrigation methods significant affected amount of water applied in both seasons with the F.c-20% irrigation treatment. The maximum value was obtained from the irrigated at F.c + 10%, while, the minimum value was obtained from the irrigated at F.c- 20%., where, the maximum values were 3275.08 and 2614.50 m^3/fed. while, the minimum values were 2143.50 and 2826.60 m^3/fed for the furrow and bed cultivate methods respectively.

Also, the results indicated that, the amount of water applied was related to seedbed methods. Finding reported by (Ragab, 1985).

However, the results in Table (4) indicate that irrigation methods affected water consumptive use m^3/fed in both seasons. The maximum values were 2523.70 and 2014.71 m^3/fed. with F.c + 10% treatment for the furrow and bed cultivate methods, respectively, while, the minimum values were obtained from the irrigated at F-c-20% and F-c-15% treatments, it were 1970.33 and 1571.47 m^3/fed. for the furrow and bed cultivate methods respectively.

Regarding to the two cultivate methods, there was significant in water consumptive use in both seasons. whereas, the furrow cultivate methods gave the highest values, it was, 2666.33 and 2199.34 m^3/fed. in both seasons, while, the bed cultivate method was opposite. Significant effect of interaction between irrigation treatments and seedbed methods.

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Table (4): Water applied m^3/fed. and water consumptive use as affected by different treatments in 2007 and 2008 seasons.

Treatments	Applied water m^3/fed			Water Consumptive (m^3/fed)		Mean
Furrow method	**2007**	**2008**	**Mean**	**2007**	**2008**	
F.C	3106	3044	3075	2364.18	2299.31	2331.75
F.C $^+$ 10%	3308	3242	3275.08	2557.80	2489.6	2523.70
F.C $^-$ 10%	2983	2924	2953.5	2231.46	2184.00	2207.73
F.C - 15%	2887	2830	2858.5	2156.28	2094.07	2125.18
F.C - 20%	2713	2662	2087.5	2010.96	1929.7	1970.33
Mean	2999.4	2940.4		2666.33	2199.34	
L.S.D at 5%				381.77	279.60	
Significant Bed method				*	**	
F.C	2465	2435	2450	1876.27	1839.30	1857.79
F.C $^+$ 10%	2637	2592	2614.5	2038.97	1990.45	2014.71
F.C $^-$ 10%	2378	2338	2358	1778.88	1746.30	1762.59
F.C $^-$ 15%	2300	2264	2282	1717.85	1675.26	1696.56
F.C - 20%	2160	2127	2143.5	1601.06	1541.88	1571.47
Mean	2388.0	2351.2		1802.61	1758.64	
L.S.D at 5%				258.10	223.60	
Significant				**	**	
interactions				*	*	

2- Water saving (m^3/fed.) :

The results in table (5) indicate that, bed cultivate method was significant, where, it gave the highest value for water saving, it was20.21% as average about the furrow cultivate method. However, no significant difference was obtained among the irrigation methods.

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Table (5): Average Water saving m^3/fed. and % as affected by different treatment in 2007 and 2008 season.

Methods Treatments	Furrow Water applied m^3/fed	Bed Water applied m^3/fed	Water saving m^3/fed.	Water saving %
F.C	3075	2450	625.0	20.32
F.C + 10%	3275	2614.5	600.5	20.17
F.C -10%	2953.5	2358	595.5	20.16
F.C -15%	2858.5	2282	576.5	20.20
F.C - 20%	2087.5	2143.5	544.0	20.24

3- Actual evapotranspiration (Etc mm/day)

Table (6) shows that, values of "Etc" increased in June and July months, were 3.12 and 4.85 mm/day respectively while in March and April was opposite it was 1.10 and 1.30 mm/day in both seasons respectively.

4- Potential evapotranspiration (ETp mm/day):

Data in Table (7) obtained that, the five methods were used for estimation (Etp mm/day), whereas, insignificant difference among these methods in before harvest period .e.g. months June, July and August. in both seasons. Values for ETp mm/day was decreased in emergence stage, while, it increased gradually with increase age of plant and decrease with before harvest period at October, after that Etp was increased in June, July and August months.

The highest value followed by modified penman methods were 5.54 and 4.98 mm/day, respectively. While, pan evapotrans method was opposite were 4.01 mm/day.

5- Seed cotton yield (Kentar/fed.) :

The results in Table (8) indicate that irrigation methods significantly affected seed cotton weight/fed. In both seasons on the 5% level of significance. The maximum seed cotton weight/fed. values was obtained from the F.C + 10% treatment were 8.19 and 7.54 Kentar/fed for the furrow and bed cultivate methods, respectively. The lowest value was found in F.C – 20% it was 6.89 and 6.76 Kentar/fed. for the furrow and bed cultivate methods, respectively It is clear that F.C + 10% and F.C treatments could be recommended to obtain the best result. This result will be fact in case of obtaining the maximum number of stand plants/fed. at harvesting and the highest value of boll weight (gm). These results were close

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to those found by **Mohamed et al (1994) and Bishr et al. (1994).** These results indicated that, increasing seed cotton yield with furrow cultivate method, whereas, this increase led to increase water applied m^3/fed about in bed cultivate method significant interaction between two cultivate methods in both seasons.

Table (8): Seed Cotton yield (Kentar/Fed.) as affected by different treatments during 2007 and 2008 seasons.

Treatments	Seed cotton Yield (Kentar/Fed.)		
	2007	2008	Mean
F.C	7.78	8.17	7.98
F.C + 10%	7.99	8.39	8.19
F.C - 10%	7.30	7.67	7.49
F.C - 15%	6.93	7.28	7.11
F.C - 20%	6.72	7.06	6.89
Mean	7.34	7.71	7.53
L.S.D at 5%	0.34	0.36	
Significant	**	**	
Bed			
F.C	7.17	7.54	7.36
F.C + 10%	7.37	7.71	7.54
F.C - 10%	6.82	7.13	6.98
F.C - 15%	6.52	6.82	6.67
F.C - 20%	6.35	7.16	6.76
Mean	6.85	7.27	
L.S.D at 5%	0.29	0.34	
Significant	**	**	
Interaction	**	**	

6- Crop and Field water use efficiency (Kg/m^3):

Data in Table (9) show that crop water use efficiency significantly affected by irrigation methods in both seasons. The maximum CWUE,% values were found for the F.C – 20% followed by F.C-15% treatment were 0.54 and 0.52 kg/m^3, for furrow cultivate method and 0.52 and 0.47 kg/m^3 for bed cultivate method, while, the minimum value was recorded by F.C + 10% it was 0.395 and 0.445 for furrow and bed cultivate methods. Data, it is clear that 3.1m^3 water irrigation gave 0.54 and 0.69 seed cotton for the furrow and bed cultivate methods respectively. This irrigation method treatment (F.C – 20%) could be recommended to obtain the lowest seed cotton

yield and highest value of save water in the same time. Also, data indicate that, insignificant effect of irrigation methods on FWUE, % in the two seasons. The minimum FWUE, % value was found for the F.C+ 10% treatment compared with other treatments.

As for furrow and bed cultivate methods, it can be noticed that, they had obvious effect on CWUE and FWUE Kg/m^3, whereas, 3.00m^3 water irrigation gave 0.51 and 0.62 kg seed cotton yield for the furrow and bed cultivate methods. respectively. Significant effect of interaction between irrigation treatment and seedbed methods.

Table (9): Crop and Field water use efficiency (Kg/m^3) as affected by different treatments during 2007 and 2008 seasons.

Treatments	Crop water use efficiency Kg/m3			Field water use efficiency Kg/m3		
	2007	2008	Mean	2007	2008	Mean
Furrow						
F.C	0.52	0.53	0.525	0.39	0.42	0.405
F.C + 10%	0.49	0.51	0.50	0.38	0.41	0.395
F.C - 10%	0.52	0.53	0.525	0. 39	0.41	0.40
F.C - 15%	0.51	0.52	0.515	0.38	0.41	0.395
F.C - 20%	0.53	0.55	0.54	0.39	0.42	0.405
Mean	0.51	0.53		0.39	0.41	
L.S.D at 5%	0.09	0.09		0.01	0.02	
Significant	*	*		ns	ns	
Bed						
F.C	0.59	0.64	0.615	0.45	0.48	
F.C + 10%	0.56	0.60	0.580	0.43	0.46	
F.C - 10%	0.59	0.63	0.61	0.44	0.47	
F.C - 15%	0.59	0.63	0.61	0.44	0.47	
F.C - 20%	0.66	0.72	0.69	0.46	0.52	
Mean	0.60	0.64		0.44	0.48	
L.S.D at 5%	0.05	0.10		0.01	0.03	
Significant	*	**		*	**	
Interaction	*	*		*	*	

7- Crop Coefficient Kc

Effect of crop characteristics on crop water requirements is indicated by the crop coefficient (KC)which represents the relationship between reference potential (Etp) and actual crop evapotranspiration (Eta). The values of crop coefficient for irrigation treatments are KC showed slight increased with time after planting till

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they reach their peak in July and then they decrease again at the end of growth season. it could be noticed that the nearest values to average KC this of Penman Monteith equation. This results led to recommended to use Penman Monteith equation for estimating water consumptive use for cotton crop in North Delta.

8- Net income for irrigation water unit (L.E/m3):

Data in Table (11) reported that, total variable cost was 1740 L.E and total fixed cost was 1260 L.E, whereas total cost for all irrigation methods was (1740+1260) = 3000 L.E as a fixed cost for all treatments.

The different cost it led to total of production value, and net income for irrigation water unit were 0.61, 0.54, 0.47 and 0.45 L.E/m^3 for F.C + 10% and F.C treatments, with the furrow method, also, the bed method gave the same results, where, the values were 0.49 and 0.48 L.E/m^3 While, the lowest value was found for F.c-20% treatment. In both methods.

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Table (11): Net income for irrigation water unit (L.E/m3) as affected by different treatments during 2007 and 2008 seasons.

	Net in come for water unit L.E/m3	Net in come for yield L.E/m3	Net in come for water unit L.E/m3	Net in come for yield L.E/m3
Furrow				
F.C	0.54	1901.40	0.60	1996.71
F.C + 10%	0.61	2033.7	0.60	2135.51
F.C - 10%	0.54	1599.0	0.53	1680.50
F.C - 15%	0.47	1365.9	0.46	1434.88
F.C - 20%	0.45	1233.60	0.44	1296.01
Mean	0.54	1626.72	0.53	1708.72
Bed				
F.C	0.48	1752.32	0.48	1842.74
F.C + 10%	0.49	1875.89	0.48	1962.43
F.C - 10%	0.43	1493.86	0.42	1562.19
F.C - 15%	0.34	1285.09	0.37	1344.21
F.C - 20%	0.36	1165.68	0.35	1314.37
Mean	0.42	1514.57	0.42	1605.19

CONCLUSIONS

The aim of the present investigation was to introduce the most suitable furrow cultivate method and all water applied treatments except F.C –15% and F.C-20% treatments to optimize water use efficiency, increase seed cotton yield and net income for irrigation water unit.

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الملخص العربي

إدارة مياه محصول القطن في شمال الدلتا

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أجريتْ التجارب الحقلية في بمحطة بحوث القرضا- محافظة كفر الشيخ أثناء عامي2007- 2008 . .المعاملة الرئيسية كانت طرق الزراعة ، تمت الزراعة بطريقتين الأولي الزراعة علي خطوط ، والثانية الزراعة علي مصاطب. بينما، المعاملة الثانويةِ كمية الماء المضاف كانت كالتالي (الري عند F.C % فقط - الري عند (F.C + 10%) - الري عند (F.C - 10%)- الري عند (F.C - 15%) - الري عند (F.C - 20%))

وأشارت النتائج إلى أن طريقة زراعة علي خطوط أعطت سجلت اعلي كمية مياه مضافة، وإنتاج المحصول بينما طريقة الزراعة علي مصاطب كانت علي العكس.

كما كشفت البيانات أن طرق الماء المضاف كان له تأثير معنوي ، حيث كان كمية الماء (F.C + 10%) من تلقى أكثر كمية المياه ، ومعدل الاستهلاك المائي ، و إنتاجية المحصول ، بينما كان التأثير معنوي بالنسبة للماء المخزن ، وكفاءة الاستهلاك المائي . وكفاءة الاستهلاك المائي الحقلي ، بينما الري عند (F.C - 20%)) كان علي العكس من ذلك. طريقة الزراعة علي مصاطب حققت أعلى قيمة للتوفير المياه (20.21 ٪) .

وتوصي الدراسة باستخدام معادلة Penman-Month equation لحساب الاستهلاك المائي واستخدامها في إنتاج المحصول في شمال الدلتا. التفاعل بين طرق الزراعة وكمية الماء المضاف كان معنوي.حيث أعطت طريقة الزراعة علي خطوط مع كمية مياه مضافة (F.C + 10%) اعلي قيمة لصافي الدخل لمياه الري (جنية /م3).