ALTERNATIVE IRRIGATION AND PRODUCTIVITY OF SWEET SORGHUM

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ABSTRACT

Two experiments were conducted during the summer seasons of 2002 and 2003 at Sakha Agricultural Research Station (Middle North Nile Delta) to improve surface irrigation performance, through using the other-row technique. The consequent effects of applying such method on total water applied, water distribution efficiency, yield and field water use efficiency, for sweet sorghum were considered. Irrigation treatments were: traditional furrow irrigation (EFI, trt. A), 1/1 irrigation fixed (AFI, trt. B) and 1/1 irrigation exchange (AFI, trt. C), obtained results showed that:

- The highest value of stripped stalk yield (20.40 ton/fed. i.e. 48.96 ton/ha) was obtained under the traditional or every furrow irrigation i.e. treatment A. While the highest yield of juice and syrup were resulted from AFI (1/1 exchange) with mean values of 8.98 and 2.25 ton/fed. i.e. 21.55 and 5.4 ton/ha, respectively. Whereas the extraction percentage of juice and syrup were the highest with values 46.7 and 11.7% under AFI (1/1 exchange). On the other hand, the highest T.S.S. of 11% was resulted from the traditional irrigation.
- Average seasonal water applied to sweet sorghum, was ranged between 2415.7 m^3/fed. (57.5 cm) for treatment B to 3186.6 m^3/fed. (75.9 cm) for treatment A. This amount included sowing irrigation, which equalized an average of 399.0 m^3/fed. or (9.5 cm).
- Average crop consumptive use (C.U.), could be arranged in descending order as: 3099.6 (73.8 cm) > 2530.3 (60.3 cm) > 2324.0 (55.3 cm) m^3/fed. for treatments A, C and B respectively. The corresponding rate of consumptive use, could be arranged as: 0.55, 0.45 and 0.41 cm/day for the same treatments, respectively.

- The highest average of water utilization efficiency (W.UT.E) for stripped stalk yield 7.33 kg/m^3, was resulted from 1/1 exchange (trt. C). On the other hand, the lowest value of about 6.40 kg/m^3 resulted from the every or traditional irrigation (trt. A). The same direction was recorded regarding W.UT.E. in relation to syrup yield. The corresponding average value were: 0.86 and 0.61 kg/m^3, respectively. Similar trend was obtained regarding the alternative irrigation treatments, on the water use efficiency (W.U.E) for both stripped stalk and syrup yields.
- No clear direction was obtained under different types of furrow irrigation system. The overall average of Ecu is about 97.0%.

INTRODUCTION

Furrow irrigation is commonly used in arid, semi-arid and subhumid regions, to apply irrigation water to row crops. Deep percolation losses of water generally occur under furrow irrigation. The percolation water is resulted from the over watering, that accompanied with the surface irrigation, in general owing to replenish the root zone of the soil, farthest from the water inlet. Alternative furrow or one by one irrigation, offers a suitable opportunity for reducing the volume of applied irrigation water. The reduced volume of irrigation water may not decrease the crop yield appreciably, and thus could be increase irrigation water use efficiency. Efficient use of irrigation water is important in Egypt, as well as, in north Nile Delta region. The shortage of irrigation water in north Nile Delta region is the main sign of this area, because it considered as the tail end of the River Nile to the Mediterranean sea.

Deep water percolation, with its associated and chemical leaching is a recognized environmental problem with furrow irrigation. Alternative-furrow irrigation (AFI) was hypothesized as a method to increase water use efficiency, and decrease chemical leaching compared with every furrow irrigation (EFI), or say the traditional furrow irrigation.

In this regard, Fischbach and Mulliner (1974) did not observe lower yields with AFI than with EFI, even though irrigation water application was 30% less with AFI. Ley and Clyma (1981) examined both EFI and AFI practices in the fields, and stated that, deep percolation losses from the fields were, from 0 to 57% of the water applied. 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 provide optimum water supplies to the crop.

Moreover, traditional furrow irrigation i.e. EFI, which accompanied with excess water applied that cause a raising of water table in such area of north Nile Delta region. The seasonal average of water table in such area is bout 70 cm. So by applying over-irrigation harsh, effects could be attained, in addition to raising water table, reducing the aeration percentage, leaching of plant nutrients and high excess weight for the drainage network. The above mentioned factors cause negative effects on root growth, and ultimately resulted in decreasing crop production with low yield quality.

Therefore, the objective of this study is a trail to improve surface irrigation performance, through using the other-row technique. The consequent effects of applying such method on total water applied, water distribution efficiency, yield and field water use efficiency for sweet sorghum were considered.

MATERIALS AND METHODS

The current study was carried out during the two growing seasons of 2002 and 2003, at the Crops Water Requirement Research Field, Sakha Agriculture Research Station, Kafr El-Sheikh Governorate. This site locates at 31°-07' N latitude and 30°-57' E longitude, with an elevation of about 6 meters above mean sea level. The location represents the conditions and circumstances of north Nile Delta region. Soil of the experimental field is clayey in texture (Table 1).

Table (1): Soil particle distribution and soil water constants for the experimental field.

Soil depth (cm)	Soil particle distribution			Textural class	F.C. %	D_b kg/m^3	W.P %	A.W. %	Ec mmhos elc at 25°C	pH
	Sand %	Silt %	Clay %							
0-15	13.75	33.05	53.20	Clay	47.91	1.05	26.12	21.79	3.00	7.80
15-30	20.75	34.50	44.75	Clay	42.65	1.38	21.85	20.80	2.10	7.96
30-45	20.30	40.74	38.96	Clay loam	40.36	1.40	21.03	19.33	2.89	7.91
45-60	21.90	41.13	36.97	Clay loam	38.08	1.43	20.10	17.98	3.00	7.92

F.C. = Field capacity D_b = Bulk density
W.P = Wilting point   A.W. = Available water

Sweet sorghum, variety Brands was sown on June 11 and 16 in 2002 and 2003, respectively. All cultural practices, such as fertilization and weed control, were as the same as implemented in the area, except for the furrow irrigation technique treatments. The studied irrigation treatments were as follows:

- Treatment A (control = EFI):
  Traditional irrigation.
- Treatment B (AFI-one by one fixed = 1/1 f.):
  One furrow irrigated and the other one un-irrigated during the whole season.
- Treatment C (AFI-one by one exchange = 1/1 ex.): one furrow irrigated alternatively with the un-irrigated one during the growing seasons.

It should be noticed that the stated treatments were applied after the first common three irrigations; namely: sowing, first (El-Mohaia) and the second one at which fertilizer doses were applied.

The irrigation intervals were the same for all treatments i.e. all treatments are watering at the same days. The only variable are treatments of irrigation water as stated before.

The three mentioned treatments were ranked in a complete randomized block design with four replicates.

The experimental basic strip unit included 4 ridges 60 cm apart and 70 m long, occupying an area of 168 m^3 i.e. 1/25 fed.

Data collections:

1. Irrigation parameters:

a. Irrigation control:

Application of irrigation water was controlled by an upstream fixed measuring weir with discharge rate of 0.01654 m^3/sec.

b. Seasonal water applied (Wa):

Seasonal water applied (Wa) was calculated as described by Giriapa (1983):

$$Wa = IW + ER + S$$

Where:

IW = Irrigation water

ER = Effective rainfall

S = Amount of soil moisture contribution to consumptive use from the soil profile either as stored moisture in root zone and/or that contributed from the shallow ground water table.

c. Crop consumptive use (ETc):

The crop evapotranspiration (ETc), or so called crop consumptive use (C.U), depending upon soil moisture depletion in root zone i.e. direct method of C.U., was calculated according to Doorenbos *et al.* (1979) as follows:

$$C.U. = \frac{F.C. - \theta}{100} * D_b * D$$

Where:

C.U. = Consumptive use (cm).
F.C. = Field capacity for each layer (%).
θ = Soil moisture content on the weight basis before irrigation (%).
D_b = Bulk density of the specified soil layer (kg/m^3).
D = Depth of each soil layer = 15 cm.

d. Crop-water efficiencies:

- **Water utilization efficiency (W.UT.E):**

It was calculated according to Doorenbos and Pruitt (1975) as:

$$\mathbf{W.UT.E.} = \frac{\mathbf{Yield}}{\mathbf{Water\ applied}}$$

For both stalk and sugar yields.

- **Water use efficiency (W.U.E):**

Water use efficiency was calculated according to Doorenbos and Pruitt (1975) as:

$$W.U.E. = \frac{\text{Yield}}{\text{Crop evapotranspiration}}$$

For both stalk and sugar yields.

- **Consumptive use efficiency (Ecu):**

It was calculated according to Doorenbos and Pruitt (1975):

$$Ecu = \frac{ETc}{Wa} * 100$$

Where:

Ecu = Consumptive use efficiency
ETc = Total evapotranspiration $\simeq$ consumptive use
Wa = Water applied to the field.

2. Yield and its quality:

Two inner furrows of each strip were harvested, collected together and cleaned. Stalks were separately weighed in kg, then it was converted to estimate:

- Stripped stalk yield ton/fed.
- Juice yield ton/fed.
- Juice extraction % = Juice yield ton/fed. x 100/stripped stalk yield ton/fed.
- Syrup yield ton/fed.
  Determined by using direct flame to boiling point and indirect using a hot plate (to T.S.S. about 73%, after cooling reached ~ 75%).
- Syrup extraction % = Syrup yield ton/fed./stripped stalk yield ton/fed.
- Total soluble solids % was determined using Abb refractometer standardized at 25°C as described in Plews (1970).
- Sucrose content in juice % was determined according to A.O.A.C. (1990).

All data were subjected to statistical analysis according to the procedures outlined by Snedecor and Cochran (1967) and treatment means were compared by Duncan's multiple range test (Duncan, 1955). Combined analysis for the obtained data were statistically analysed using the procedures outlined of SAS Computer Package Programme (1992).

RESULTS AND DISCUSSION

1. Seasonal water applied (Wa):

The water applied for the control traditional treatment i.e. EFI represented in the highest value of 3186.6 m^3/fed. or 75.87 cm, as shown in Table 2. While under the alternative furrow irrigation technique AFI treatments, applied water was about 75.8 and 81.8% for the fixed and exchangeable ones (trt. B and trt. C), respectively in comparison with the traditional irrigation (trt. A).

Such technique of AFI might be considered as a principal way towards on-farm effective irrigation management . Saving amount of irrigation water could be achieved by implement such technique of surface irrigation, with an average value of 770.9 and 580.4 m^3/fed. in case of 1/1 fixed (trt. B) and 1/1 exchange (trt. C), respectively. Perniola *et al.* (1992) stated that, the best results were obtained with an irrigation volume of 3700 to 5900 m^3/ha, with yields of 71.4 ton fresh stalks/ha and 12.1 tons, sugar/ha. Sweet sorghum, as a summer crop, which facing as other summer ones from the water shortage in the area. This water shortage is resulted form the vast rice cultivated area in the region, North Nile Delta is considered as the core area in rice production in Egypt. Water needs for rice is exceeded by an amount of water in average with at least 2000 m^3/fed. So, due to the extra rice cultivated area, which consume the more portion of the available irrigation water, and ultimately introduce less water to irrigate other summer crops. Consequently, by introducing the AFI method to irrigate the furrow crops, a remarkable volume of irrigation water could be gained. Here, it is cleared that, by implement the 1/1 fixed AFI, highest saving water than that obtained under 1/1 exchange. The corresponding percentages are about 25 and 12%, respectively. The stated values are in comparison with the traditional furrow irrigation.

Watering of other furrow irrigated summer crops, such as cotton and maize, is more or less similar to that of sweet sorghum. In this regard, the average saving water was about 670.0 or at least 650.0 m^3/fed. by implement the AFI method. The cultivated area of the stated crops in north Nile Delta of the clayey soils which, it is more convenient to apply AFI method due to the lateral movement of soil moisture, are 151,766 and 41,770 feddan, respectively.

The total cultivated furrow summer crops in north Nile Delta is in average of 193,536 feddan. Therefore, the proposed saving water for such saved irrigating such crops by AFI technique, could reach about 125,798,400 m^3. saved water is enough to cultivate new lands and/or irrigate other crops.

Table (2): Seasonal water applied (Wa, m^3/fed.), seasonal consumptive use (ETc, m^3/fed.) and its rate (ETc rate cm/day) as affected by irrigation regime in the two seasons, 2002 and 2003.

Treatments	Characters								
	Wa m^3/fed.			ETc m^3/fed.			ETc rate cm/day.		
	1st	2nd	Av.	1st	2nd	Av.	1st	2nd	Av.
A (control):									
Traditional irrigation	3109.7	3263.4	3186.6	3024.0	3175.2	3099.6	0.53	0.56	0.55
B (1/1 fixed):									
Irrigated furrow	2734.2	2893.8	2814.0	2638.0	2805.2	2721.6	0.47	0.50	0.48
Un-irrigated furrow	1940.8*	2093.7	2017.3	1843.8	2008.9	1926.4	0.33	0.35	0.34
Average			2415.7			2324.0			0.41
C (1/1 exchange):									
First furrow	2592.2	2757.3	2674.8	2521.3	2669.9	2595.6	0.45	0.47	0.46
Second furrow	2449.9	2625.0	2537.5	2389.8	2540.2	2465.0	0.42	0.45	0.44
Average			2606.2			2530.3			0.45

*This value is the summation of the first three irrigations of sowing, first and second ones.

2. **Crop consumptive use (ETc):**

Seasonal consumptive use for sweet sorghum, in cm, was determined for the treatments as listed in Table (2).

From data obtained, it is shown that, the highest value 3099.6 m^3/fed. or 73.8 cm was resulted from the control (trt. A). While the second order of values 2530.3 m^3/fed. or 60.25 cm. was obtained under trt. C (1/1 ex.). Whereas, the lowest value 2324.0 m^3/fed. or 55.33 cm was resulted under 1/1 f. (trt. B). Therefore, in the same direction, average values of seasonal consumptive use rate, for the same treatments are: 0.55, 0.41 and 0.45 cm/day for A, B and C, respectively. Shin (1986) stated that the average ET varied from 3.5 to 4.7 mm/day. The obtained findings of seasonal C.U. are in the same order with applied irrigation water. Meaningfully, the traditional furrow irrigation that associated with high water applied in comparison with AFI treatments, is having also high C.U. due to the availability of soil moisture status. In other words, the more water applied, is the more consumed water by growing crops.

3. **Crop-water efficiencies:**

a. **Water utilization efficiency (W.UT.E.):**

This parameter is an indicator to find out the yield per unit of applied water (Wa).

As presented in Table (3), it can be noticed that there is an adverse effect of the amount of applied water on W.UT.E. The average values of W.UT.E. regarding stripped stalk yield in the two seasons are, 6.40, 6.99 and 7.33 kg/m^3 for treatments A, B and C, respectively. Meaning that, treatment C (1/1 ex.) was accompanied with the highest average of W.UT.E. 7.33 kg stripped stalk/m^3. While the lowest value 6.40 kg stripped stalk/m^3 as W.UT.E. obtained from treatment A (traditional irrigation). Treatment B had average value of W.UT.E. in between. This finding could be explained as this trait of W.UT.E. is affected by both the yield, as nominator and the water applied as dominator. So, by increasing the dominator i.e. the amount of water applied, it decreased the efficiency of water utilized and vise versa.

The same trend was obtained regarding syrup yield (Table 3). In other words, treatment C resulted in the highest value 0.86 kg syrup/m^3. Whereas, the lowest value 0.61 kg syrup/m^3 was recorded from treatment A.

Table (3): Water utilization efficiency (W.UT.E., kg/m^3), water use efficiency (W.U.E., kg/m^3) and consumptive use efficiency (Ecu, %) as affected by irrigation regime in the two seasons 2002 and 2003.

Treatments	Characters														
	W.UT.E (kg/m^3)						W.U.E. (kg/m^3)						Ecu %		
	Stripped stalk yield			Syrup yield			Stripped stalk yield			Syrup yield					
	1st	2nd	Av.	1st	2nd	Av.	1st	2nd	Av.	1st	2nd	Av.	1st	2nd	Av.
A (control):															
Traditional irrigation	6.33	6.47	6.40	0.57	0.64	0.61	6.51	6.65	6.58	0.59	0.66	0.63	97.24	97.30	97.27
B (1/1 fixed):															
Irrigated furrow	5.81	5.90	5.86	0.64	0.70	0.67	6.02	6.09	6.06	0.66	0.72	0.69	96.48	96.94	96.71
Un-irrigated furrow	8.12	8.12	8.12	0.67	0.91	0.79	8.54	8.46	8.50	0.71	0.95	0.83	95.00	95.95	95.48
Average			6.99			0.73			7.28			0.76			96.10
C (1/1 exchange):															
First furrow	7.57	7.53	7.55	0.91	1.07	0.99	7.78	7.77	7.78	0.93	1.11	1.02	97.27	96.83	97.06
Second furrow	7.05	7.17	7.11	0.71	0.74	0.73	7.22	7.41	7.32	0.72	0.77	0.75	97.55	96.77	97.16
Average			7.33			0.86			7.55			0.89			97.11

So, the stripped stalk yield per unit applied water obtained form AFI is in average of 7.2 kg/m^3 and 0.80 kg syrup/m^3 of applied water. The corresponding values obtained from the traditional furrow irrigation is 6.4 and 0.61 kg/m^3 from stripped stalk and syrup, respectively. Similar findings were obtained by Shin (1989), who menthat sweet sorghum required about 275 to 891 kg of water to produced 1 kg of the sweet sorghum sugar yield.

b. Water use efficiency (W.U.E.):

Water use efficiency, is an indicator to determine the capability of the plants to use the consumed water, in producing the marketable yield.

Obtained results of W.U.E., which are listed in Table 3, showed reversible relationship with the water consumed by the plants. Average values of 6.58, 7.28 and 7.55 kg stripped stalk/m^3 obtained from treatment A (control or traditional irrigation), B (1/1 f.) and C (1/1 ex.), respectively. The same direction was resulted in relation to syrup yield. Values of 0.63, 0.76 and 0.89 kg syrup/m^3 obtained from A, B and C treatments, respectively. This trait of W.U.E. is affected by both the yield as nominator, and the water consumed as dominator, by increasing the dominator, the efficiency of water consumed was decreased .

So, the stripped stalk yield per unit consumed water, obtained from AFI is in average of 7.4 kg/m^3 and 0.83 kg syrup/m^3 of consumed water. The corresponding values obtained from the traditional furrow irrigation is, 6.6 and 0.63 kg/m^3 for stripped stalk and syrup, respectively.

c. Consumptive use efficiency (Ecu):

Consumptive use efficiency (Ecu) reflects the capability of plants to utilize the soil moisture stored in the effective root zone.

Data in Table (3) showed that, no clear direction was obtained under different types of furrow irrigation systems. The overall average of Ecu is about 97.0%. Meaningful that about only 3% from the applied water was most used by the growing plants. Doorenbos *et al.* (1979) stated that, the consumptive use efficiency increased with the increase of consumptive use and with the decrease in water applied.

4. Yield (ton/fed.):

a. Stripped stalk yield (ton/fed.):

Highly significant effect of alternative irrigation treatments on stripped stalk yield which was resulted over both the two seasons. As shown in Table (4), treatment A (traditional irrigation) was recorded the highest value 20.40 ton/fed. but treatment B (1/1 f.) was resulted in the lowest value 16.43 ton/fed. No significant differences was found between the values of stripped stalk yield, under either 1/1 exchange (trt. C) or the traditional irrigation (trt. A). The overall mean values of stripped stalk yield were 20.40, 16.43 and 19.12 ton/fed. for treatments A, B and C, respectively.

So, by using 1/1 AFI, exchange (trt. C) 93.7%, the maximum yield (100% for trt. A) could be resulted. While 80.5% of the percentage yield was obtained from 1/1 fixed technique. Meaning that the reduction in stripped stalk yield was about 6.3 and 19.5% for implementing 1/1 AFI, exchange and 1/1 fixed. This finding could be attributed to that under the 1/1 fixed irrigation, the un-irrigated furrow depends mainly, for its water needs, on the lateral movement from the beside irrigation furrow during the whole season. This might be due to un-sufficient soil water to be extracted by the growing sweet sorghum plants. Fishbak and Mulliner (1974) had got similar results.

Table (4): Stalk, juice and syrup yields (ton/fed.) as affected by irrigation regime in the two seasons, 2002 and 2003.

Treatments	Characters								
	Stripped stalk yield ton/fed.			Juice yield ton/fed.			Syrup yield ton/fed.		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
A (control):									
Traditional irrigation	19.69	21.11	20.40 a	6.85	8.61	7.73b	1.78	2.09	1.93b
F-test			**			**			**
B (1/1 fixed):									
Irrigated furrow	15.88	17.08	16.48	6.81	8.21	7.51	1.75	2.01	1.88
Un-irrigated furrow	15.75	17.00	16.38	5.50	7.30	6.40	1.30	1.90	1.60
Average			16.43b			6.96c			1.74c
F-test			**			**			**
C (1/1 exchange):									
First furrow	19.61	20.75	20.18	9.60	11.60	10.60	2.35	2.95	2.65
Second furrow	17.26	18.83	18.05	6.45	8.26	7.36	1.73	1.95	1.84
Average			19.12a			8.98a			2.25a
F-test			**			**			**

b. **Juice and syrup yields (ton/fed.):**

As presented in Table (4) a highly significant effect was noticed from the alternative furrow irrigation (AFI) on juice and syrup yields over both seasons of study. The highest mean yield of juice 8.98 ton/fed. was resulted from 1/1 ex. (trt. C). While, under the AFI, 1/1 f. (trt B), the lowest mean yield of juice 6.96 ton/fed. was obtained over both seasons. Whereas, the yield under traditional irrigation was in between. These results clearly showed that, the excess applied water under the traditional irrigation (trt. A) produced only higher stripped stalk yield. This finding could be attributed to the higher sucrose content that associated with the medium soil moist status which resulted from the technique of 1/1 ex. (trt. C) more than the traditional irrigation (trt. A) or the most severe stress of about half of irrigated were 1/1 f. (trt. B) which ultimately produced higher juice yield.

The same trend of juice results were obtained with the syrup yield. The values were 2.25 and 1.74 ton/fed. for the same mentioned treatments, respectively. Similar finding was reported by Fishbak and Mulliner (1974).

c. **Juice and syrup extraction percentage:**

Juice and syrup extraction percentage are highly significant affected by varying irrigation techniques Table (5). The highest extraction percentage values 46.7 and 11.7% were obtained from the technique of 1/1 ex. (trt. C) for juice and syrup, respectively. While the lowest value 37.9 and 9.5% were obtained from trt. A (traditional irrigation). whereas, values of treatment B (1/1 f.) were in between. These results indicated that increasing applied irrigation water caused a marked reduction in juice and syrup extraction percentage. In other words, juice and syrup percentage have the opposite trend with the amount of applied water. These results stand in the same line with those recorded by El-Koliey *et al.* (1999).

Table (5): Juice and syrup extraction, sucrose and T.S.S. % as affected by irrigation regime in the two seasons, 2002 and 2003.

Treatments	Characters											
	Juice extraction %			Syrup extraction %			T.S.S. %			Sucrose %		
	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.	1st	2nd	Comb.
A (control):												
Traditional irrigation	36.9	38.9	37.9c	8.6	10.4	9.5	10.0	12.0	11.0a	6.17	6.34	6.26
F-test			**			**			**			**
B (1/1 fixed):												
Irrigated furrow	43.8	47.4	45.6	10.5	12.3	11.4	8.0	10.0	9.0	6.74	6.91	6.83
Un-irrigated furrow	38.2	40.0	39.1.	8.7	10.9	9.8	7.0	9.0	8.0	8.92	9.05	8.99
Average			42.4b			10.6b			8.5b			7.91b
F-test			**			**			**			**
C (1/1 exchange):												
First furrow	50.7	54.3	52.5	12.2	14.0	13.1	7.8	9.6	8.7	6.64	6.77	6.71
Second furrow	38.9	42.7	40.8	9.3	11.1	10.2	7.7	9.7	8.7	10.44	10.78	10.61
Average			46.7a			11.7a			8.7b			8.66a
F-test			**			**			**			**

d. Total soluble solids percentage (T.S.S. %):

As shown in Table (5), AFI treatments had a highly significant effect on T.S.S. percentage over both seasons. Treatment A (traditional irrigation) gave the highest value 11%. On the other hand, treatment B of 1/1 f. gave the lowest values 8.5%. No significant difference was found between trt. B (1/1 f.) and trt. C (1/1 ex.) on this trait. Obtained results provide evidence that T.S.S. % is very sensitive to soil water status and decreased when plants subjected to water stress El-Koliey *et al.* (1999) came to similar results.

e. Sucrose percentage:

As shown in Table (4), AFI treatments had a highly significant effect on sucrose percentage over both seasons. Treatment C (1/1 AFI, ex.) gave the highest value 8.66%. On the other hand, treatment A of traditional irrigation, gave the lowest values 6.26%. While, under 1/1 AFI, fixed (trt. B) was in between These results indicated that sucrose percentage has the opposite trend with the amount of water applied. In other words, sucrose percentage is affected by the long interval of irrigation, more than with the amount of irrigation water. Meaningfully, sucrose percentage is a function of irrigation interval, more than the amount of applied water. This finding might be attributed to that under stress conditions, i.e. elongation of irrigation interval, the speed of sugar accumulation will be higher than the corresponding accumulation of water in the cells i.e. the more water stress, is the more sugar accumulation. El-Koliey *et al.* (1999) reported that highest sucrose % was resulted in plants irrigated at 50% depletion of the available soil moisture.

CONCLUSION AND REMARKS

Data obtained may encourage the recommendation of the implementation of AFI, 1/1 exchange technique for the following advantages:

- High stripped stalk juice and syrup yield (19.12, 8.98 and 2.25 ton/fed.).
- High extraction of juice and syrup percentage (46.7 and 11.7%).
- Saving in irrigation water with an average of 770.9 m^3/fed.
- Higher values of water efficiencies parameters, values were: 7.33, 0.86 kg/m^3, 7.55, 0.89 kg/m^3 and 97.11% for water utilize, use and storage efficiencies, respectively.

REFERENCES

A.O.A.C. (1990). Official Methods of Analysis of the Association of Official Chemists Kenneth Helrich (ed.) 15th end Association of Official Analytical Chemists. Arlington, Virginia 22201 U.S.A.

Doorenbos, J. and W.O. Pruitt (1975). Crop water requirements. Irrigation and Drainage Paper, 24, F.A.O., Rome.

Doorenbos, J.; A.H. Kassam; C.L.M. Bentvelsen and V. Brancheid (1979). Yield response to water F.A.O. Irrigation and Drainage Paper, No. 33 Rome.

Duncan, S.D. (1955). Multiple Range and Multiple F-test Biometrics. 11: 1-42.

El-Koliey, M.M.; N. El-Hoda and M. Taha (1999). Effect of soil moisture stress on yield, juice quality and water relations of some sugar sorghum varieties. Assiut. Journal of Agric. Sci., 30(2): 83-95.

Fischbach, P.E. and H.R. Mulliner (1974). Every-other furrow irrigation of corn. Trans. ASAE 17: 426-428.

Giriapa, S. (1983). Water use efficiency in agriculture-Oxford-IBH Publishing Co., New Delhi, 6-9.

Ley, T.W. and W. Clyma (1981). Furrow irrigation practices in northern Clorado. Trans. ASAE 24: 610-616.

Perniola, M.; A.R. Rivelli and E. Tarantino (1992). Effect of irrigation regime on sweet sorghum productivity in Southern Italy. Rivista-di-Agronomia. 1992, 26: 4, 517-523.

Plews, R.W. (1970). Analytical methods used in sugar refining. Elsevier Pub. Co. New York, 5: 23.

Shih, S.F. (1986). Evapotranspiration, water use efficiency and water table studies of sweet sorghum. Transactions of the ASAE American Society of Agricultural Engineers. 29: 3, 767-773.

Snedecor, W.G. and W.G. Cochran (1967). Statistical Methods. 6th Ed. The IowState Univ. Press. USA.

الملخص العربى

الرى التبادلى وإنتاجية الذرة السكرية

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أقيمت تجربتان حقليتان بمحطة البحوث الزراعية بسخا ــ كفرالشيخ خلال الموسمين الزراعيين ٢٠٠٢ ، ٢٠٠٣ بهدف تحسين كفاءة الرى السطحى عن طريق استخدام رى الخطوط المتبادلة كتقنية حديثة وقد أخذ فى الاعتبار تأثير هذه التقنية على كل من المحصول والجودة وكمية المياه المضافة والمستهلكة وكفاءات الرى المختلفة لتعظيم العائد من وحدة المياه.

وقد كانت المعاملات كالآتى:

١- معاملة أ : رى جميع الخطوط (معاملة المقارنة).

٢- معاملة ب : رى خط وخط ثابت (١/١ ثابت).

٣- معاملة جـ: رى خط وخط بالتبادل (١/١ متبادل).

وقد أوضحت النتائج المتحصل عليها الآتى:

- نتجت أعلى متوسطات القيم لمحصول السيقان النظيفة (٢٠,٤٠ طن/فدان أى ٤٨,٩٦ طن/هكتار) من المعاملة أ (رى جميع الخطوط). بينما نتجت أعلى القيم لكل من محصول العصير والعسل (٨,٩٨ ، ٢,٢٥ طن/فدان أى ٢١,٥٥ ، ٥,٤٠ طن/هكتار على التوالى) من المعاملة جـ (خط/خط بالتبادل) فى حين بلغت النسبة المئوية للاستخلاص لكل من العصير والعسل أعلى القيم (٤٦,٧ ، ١١,٧%) تحت نفس المعاملة ، من ناحية أخرى فقد جاءت أعلى القيم للنسبة المئوية للمواد الصلبة الذائبة (١١%) من المعاملة أ (رى جميع الخطوط).
- بلغ المتوسط الموسمى للماء المضاف للذرة السكرية ما بين ٢٤١٥,٧ م٣/ف (٥٧.٥سم) للمعاملة ب إلى ٣١٨٦,٦ م٣/ف (٧٥.٩سم) للمعاملة أ. وهذه الكمية من الماء المضاف تتضمن ريه الزراعة والتى بلغت ٣٩٩ م٣/ف (٩.٥سم).
- أمكن ترتيب متوسطات قيم الاستهلاك المائى تنازليا كالآتى: ٣٠٩٩,٦ م٣/ف (٧٣.٨سم) > ٢٥٣٠,٣ م٣/ف (٦٠,٣ سم) > ٢٣٢٤,٠ م٣/ف (٥٥,٣ سم) للمعاملات أ ، جـ ، ب على التوالى. وبالمثل نتجت قيم معدل الاستهلاك اليومى والتى كانت كالآتى ٠,٥٥ سم/يوم > ٠,٤٥ سم/يوم > ٠,٤١ سم/يوم لنفس المعاملات بالترتيب.
- كانت أعلى متوسطات القيم لكفاءة استخدام المياه (W.UT.E) لمحصول السيقان النظيفة ٧,٣٣ كجم/م٣ وذلك من المعاملة جـ (رى خط/خط بالتبادل) على الجانب الآخر فقد بلغت أقل القيم ٦.٤٠ كجم/م٣ لمعاملة المقارنة أو المعاملة أ (رى جميع الخطوط). وقد لوحظ نفس الاتجاه لكفاءة استخدام المياه فى علاقتها بمحصول العسل وكانت متوسطات القيم ٠,٨٦ كجم/م٣ ، ٠,٦١ كجم/م٣ على التوالى.
- أظهرت النتائج وجود اتجاه مشابه لمعاملات الرى التبادلى على الكفاءة الاستعمالية للمياه (W.U.E) وذلك لكل من محصولى السيقان النظيفة والعسل.
- لم يكن هناك اتجاه واضح لمختلف معاملات الرى التبادلى على كفاءة استهلاك المياه وقد كان المتوسط العام لقيم كفاءة الاستهلاك المائى لمختلف المعاملات ٩٧%.