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ROLE OF SURFACE ALTERNATIVE IRRIGATION IN WATER MANAGEMETN OF CORN

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ABSTRACT

Two field experiments were carried out during summer seasons, of 2002 and 2003, at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt. Three treatments, of furrow length 30, 40 and 50 m, were studied under two surface irrigation methods; traditional and alternative. Data showed that, both water advance time and recession time were increased under traditional furrow irrigation, while opportunity time decreased under alternative irrigation.

The results also revealed that, the applied irrigation water amount was less under alternative method. Values of amount were 2673, 2727 and 2856 m^3/fed. for 30, 40 and 50 m furrow lengths, under alternate irrigation. While these values were 3177, 3282 and 3378, under traditional irrigation, for the studied lengths, respectively.

Water application efficiency (Ea), was higher under the alternative technique. The average values of (Ea), for traditional irrigation method were 60.2, 64.3 and 59%. The corresponding values for alternate irrigation method were 77.5, 86.3 and 80.3% under furrow length of 30, 40 and 50 m respectively. Average values of water use efficiency (WUE), for alternative irrigation method were 1.34, 1.40 and 1.3 kg/m^3 under 30, 40 an 50 m furrow length respectively. Meanwhile, corresponding values under traditional irrigation method were 1.06, 1.07 and 1.00 kg/m^3, respectively.

INTRODUCTION

Agricultural production in Egypt, almost entirely depends on irrigation with water from the Nile river, as rainfall amount is negligible. Approximately, all the national cultivated area of 8 million feddan (3.36 mil.ha) are irrigated. The Egyptian water budget is limited to the country's share of the Nile, which is fixed according to international agreements. We are hopeful, through this work, to improve the surface irrigation, the most common implemented irrigation method, for better efficiency, and water saving, by trying to use alternative technique.

El-Sherbeny *et al.* (1997) showed that, water use efficiency (W.U.E.) increased with alternative irrigation. He also indicated that, water advance and recession time, increased for traditional furrow irrigation and opportunity time decreased under alternate irrigation technique.

In Egypt, irrigated agriculture faces a number of difficult problems, at parents and in furrow as well. One of the major concerns is the generally low efficiency, with which water resources have been used for irrigation. A relatively safe estimation is about 40 percent, or more of water diverted for irrigation, in wasted at the farm level, through either deep percolation or surface runoff. The principal objective of evaluating surface irrigation system, is to identify management practices and system configurations, that can be feasibly and effectively implemented, to improve the irrigation efficiency.

Among the factors used to judge the performance of an irrigation system, or its management, the most common are efficiency and uniformity (Walker, 1989).

New (1971) compared every furrow irrigation, and every-other furrow irrigation, with 91.5 cm spacing and 80.4 m furrow length. His results showed that, every-other furrow irrigation increased yield slightly, when amount of water applied during five irrigations to every-other furrow irrigation, equaled the amount applied during four irrigations to every furrow irrigation.

In Northern Colorado, Ley and Clyma (1981) examined both every furrow irrigation, and alternative furrow irrigation practices. They found that deep percolation losses from these yields, were from 0 to 57% of the water applied. They also added that the amount of over irrigation increased, as the length of furrow increased. Better knowledge of two-dimensional water infiltration, and water-holding capacities for different soil types, would help minimize over irrigation, yet to provide optimum water supplies to the crop.

The present investigation aimed to, improve surface irrigation through, improving water application efficiency, water use efficacy and saving water by implementing the alternate irrigation technique.

MATERIALS AND METHODS

Two field experiments were carried out at, Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, during the two successive seasons of 2002 and 2003. The soil physical characteristics were determined according to Klute (1982), are presented in Table (1).

Table (1): Some physical characteristics of experimental site.

Soil depth	Particle size distribution Sand	Silt	Clay	Texture	Bulk density gm/cm^3	Field capacity w%	PWP w%	Available water w%
0-15	15.18	18.85	55.97	Clay	1.15	47.2	25.3	21.9
15-30	19.90	13.80	66.30	Clay	1.19	40.5	21.8	18.7
30-45	16.59	16.97	67.94	Clay	1.24	39.0	21.1	17.9
45-60	12.65	15.24	67.12	Clay	1.26	38.5	20.8	17.7

The field experiments included two factors:

1. Irrigation method (main treatment):
A. Traditional irrigation (all furrows are irrigated).
B. Alternate irrigation (one by one irrigated furrow).
2. Furrow length (subtreatment):
1.30 cm. 2. 40 cm. 3. 50 m.

It should be stated that, under the traditional method of irrigation events were implemented at each of 15 days during the growing season, while it was at each 10 days for the alternative irrigation.

Maize (*Zea mays* L.), as summer crop was sown in June 29, 2002 and June, 30, 2003, and harvested on November, 5 and 9 for the first and second years respectively. All cultural practices were the same as recommended, for the area except the treatments under study. The experiment was arranged in split plot design with four replicates.

Field measurements:

1. Soil moisture:

Soil moisture was determined gravimetrically, before and after each irrigation, samples were taken from different soil layers of 15 cm thickness, down to 60 cm. depth, from three selected sites, along the furrow of two replicates.

2. Determination of advance and recession of irrigation water:

The irrigation run in each plot, was divided into equal distances, 'stations", each 5 meters.

a. Advance time (t_1):

The total elapsed time required for water, to advance from the upstream of an irrigation pathway, to the distal end of the pathway.

b. Recession time (t_2):

The time elapsed after water application ceases, until the water recedes or disappeared, from the irrigation pathway.

c. Opportunity time (t_0):

Opportunity time for each station was calculated according to $T_0=t_2- t_1$.

3.Applied irrigation water:

The applied irrigation water to each experimental plot was measured, using spile tubes. The effective head of irrigation water above the center of the spile, was measured several times during irrigation time, and the averaged value was about 6 cm. The water in the canal was controlled, to maintain a constant head, by means of fixed sliding gates. The amount of water delivered through a spile was calculated by the equation.

$q = 0.0226\ D^2\ h^{1/2}$

Israelson and Hensen (1962)

as where:

q = Discharge of irrigation water (L/sec).

D = Inside diameter of the spile tube = 10 cm. and

H = Average effective head = 6 cm

Therefore, irrigation water applied for each strip was calculated as follows:

a = qTn

Where:

a = Water volume m^3/strip

T= Total time of irrigation

n= Number of spile = 1 and

q= Discharge m^3/min.

4.Water application efficiency (WAE):

Water application efficiency, defined as the amount of water stored in root zone, that is available for plant use, divided by the average amount of water applied during an irrigation. It was calculated according to Michael (1978) follows:

WAE = WS/WF x 100

Where:

WS = Stored water in the root zone.

WF = Water delivered to each treatment.

5.Water use efficiency (WUE):

Water use efficiency, as a measure, to clarify variations in yield due to irrigation water, was calculated according to Michael (1978) as follows:

$$WUE = \frac{\text{Total yield produced kg/fed}}{\text{Total applied water, m}^3\text{/fed.}}$$

RESULTS AND DISCUSSION

Advance time:

Data in Table (2) indicated, that the relationship between the advance time and distance from water inlet, for traditional and alternative irrigation methods. Data revealed that, the traditional irrigation required more time, to complete the advance phase, than the alternative irrigation method, for strips of 30, 40 and 50 m, the mean seasonal advance time, for the traditional irrigation, was 43 min., 58 min. and 76 min, while the corresponding values, under the alternative irrigation were, 24 min., 36 min: and 52 min, respectively.

Table (2): Advance time (AT) min., recession time (RT) (mm) and opportunity time (OT) min.

Furrow length		Alternative irrigation										Traditional irrigation									
		Stations (m)										Stations (m)									
		5	10	15	20	25	30	35	40	45	50	5	10	15	20	25	30	35	40	45	50
30	AT	4	7	12	16	20	24					7	13	19	28	33	43				
	RT	120	125	128	132	136	140					243	255	266	219	280	286				
	OT	116	118	116	116	116	116					236	242	247	251	247	243				
40	AT	4	8	13	17	22	28	34	36			8	13	18	23	33	42	50	58		
	RT	123	128	130	136	140	142	146	150			245	250	260	266	271	2799	283	290		
	OT	119	120	117	118	118	114	112	114			247	237	242	243	234	237	233	232		
50	AT	5	8	12	18	24	30	36	40	46	52	8	16	22	30	38	45	52	60	68	76
	RT	122	124	130	137	144	147	150	155	162	168	258	261	264	270	278	284	288	296	303	310
	OT	117	116	118	119	120	117	114	115	116	116	250	245	242	240	240	239	236	236	235	234

It is obvious that, advance time decreases for alternating irrigation, this finding may be due to increase of flow rate, as a result of decreasing the number of furrows under such irrigation. These results are in agreement with El-Sherbeny *et al.* (1997). In addition, the results indicated that, the total irrigation time per feddan, was decreased by about 20.5% under alternative irrigation method. The least advance time, was obtained by alternative irrigation method, with 40 m furrow length.

Opportunity time:

Data of opportunity time in minutes, are shown in Table (2). It has been noticed that, the opportunity time increased for traditional furrow irrigation. As the irrigation discharge increased for alternative method, the opportunity time decreased and vice versa, for the traditional method.

Applied irrigation water:

The number of irrigations during the growing season of corn, were six for traditional irrigation, and eight for alternate irrigation, excluding the sowing and El-Mohaya (first after sowing) irrigations. Amount of irrigation water, which added to each treatment, during the season are illustrated in Fig. (1). Data revealed that, alternative irrigation saved about 504, 555 and 522 m^3/fed. for furrow length 30, 40 and 50 m, respectively.

The saving amount of water is in average of about 500 m^3/fed. which equaled nearly 15%. This saving water was occurred under the alternative irrigation, in spite of the high numbers of irrigation events under such irrigation, compared to the traditional surface one (10 and 8, respectively). On the other hand, the difference was found between treatments of furrow length, where the lowest amount of water irrigation was 504 m^3/fed./season for 30 m furrow length, and the highest amount of irrigation water (555) m^3/fed./season, for 50 m furrow length Regarding to increasing furrow length, the amount of water irrigation lightly increased. These results agree with Zongsou *et al.* (1997) who studied the effect of controlled roots-divided alternative irrigation on water use efficiency in maize. They reported, as that in maize irrigation of roots to 60% of field water capacity, saved 356% of irrigation water while biomass yield decreased only by 9%.

Water application efficiency (Ea):

Fig. (2) show that, the alternate irrigation had developed the water application efficiency, compared with traditional method, due to the less applied irrigation water, under this method. An other reason for high Ea under alternate irrigation, is due to its nature of high horizontal water movement from the irrigated furrow to the driest one, which resulted in less one, stored deep percolation and therefore, high soil water which ultimately caused a higher Ea. The overall average of water application efficiency, during the two seasons are 77.5, 86.3 and 80.3% for alternative irrigation under 30, 40 and 50 m furrow length respectively. The corresponding values for traditional irrigation, are 60.2, 64.3 and 59%. The high Ea means that, less deep percolation below the crop root zone and less tail water of furrow (Samani *et al.*, 1985).

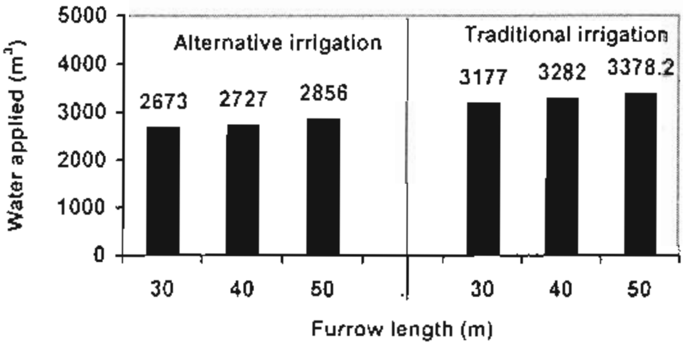

Fig. (1):The overall values of water applied (m^3/fed) under different irrigation treatments for the furrow irrigation of corn during the two seasons.

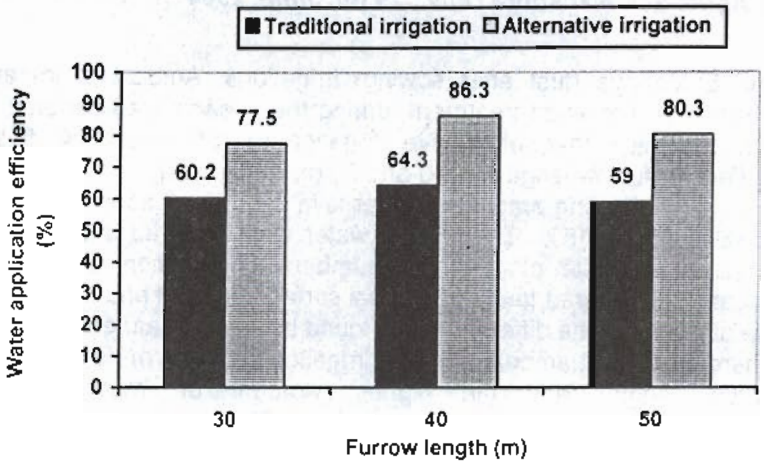

Fig. (2):Effect of furrow length and irrigation method on water application efficiency (Ea) during the two seasons.

Water use efficiency (WUE):

Mean values of WUE as affected by irrigation treatments, are shown in Table (3). Data revealed that alternate irrigation method recorded the highest values of WUE, compared with traditional irrigation method, under all furrow lengths. The overall average of WUE values for alternate irrigation are; 1.34, 1.40 and 1.30 kg/m^3 for 30, 40 and 50 m furrow length respectively. While values under traditional irrigation are, 1.06 , 1.07 and 1.00 kg/m^3 for the stated furrow lengths, respectively.

Table (3): Field water use efficiency of maize in kg/m^3 under different irrigation treatments.

Irrigation method	Furrow length	2002 Yield kg/fed.	2002 WA m^3/fed.	2002 WUE kg/m^3	2003 Yield kg/fed.	2003 WA m^3/fed.	2003 WUE kg/m^3	Average of two season
Traditional irrigation	30	3390.5	3162.0	1.07	3380.0	3182.0	1.06	1.06
	40	3540.5	32620.0	1.08	3560.0	3302.0	1.07	1.07
	50	3420.0	3370.0	1.01	3430.0	3386.0	0.99	1.00
Alternate irrigation	30	3604.3	2663.0	1.35	3590.0	2683.0	1.33	1.34
	40	3830.2	2700.0	1.41	3850.0	2754.0	1.39	1.40
	50	3720.2	2890.0	1.28	3760.0	2822.0	1.33	1.30

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دور الرى السطحى التبادلى فى الادارة الجيدة للمياه لمحصول الذرة

صبحى محمد عيد

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أجريت تجربتان حقليتان بالمزرعة البحثية بمحطة البحوث الزراعية بسخا – محافظة كفرالشيخ خلال موسمي ٢٠٠٢م ، ٢٠٠٣م وكانت المعاملات كالآتى:

المعاملات الرئيسية – طريقة الرى:

أ- الرى التقليدى.

ب- الرى التبادلى.

المعاملات تحت الرئيسية – طول الخط:

١-٣٠م. ٢- ٤٠م. ٣- ٥٠م

والنتائج المتحصل عليها أوضحت أن معدل تقدم المياه وانحسارها كان أزيد فى الرى التقليدى عنه فى الرى التبادلى. كما أوضحت النتائج أيضا أن الرى التبادلى كان أقل من الرى التقليدى فى المياه المضافة حيث كانت ٢٦٧٣م٣/فدان ٢٧٢٧ ، ٢٨٥٦م٣/فدان للرى التبادلى لأطوال الخط ٣٠ ، ٤٠ ، ٥٠م ، بينما كانت ٣١٧٧ ، ٣٢٨٢ ، ٣٣٧٨م٣/فدان للرى التقليدى لنفس أطوال الخط على الترتيب ، كما كانت كفاءة الرى التطبيقية ٦٠,٢% ، ٦٤,٣% ، ٥٩,٠% للرى التقليدى ، بينما كانت ٧٧,٥% ، ٨٦,٣% ، ٨٠,٣% للرى التبادلى لأطوال الخط ٣٠ ، ٤٠ ، ٥٠م على الترتيب. كما كانت الكفاءة الاستعمالية لوحدة المياه ١,٠٦ ، ١,٠٧ ، ١,٠ كجم/م٣ للرى التقليدى بينما كانت ١,٣٤ ، ١,٤ ، ٠,٣ كجم/م٣ لأطوال الخط ٣٠ ، ٤٠ ، ٥٠م على الترتيب.