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Alternative Furrow Irrigation to Rationalize of Irrigation Water for Maize in North Nile Delta Soils

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ABSTRACT

Two field experiments were conducted at the Sakha Agric. Res. Station Farm, Kafr El-Sheikh Gov., North Nile Delta to assess the influence of the alternate furrow irrigation on water conservation and maize productivity during two consecutive summer seasons (2019 and 2020). The location is located at 31^0-07' N Latitude, 30^0-57'E Longitude, with an elevation of around 6 m above mean sea level. A randomized complete block design (RCBD) with four repetitions was used to cultivate maize (Giza 310). Irrigation was applied to furrows in three ways: a) watering every furrows (traditional irrigation) with 15-day interval (EFI_{15}), b) alternate irrigation (watering every other furrows) 10-day interval ($A1/1E_{10}$), and c) alternative irrigation one by one fixed ($A1/1C_{10}$). During the growing season, one furrow is irrigated while the other is left unwater next door. The following is a summary of the findings: 1-The highest maize yield (3945.55 kg fed^{-1}) was obtained with $A1/1E_{10}$ treatment, while the lowest yield (3703.5 kg fed^{-1}) was recorded with the EFI_{15} system. 2-$A1/1E_{10}$ was the best irrigation treatment since it achieved the highest grain yield and saved irrigation water by about 19.8% (663.5 m^3) compared to the traditional irrigation treatment (EFI_{15}). 3- Alternate irrigation ($A1/1E_{10}$) recorded the highest values of oil and protein % in grain and increased the benefit-cost ratio (BCR), and net return (NR) as compared with other irrigation regimes. 4-In addition, $A1/1C_{10}$ treatment achieved the highest water productivity (1.92 kg/m^3).

Keywords: Alternate irrigation, maize, water productivity.

INTRODUCTION

Due to water scarcity and severe drought with an average annual rainfall of less than 250 mm, Egypt is the only country in the world that relies on irrigated agriculture, i.e. rain-fed agriculture is not practiced from an economic standpoint. The annual per capita share of water below the water poverty criterion (1,000 m^3) and is predicted to be less than 500 m^3 in the next several decades because of the existing circumstances of fast population growth and restricted water availability. It is difficult to make any progress in any development area under this situation. The agriculture consumes the majority of the nation's water supply (about 85%). Maize (*Zea mays L.*) is one of the most important grain crops in Egypt and it is the most vital food for individuals living in rural areas. Alternative flow irrigation is being utilized to save irrigation water, improve irrigation efficiency and increase maize yield (Shayannejad and Moharreri, 2009; Nasri et al., 2010; Rafiee and Shakarami, 2010 and Kashiani et al., 2011). The alternative irrigation means that only one side of the plant furrow or half of the root system is watered during the watering event, while the other side receives water at the following irrigation. To improve surface irrigation, increase water usage efficiency and therefore increase water savings, two innovative irrigation systems are utilized. These techniques improve the quality of surface irrigation, save water; increase crop yield and encourage the development of modern agriculture in Egypt. According to Li et al. (2005), alternate and partial root-zone irrigation techniques, as well as fixed partial root-zone irrigation techniques, reduce transpiration, increase photosynthesis and increase water usage efficiency (WUE). As a result, extensive programming must be done to decrease water losses in irrigated agriculture, particularly in surface irrigation systems. On the other hand, improving surface irrigation performance should be cost-effective, practicable, and even desired.

Alternative furrow irrigation may be reparable and less expensive in enhancing surface irrigation, which is reflected in increasing irrigation efficiency, for the old soils of the Nile Delta. The fact that the horizontal flow of soil water in the Nile Delta's clay soils is higher than the vertical downward movement, and vice versa for sandy soils, contributed to the method's increased irrigation efficiency. As a result of this strategy, less irrigation water is needed, and non-irrigated gullies can get their water demands met by horizontal soil water flow from neighboring irrigated furrows. Crabtree et al. (1985) reported that the alternative furrow irrigation (AFI) caused minimal losses in sugar beet production and reduced irrigation water usage by 30 to 50 % when compared to other furrow irrigation systems (EFI). Furthermore, Benjamin et al. (1994) observed that water content variations in clay loam soils with EFI and AFI were less than that in sandy clay soils. Because of the reduced hydraulic conductivity and subsequent longer irrigation period, more water was able to flow sideways under the rim and down the non-irrigated furrow. In other words, because surplus water discharged immediately under the irrigated furrow, AFI in clay soils permitted greater lateral flow and the water content in the soil was more constant than in sandy clay soils. Therefore, according to Nelson and Al-Kaisi (2011), the alternative furrow irrigation method has more economic and environmental benefits than other irrigation systems since less water is used and the net return is larger. The AFI technique is a method for conserving irrigation water, increasing irrigation efficiency and increasing corn yields (Shayannejad and Moharreri, 2009; Nasri et al 2010; Rafiee and Shakarami, 2010 and Kashiani et al., 2011). The use of modern irrigation systems and the scheduling of irrigation frequencies are examples of technological techniques. Domestication of possibly drought-resistant plant species and breeding drought-tolerant agricultural plants are part of the biological approach. Because

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many vegetable crops are shallow-rooted and hence vulnerable to water shortages, irrigation can be critical. Because vegetable cultivation is a high-cost business with a high-value end product, producers must ensure irrigation availability as a kind of drought insurance. Alternative irrigation with proper irrigation intervals, AFI (7-day), according to Awad (2013), can be implemented as a successful strategy for maize production in arid regions where irrigation is overly dependent. It may be established that AFI (7-day), treatment reduces irrigation pressure without reducing grain production.

Therefore, this study intends to enhance the performance of surface irrigation, increase maize production, and improve water productivity through an alternate irrigation approach.

MATERIALS AND METHODS

Site: Two field experiments were conducted during two growing seasons (2019 and 2020) at Sakha Agric. Res. Station Farm, Kafr El-Sheikh Gov.. The soil texture of the experimental site was clayey (46.5% clay, 29.8% silt and 23.7% sand), irrigated by irrigation water with an average EC of 0.46 dSm^{-1}. Some soil physical and chemical properties of the experimental site were presented in Table (1). Maize (*Zea maize* L.), variety Giza 310 was sown on July 1st, 2019 and July 3rd, 2020 and harvested on Oct., 28th, 2019 and Oct., 29th, 2020. All recommended agronomic practices for the study area were applied, except the irrigation methods. The plot area was 90 m^2, the distance between ridges was 70 cm and the seeds were sown at 25 cm spacing within the ridge.

A randomized complete block design (RCBD) with four repetitions was adopted. Irrigation was applied to furrows in three ways: a) conventional irrigation (watering every furrows) at a 15-day interval (EFI_{15}), b) alternate irrigation (watering every other furrow) at a 10-day interval ($A1/1E_{10}$), and c) alternative irrigation one by one fixed ($A1/1C_{10}$), in which one furrow is irrigated while the other is left without irrigation during the growing season. The experimental plot was 52.5 m^2 in size (7.5 m width* 7.0 m length). There were 11 furrows and 10 planting ridges (rows) in each treatment. The experimental plots were divided by Earth banks (1.3 m width and 0.5 m height). Mineral fertilizers at rates of 120 kg N (as $NH_4)_2SO_4$, 20 % N), 30 kg P_2O_5 (as regular superphosphate, 15.5 % P_2O_5) and 48 kg K_2O/fed (as K_2SO, 48 % K_2O) were applied.

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

Soil Depth (cm)	Hydro physical properties				Chemical properties					
	Bulk density Mgm^{-1}	Field capacity (%)	PWP (%)	Available water (%)	pH	EC dSm^{-1}	SAR	Available nutrients (ppm) N	P	K
0-15	1.12	47.2	25.4	21.82	8.15	1.5	2.46	24.0	7.5	210.0
15-30	1.14	40.5	21.9	18.85	8.0	1.57	2.29			
30-45	1.23	39.0	21.2	17.81	8.0	1.65	4.29			
45-60	1.25	38.5	20.8	17.69	7.9	2.78	4.67			

Irrigation water applied (Wa):

The irrigation water was conveyed and measured using a submerged flow aperture with a fixed diameter according to the following equation (Michael, 1978):

$$Q = CA\sqrt{2gh} \quad \text{……………………(1)}$$

Where: Q= Denotes orifice discharge ($cm^3\ sec^{-1}$).

C= Discharge Coefficient (0.61). A = Orifice cross-sectional area (cm^2).

g= Gravitational acceleration, cm/sec^2 (980.7 cm/sec).

H= H is the height of the pressure head above the orifice center

Soil moisture monitoring: Time Domain Reflect meter (TDR) probe Fig (1) was used to measure soil moisture, before each irrigation, two days after irrigation and at 15 day-intervals between irrigation and harvesting in four consultative depths (0-15, 15-30, 30-45 and 45-60 cm).

Fig. 1. Time Domain Reflect meter (TDR).

Consumptive use (CU): The equation of Hansen et al., (1980) was used to compute water consumption:

$$CU = \sum_{i=1}^{i=n}\left(\frac{\theta_2-\theta_1}{100}\times\rho_{bi}\times D_i\right) \text{……………..(2)}$$

Where:

i: Number of soil layers (1-4), Di: Soil layer thickness (15 cm),

ρ_{bi}: Bulk density ($Mg\ m^{-3}$) of the layer, θ_1: Soil moisture before the next irrigation, and θ_2: Soil moisture, 48 hours after irrigation

Water productivity (WP): According to Ali et al. (2007), it was estimated as follows:

$$WP\ (kg/m^3) = GY/CU \text{……………………(3)}$$

Where: GY: grain yield (kg/fed) and

CU = total water consumption during the growing season ($m^3 fed^{-1}$)

Productivity of irrigation water (PIW): Ali et al. (2007) computed PIW as following:

$$PIW\ (kg/m^3) = GY/IWa \text{……………..….(4)}$$

Where: IWa is irrigation water applied (m^3/fed.).

Protein and oil content: Standard A.O.A.C. procedures were used to determine protein and oil percent in grain samples from each plot.

Statistical analyses: The data were statistically examined according to Gomez & Gomez (1984).

Economic evaluation: The economic evaluation profitability was calculated according to the equations outlined by Li *et al.* (2005) as follows:

A- Gross revenue = (grain yield * price) + (straw yield * price),

B- Net return (NR) = total return - total cost, and

C- Benefit-cost ratio BCR = NR /total cost.

Gross revenue has been calculated by multiplying the total yield in kg fed^{-1} and maize market price/ kg (the farm-gate price for maize).

Irrigation management: For each application, the irrigation water was applied until the water reached 90 percent of furrows running length. A stopwatch was used to record the time and estimate the amount of water applied to each plot. The furrows that were irrigated had open ends, but the water did not go beyond the plot's boundary because it flowed along parallel canyons, whereas the other canyons that were not irrigated were closed-ended. The water in the irrigation canal was controlled to maintain a consistent head using the fixed rod in order to give a suitable flow rate during irrigation events. The end of the channel was connected to a drain trench to release excess water.

RESULTS AND DISCUSSION

Irrigation water applied (IWa) as affected by irrigation treatments:

The number of irrigation events and amount of applied water (IWa) for each treatment is shown in Tables (2-3). The data indicated that A1/1E$_{10}$ and A1/1C$_{10}$ treatments were more frequent (9 irrigation events) than EFI$_{15}$ irrigation (7 irrigation events). The mean values of the IWa for the two seasons were 3365, 2701, and 2726 m^{3}fed^{-1} for EFI$_{15}$, A1/1E$_{10}$, and A1/1C$_{10}$ treatments, respectively. Consequently, IWa with the alternate watering one by one fixed A1/1C$_{10}$ and alternative irrigation one by one with exchangeable (A1/1E$_{10}$) treatments received the lowest irrigation water value, while EFI$_{15}$ treatment required the highest amount of irrigation water. These data indicate also that using A1/1E$_{10}$ or A1/1C$_{10}$ irrigation treatments saved irrigation water by about 19.7% (664 m^3) and 18.9% (639 m^3) compared with the conventional irrigation treatment (EFI$_{15}$). The alternative furrow irrigation (AFI) may feed the plant by water in a way that decreases the amount of wetted surface, resulting in reduced deep percolation and evapotranspiration Graterol et al. (1993). Reduced irrigation water due to the alternate-furrow technique was reported by El-Sharkawy et al. (2006), Sepaskhah and Parand (2006), Sepaskhah and Ghasemi (2008), Shayannejad and Moharreri (2009) for potato; Sepaskhah and Hosseini (2008) for wheat; Ibrahim and Emara (2010) for sugar beet; Nelson and Al-Kaisi (2010) for sugar beet.

Table 2. Number of irrigation events and the IWa for each irrigation event/fed under different irrigation treatments.

Irrigation event	Season 2019			Season 2020			Mean of two seasons		
	EFI$_{15}$	1/ 1E$_{10}$	1/ 1F$_{10}$	EFI$_{15}$	1/ 1E$_{10}$	1/ 1F$_{10}$	EFI$_{15}$	1/ 1E$_{10}$	1/ 1F$_{10}$
First	696	719	738	724	741	760	710	730	749
Second	375	371	357	390	382	368	383	377	362
Third	490	481	466	510	495	480	500	488	473
Fourth	411	201	206	427	207	212	419	204	209
Fifth	429	195	206	446	201	212	438	198	209
Sixth	435	183	194	452	188	200	444	186	197
Seventh	463	177	181	482	182	186	472	180	184
Eighth	0	171	175	0	176	180	0	174	178
Ninths	0	164	163	0	169	168	0	166	165
Total	3299	2662	2686	3431	2741	2766	3365	2701.5	2726
Irri. no.	7	9	9	7	9	9	7	9	9

Water consumptive use (CU):

CU value was obviously affected by the irrigation treatments and had the same trend in both seasons (Table 3 and Fig 2). The highest values of CU (1900.9 and 1918.7 m^{3}fed^{-1}) were recorded with EFI$_{15}$ followed by A1/1C$_{10}$ (1790.9 and 1810.8 m^{3}fed^{-1}), while the lowest values (1772.9 and 1810.8 m^{3}fed^{-1}) were obtained under A1/1E$_{10}$ in the 1st and 2nd season, respectively. These mean results of the two seasons indicated that conventional AFI$_{15}$ treatment increased CU values by about 11.7 and 8.4% over that with A1/1E$_{10}$ and A1/1C$_{10}$ treatments, respectively. This effect may be due to the regular irrigation for all furrows with AFI$_{15}$ treatment. As shown in Fig. (1), the traditional EFI$_{15}$ method never experienced water stress because soil moisture content remained above or near field capacity throughout the season, while soil moisture content with A1/1E$_{10}$ and A1/1C$_{10}$ remained near the wilting point, posing serious problems for maize. As a consequence, the plants grown under the alternate irrigation treatments (A1/1E$_{10}$ or A1/1C$_{10}$) are subjected to moisture stress due to un-irrigated furrows. These findings indicated that when available soil moisture in the root zone declined, CU values fell. This result is consistent with those reported by Ibrahim and Emara (2010) and El-Tantawy et al., (2007).

Table 3. Seasonal IWa and CU as affected by irrigation treatments during both seasons.

Irrigation treatment	Irrigation water applied (m^{3}fed^{-1})			Consumptive use (m^{3}fed^{-1})		
	1st season	2nd season	Mean	1st season	2nd season	Mean
EFI$_{15}$	3299	3431	3365	1900.9	1918.7	1909.8
A1/1E$_{10}$	2686	2766	2726	1790.9	1858.9	1824.9
A1/1C$_{10}$	2662	2741	2702	1772.9	1810.8	1791.8

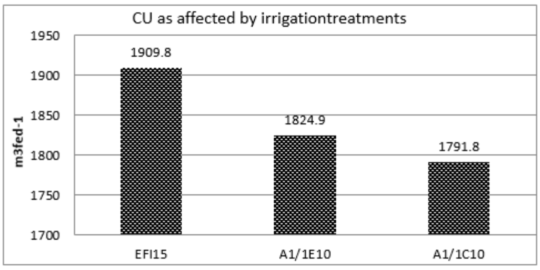

Fig. 2. Water consumptive use as affected by irrigation treatments (mean of both season

Grain yield (GY):

"GY" was influenced significantly at p (<0.05) by the irrigation treatments and had the same trend in both seasons. The highest value of GY was recorded under the water regime treatment of A1/1E$_{10}$ as compared with other two treatments in both seasons. The mean GY for both growing seasons obtained by EFI$_{15}$, A1/1E$_{10}$ and A1/1C$_{10}$ treatments were 3703.5, 3945.5, and 3763.5 kg fed^{-1}, respectively (Fig 3 and Table 5). The increases in GY caused by the A1/1E$_{10}$ method compared to EFI$_{15}$ and A1/1C$_{10}$ methods were 6.5% and 4.8%, respectively. These finding are in agreement with those obtained by Ashoub *et. al., (2000),* who reported that decreasing irrigation interval gave significant increases in seed and straw yields. In addition, Sepaskhah and Khajehabdollahi (2005) and Sepaskhah and Ghasemi (2008) found comparable results for sorghum grain.

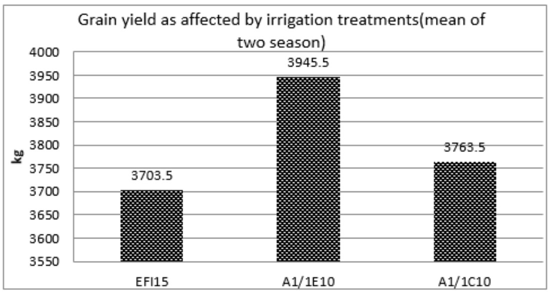

Fig. 3. Grain yield (kg fed^{-1}) as affected by irrigation treatments (mean of two seasons)

Oil contents:

The highest values of oil contents were achieved with A1/1E$_{10}$ treatment compared with the other irrigation regimes in both seasons as shown in Table (4). The mean values of oil contents for the two seasons with EFI$_{15}$, A1/1E$_{10}$, and A1/1C$_{10}$ treatments were 4.504, 4.684, and 4.637%, respectively. So, the oil content with the treatment of A1/1E$_{10}$ was higher than those of EFI$_{15}$ or A1/1C$_{10}$ treatment. It means that oil content was increased by increasing irrigation intervals. The oil content with A1/1E$_{10}$ was superior to EFI$_{15}$ and A1/1C$_{10}$ treatments by about 4.0% and 1.0%, respectively. Similar results were obtained by Khalil *et al.* (2000); Zein *et al.* (2000) and Khalil and Aly (2004).

Protein %:

Regarding the effect of irrigation intervals regimes on protein contents in maize grain, the results in Table (4) proved that A1/1E$_{10}$ treatment gave the highest protein content (8.701%)

followed by $A1/1C_{10}$ (8.395%) and EFI_{15} traditional method (7.681%) as the mean of the two growing seasons. Therefore, the protein content with $A1/1E_{10}$ irrigation treatment was higher than that recorded with EFI_{15} and $A1/1C_{10}$ by 8.1 and 1.7% o, respectively.

Table 4. Average values of oil and protein contents of maize as affected by irrigation treatments during the two growing seasons.

Irri. treatment	1st Season		2nd Season		Mean of the two seasons	
	Oil %	Protein %	Oil %	Protein %	Oil%	Protein%
EFI_{15}	4.467	7.53	4.542	7.831	4.504	7.681
$A1/1E_{10}$	4.643	8.53	4.725	8.871	4.684	8.701
$A1/1C_{10}$	4.597	8.23	4.677	8.559	4.637	8.395

Water productivity (WP):

When it came to the influence of water regimes on WP in maize, the data in Table (5) demonstrated that the $A1/1E_{10}$ treatment had the greatest WP value when compared to the other treatments. The EFI_{15}, ($A1/1C_{10}$), and ($A1/1EX_{10}$) irrigation techniques produced mean WP values of 1.94, 2.16, and 2.10 kg m^{-3}, respectively, during two seasons. WP values increased by 11.3 % and 2.9 %, respectively, when the $A1/1E_{10}$ regime was applied to the (EFI_{15}) and ($A1/1C_{10}$) treatments. Similar findings were reported by Abdel-Maksoud et al. (2002) for wheat and Tavakoli and Oweis (2004) and Webber et al. (2006) for common green game bean.

Productivity of irrigation water (PIW):

As shown in Table (5), PIW values showed that the highest value of PIW was achieved with $A1/1E_{10}$ (1.46 kg/m^3) as compared with the irrigation treatments of EFI_{15} (1.1 kg/m^3) and $A1/1C_{10}$ (1.38 kg/m^3). So, the increase in PIW due to the ($A1/1E_{10}$) method over that with EFI_{15} and $A1/1C_{10}$ were 32.7 % and 8.8%, respectively.

Benefit-cost ratio (BCR):

The highest BCR (1.54 and 1.59) occurred with $A1/1E_{10}$ and the lowest (1.42 and 1.45) occurred with EFI_{15} during the 1st and 2nd seasons, respectively. The mean BCR (over the two seasons) due to EFI_{15}, $A1/1E_{10}$, and $A1/1C_{10}$ were 1.49, 1.56, and 1.45, respectively (Table 6). The increases due to $A1/1E_{10}$ to the EFI_{15} and $A1/1C_{10}$ regimes were 4.6% and 7.6%. This finding is agreed to the results obtained by Igbadun et al. (2006); Nelson and Al-Kaisi (2011).

Table 5. Grain yield kg fed^{-1}, IWa m^3fed^{-1}, CU m^3fed^{-1}, PW kg m^{-3} and PIW kg m^{-3}. as affected by irrigation treatments during the two growing seasons.

Irrig. Treatment	Grain yield (kg fed^{-1})	IWa (m^3fed^{-1})	Cu (m^3fed^{-1})	WP kg m^{-3}	PIW kg m^{-3}
		1ST Season			
EFI_{15}	3667 b	3299 a	1901a	1.93 b	1.11 b
$A1/1E_{10}$	3906 a	2662 b	1791 b	2.18 a	1.47 a
$A1/1C_{10}$	3726 b	2686 b	1773 c	2.10 a	1.39 b
$LSD_{0.05}$	102.6	78.7	0.096	0.057	0.036
		2nd Season			
EFI_{15}	3740 c	3431 a	1919 a	1.95 b	1.09 c
$A1/1E_{10}$	3985 a	2741 b	1859 b	2.14 a	1.45 a
$A1/1C_{10}$	3801 b	2766 b	1811 b	2.10 a	1.37 b
$LSD_{0.05}$	108.4	84.296	52.612	0.058	0.037
		Mean of two seasons			
EFI_{15}	3703.5	3365	1910	1.94	1.10
$A1/1E_{10}$	3945.5	2701.5	1825	2.16	1.46
$A1/1C_{10}$	3763.5	2726.0	1792	2.10	1.38

Net return (NR):

Regarding the effect of irrigation treatments during the two growing seasons on "NR", the data shown in Table (6) indicated that the highest "NR" values (9233.4 and 9541.5 LE fed^{-1}) were achieved with $A1/1E_{10}$, while the lowest values (8501.3 and 8786 LE fed^{-1}) were occurred with EFI_{15} during the 1st and 2nd seasons, respectively. The mean NR (over the two seasons) due to EFI_{15}, $A1/1E_{10}$, and $A1/1C_{10}$ were 8643.65, 9387.45 and 8677.65 LE fed^{-1}, respectively. The increases in NR due to $A1/1E_{10}$ over the EFI_{15} and $A1/1C_{10}$ regimes were 8.6% and 8.2%. These trends were in somewhat with those observed by Ghasemi and Sepaskhah (2003) who found that benefit-cost ratio (BCR) for the alternative furrow irrigation (AFI) with 10-day intervals was similar to BCR for ordinary furrow irrigation with 10-day intervals, and these were even greater than other irrigation methods in the Bajgah area. Furthermore, they suggested that with a higher water price, farmers should raise the efficiency of their irrigation application to minimize economic losses.

Table 6. Grain yield, applied water, cost of applied water LE, operating costs LE, total costs LE, gross revenue LE, NR, and BCR as affected by irrigation treatments.

Irrig. Treat.	Grain yield kg fed^{-1}	Applied Water m^3	Cost of applied water LE	Operating Costs LE	Total Costs(LE)	Gross Revenue LE	NR	BCR
				1ST Season				
EFI_{15}	3667	3299	1600	10200	5800	14301.3	8501.3	1.47
$A1/1E_{10}$	3906	2662	1800	10200	6000	15233.4	9233.4	1.54
$A1/1C_{10}$	3726	2686	1800	10200	6000	14531.4	8531.4	1.42
				2nd Season				
EFI_{15}	3740	3431	1600	10200	5800	14586	8786	1.51
$A1/1E_{10}$	3985	2741	1800	10200	6000	15541.5	9541.5	1.59
$A1/1C_{10}$	3801	2766	1800	10200	6000	14823.9	8823.9	1.47
				Mean of two seasons				
EFI_{15}	3703.5	1910	1600	10200	5800	14443.65	8643.65	1.49
$A1/1E_{10}$	3945.5	1825	1800	10200	6000	15387.45	9387.45	1.56
$A1/1C_{10}$	3763.5	1792	1800	10200	6000	14677.65	8677.65	1.45

CONCLUSION

In arid regions where maize production is heavily reliant on irrigation, alternating irrigation with proper irrigation intervals (10 days) can be a successful strategy. It may be inferred that the $A1/1E_{10}$ irrigation strategy reduces soil moisture stress with little effect on grain output. $A1/1E_{10}$ irrigation has also improved the benefit-cost ratio (BCR), net return (NR) and irrigation water savings. The value of water applied to crop with each irrigation method determines whether the $A1/1E_{10}$ method or other irrigation methods are preferred. Therefore, it is recommended that if the cost of available water is not high and the delivery of excess water to the field does not require any additional expenses, then alternative furrows irrigation with 10-day intervals will be the best option mainly under the conditions of this study.

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الري السطحي التبادلي لترشيد مياه ري الذرة في التربة بشمال دلتا النيل

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اجريت تجربتان حقليتان بمحطة البحوث الزراعية بسخا بمحافظة كفر الشيخ لتقييم تأثير الري التبادلي على ترشيد مياه الرى وإنتاجية الذرة خلال موسمين صيفيين متتاليين (2019 و 2020). كان موقع التجربة عند خط طول N '07-31^0 وخط عرض E '57-30^0 , مع ارتفاع حوالي 6 أمتار فوق متوسط مستوى سطح البحر. تم زراعة الذرة (جيزة 310) في تصميم بلوك كامل العشوائية بأربعة مكررات. تم اضافة مياة الري فى خلال الخطوط باستخدام ثلاث طرق: 1-الري التقليدي (ري كل الخطوط) في فترة 15 يوما (EFI_{15}), 2- الري التبادلي (ري خط وخط) كل 10 أيام مع تبادل الخطوط ($A1 / 1E_{10}$)، 3- الري التبادلي (ري خط وخط مع ثبات الخطوط المروية أي الخط المروى يروى طول موسم النمو (A1 / 1C10). ويمكن تلخيص النتائج التي تم الحصول عليها على النحو التالي: 1. تم الحصول على أعلى محصول ذرة (3945.55 كجم فدان$^{-1}$) بمعاملة A1/1E10 بينما كان أقل محصول (3703.5 كجم فدان$^{-1}$) مع نظام (EFI_{15}). 2. كذلك كانت معاملة الري ($A1/1E_{10}$) أفضل معاملة حيث وفرت مياه الري بحوالي 19.8٪ (663.5 م^3) وزادت محصول حبوب الذرة مقارنة بمعاملة الري التقليدية (EFI_{15}). 3. كذلك حققت معاملة الرى ($A1/1E_{10}$) أعلى نسبة مئوية للزيت والبروتين بحبوب الذرة مقارنة بأنظمة الري الأخرى. 4. أيضا حققت المعاملة ($A1/1E_{10}$) اعلى صافى دخل (NR) واعلى عائد على التكلفة (BCR) 5. تم تحقيق أعلى إنتاجية للمياه (1.92 كجم / م3) باستخدام معاملة ($A1/1C_{10}$) .