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CLIMATE CHANGE AND SUGAR BEET PRODUCTION

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ABSTRACT

This study was carried out to verify the experimental data of sugar beet in Kafr El-Sheikh Governorate in connection with the climate change from point of view. In particular, sowing date, and other beet-water relations. Therefore, this investigation sets out to analyze the climatological change in Kafr El-Sheikh Governorate (middle north Nile Delta) for a period of 30 years (1972-2002) to find out the impact effect of climate change on several scenarios of sowing date, how much water to be applied, what the suitable interval between irrigations and prediction of yield reduction at different growth stages under different water supply. The sowing dates of sugar beet under study are: 1st Oct., 1st Nov. and 1st Dec., respectively. The main findings can be summarized as:

- Rainfed agricultural resulted in yield reduction of 35.6 and 76.1% for 1st Oct, 31.7% and 88.7% for 1st Nov. and 65.7% and 96.6% for 1st Dec. at mid and late season, respectively, i.e. rainfall is not sufficient to produce sugar beet in the studied area.
- Under shortage water supply, of water regime net irrigation 160.0 mm for 1st Oct. and irrigation intervals of 40 days resulted in yield reduction of 10.8% at late season stage. While for 1st Nov. net irrigation of water regime 279.9 mm and interval of 40 days resulted in yield reduction of 5.6% at the same stage. Whereas, net irrigation for 1st Dec. 475.9 mm and irrigation interval is 30 days resulted in yield reduction of 9.1% for the same stage.
- Under adequate supply of water, i.e. no yield reduction i.e. at mid and late-season, for 1st Oct. minimum net irrigation 245.0 mm and irrigation interval 21 days, for 1st Nov. minimum net irrigation 375.0 mm and irrigation interval 20 days and for 1st Dec. minimum net irrigation 502.4 mm and irrigation interval 20 days are the adequate to get the maximum yield with no reduction on it as well as no water losses could be obtained.

INTRODUCTION

In Egypt, Kafr El-Sheikh Governorate considered as the main area in sugar beet production, at which almost 80% from the national production is produced. This status is found due to the salt affected soils that nearly accompanied with the state soils as a result of its tail end of the River Nile. Sugar beet is salt tolerant crop and growing well in such soils. In more details, its root is enable to penetrate the clayey soils with its hard pans, which improve its infiltration and consequently up-grade the physical properties of the soil. Moreover, the green canopy of the crop considered as a green manure which mixed with the top soil, and ultimately enhance the soil conditions especially its organic matter content and aeration process.

In addition, one of the biggest sugar plant not only in Egypt but world-wide is existed in the area. This encourage the farmers to grow beet in the area as a row material for this factory and to get a high return from its farming.

Moreover, as a fact of Kafr El-Sheikh Governorate lies at the tail end of the national watering (irrigation & drainage) network, a deficit of water counted with 14.5, 12.1 and 23.2% during March, April and May (Ibrahim *et al.*, 1992). This period is presented in the second half growing beet season. Therefore, incentive studies should be carried out concerning what is the suitable time for beet cultivation as well as its irrigation scheduling that is determination of both the proper time for watering and the accurate amount of irrigation water should be applied.

In this direction, climatological elements play a vital role on such investigation points. Meaningfully, the impact of climate change on selection of the suitable beet sowing date, how much water to be applied and what the most effective irrigation intervals. Such data are essential to the policy makers in the irrigation sector, especially under the shortage status of renewable water that facing Egypt at present and in future as well.

The relationship between crop yield and water supply can be determined when crop water requirements and crop water deficits, on the one hand, and maximum and actual crop yield on the other can be quantified. Water deficits in crops, and the resulting water stress on the plant, have an effect on crop evapotranspiration and crop yield. Water stress in the plant can be quantified by the rate of actual evapotranspiration (ETa) in relation to the rate of maximum evapotranspiration (ETm). When crop water requirements are fully met from available water supply then ETa = ETm; when water supply is insufficient, ETa < ETm. To evaluate the effect of plant water stress on yield decrease through the quantification of relative evapotranspiration (ETa /ETm) , an analysis of research results shows that it is possible to determine relative yield losses if information is available on actual yield (Ya) in relation to maximum yield (Ym) under different water supply regimes. Where economic conditions do not restrict production and in a constraint-free environment, Ya =Ym when full water requirements are met; when full water requirements are not met available water supply, Ya < Ym (Doorenbos and Kassam, 1979).

So, the objective of this study was to analyse the different scenarios of climate change on water and productivity of beet in North Nile Delta.

Specific goals are:

- Impact of different sowing date on yield and its productivity.
- Role of different amounts of irrigation water applied at a specific irrigation interval.
- Irrigation interval and its effect on yield and beet productivity practiced under a fixed level of irrigation water.
- Level of renewable soil water (RSW) on yield reduction at different stages of growth.

MATERIALS AND METHODS

Procedures:

Kafr El-Sheikh Governorate is located 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. The obtained results from the previous field trails revealed that watering each 21 days resulted in the highest beet yield. Therefore, by using the average climatological data of the area for a period of 30 years (Table, 1) and with the values of the obtained actual results are considered as the input data for different scenarios or predictions of the impact of climate change on beet-water productivity.

Table (1): Agroclimatological data during the period (1972 to 2002) for Kafr El-Sheikh region.

Months	T. max.	T. min.	Average	RH (%)	SS (hrs)	WS (m/sec)	Rainfall (mm)
Jan.	18.9	6.6	12.8	81	7.0	1.3	13.9
Feb.	19.9	6.8	13.4	81	7.7	1.4	17.2
Mar.	22.1	8.3	15.2	75	8.6	1.7	7.4
Apr.	26.6	11.0	18.8	67	9.6	1.5	2.3
May	30.6	14.3	22.5	59	10.6	1.5	1.8
Jun.	32.4	17.9	25.2	65	11.9	1.5	0.0
Jul.	32.9	19.8	26.4	69	11.6	1.3	0.0
Aug.	33.0	19.6	26.3	75	11.3	1.3	0.0
Sept.	31.9	17.7	24.8	74	10.3	1.1	0.0
Oct.	29.6	15.3	22.5	74	9.3	1.0	2.0
Nov.	25.5	12.2	18.9	75	8.0	1.1	6.2
Dec.	20.7	8.4	14.6	79	6.6	1.1	11.2
Mean	27.0	13.2	20.1	73	9.4	1.3	62.0

***Where: T. max., T. min. = maximum and minimum temperatures °C; RH = relative humidity* (%); SS = actual sunshine (hour) and WS = wind speed (m/sec.)**

Water consumptive use or crop evapotranspiration (ET crop) was determined using the computer program CROPWAT 4.3 version (Derek *et al.*, 1998).

CropWat for Windows is a Program uses the FAO Penman-Monteith method (1992) for calculating reference crop evapotranspiration (ETo). These estimates are used in crop water requirements and irrigation scheduling calculation.

The FAO Penman-Monteith method is as follows:

$$ETo = \frac{0.408(Rn - G) + \gamma \frac{900}{T + 273} u_2 (e_s - e_a)}{\Delta + \gamma (1 + 0.34 u_2)}$$

Where:

ETo	=	reference evapotranspiration (mm day^{-1})
Rn	=	net radiation at the crop surface ($MJm^{-2} day^{-1}$)
G	=	soil heat flux density ($MJm^{-2}day^{-1}$)
T	=	mean daily air temperature at 2 m height (°C)
u_2	=	wind speed at 2 m height ($m s^{-1}$)
e_s	=	saturation vapour pressure (kPa)
e_a	=	actual vapour pressure (kPa)
e_s-e_a	=	saturation vapour pressure deficit (kPa)
Δ	=	slope vapour pressure curve (kPa $°C^{-1}$)
γ	=	psychrometric constant (kPa $°C^{-1}$)

The aim of the present investigation is to study scheduling irrigation of sugar beet crop at North Delta region under different sowing dates, watering time and application depth of irrigation water and their effect on yield reduction.

Prediction of yield reduction under different water deficit at different growth stages and determine the stages which are more vulnerable to water deficit. The reduction at each growing stage was computed as:

$$(1 - Ya/Ym) = Ky\ (1 - ETa/ ETm)$$

Where:

- Ya = actual harvested yield.
- Ym = maximum harvested yield
- Ky = yield response factor
- ETa = actual evapotranspiration
- ETm = maximum evapotranspiration

Three sowing date were suggested as they the most applicable ones in the area, they are; 1st Oct., 1st Nov. and 1st Dec. Description of the studied treatments under each sowing date can be summarized in the following Table (2, a, b, c).

a. Sowing date: 1st Oct.

Sowing date	Treatments	When to irrigate	How much water
1st Oct.	I_{20}	Rainfed	
	I_{21}	Each 21 days	50 mm (water depth)
	I_{22}	Each 30 days	30 mm w.d.
	I_{23}	Each 30 days	20 mm w.d.
	I_{24}	Each 40 days	40 mm w.d.
	I_{25}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 15 mm at 4th irri., 25 mm at 5th irri., 35 mm at 6th irri., 50 mm at 7th irri. and 75 mm at 8th irri.
	I_{26}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 25 mm at 5th irri., 50 mm at 6th irri., 50 mm at 7th irri. and 50 mm at 8th irri.
	I_{27}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 25 mm at 5th irri., 50 mm at 6th irri., 50 mm at 7th irri.

b. Sowing date: 1st Nov.

Sowing date	Treatments	When to irrigate	How much water
1st Nov.	I_{28}	Rainfed	
	I_{29}	Each 30 days	30 mm (water depth)
	I_{30}	Each 30 days	To 100% RSW
	I_{31}	Each 40 days	To 100% RSW
	I_{32}	Each 20 days	To 100% RSW
	I_{33}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 35 mm at 5th irri., 35 mm at 6th irri., 50 mm at 7th irri. and 75 mm at 8th irri.
	I_{34}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 25 mm at 5th irri., 50 mm at 6th irri., 50 mm at 7th irri. and 50 mm at 8th irri.
	I_{35}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 25 mm at 5th irri., 50 mm at 6th irri., 50 mm at 7th irri.

c. Sowing date: 1st Dec.

Sowing date	Treatments	When to irrigate	How much water
1st Dec.	I_{36}	Rainfall	
	I_{37}	Each 30 days	30 mm (water depth)
	I_{38}	Each 30 days	To 100% RSW
	I_{39}	Each 40 days	To 100% RSW
	I_{40}	Each 20 days	To 100% RSW
	I_{41}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 35 mm at 5th irri., 50 mm at 6th irri. and 75 mm at 7th irri.
	I_{42}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 25 mm at 5th irri., 50 mm at 6th irri., 50 mm at 7th irri. and 50 mm at 8th irri.
	I_{43}	Each 21 days	15 mm at 1st irri., 15 mm at 2nd irri., 15 mm at 3rd irri., 25 mm at 4th irri., 25 mm at 5th irri., 50 mm at 6th irri., and 50 mm at 7th irri.

RSW = Readily soil water

RESULTS AND DISCUSSION

A. Under 1st Oct. sowing date:

Rainfall in the studied area provides enough water to sustain the development of the growing plants during initial and development stages as shown in Table (3) growth stages 1 and 2. On the other hand, a yield reduction accounted with 35.6 and 76.1% at the mid and late-stages or as shown in Table (3, Trt. I_{20}) growth stages 3 and 4, respectively.

Table (3): Prospected yield reduction at different growth stages of sugar beet as affected with sowing date, consumed and applied water.

Treatments	ETc mm	ETc/Etm (%)	Net Irri. (mm)	Irri. losses (mm)	Yield reduction (%)			
					Growth stage # 1	Growth stage # 2	Growth stage # 3	Growth stage # 4
I_{20} rainfed	230.7	60.9	0.0	0.0	0.0	0.0	35.6	76.1
I_{21} irri.	378.7	100.0	400.0	143.0	0.0	0.0	0.0	0.0
I_{22} irri.	358.1	94.5	150.0	0.0	0.0	0.0	0.0	14.0
I_{23} irri.	321.4	84.9	100.0	0.0	0.0	0.0	0.0	38.9
I_{24} irri.	362.8	95.8	160.0	0.2	0.0	0.0	0.0	10.8
I_{25} irri.	378.7	100.0	245.0	0.0	0.0	0.0	0.0	0.0
I_{26} irri	378.7	100.0	245.0	0.0	0.0	0.0	0.0	0.0
I_{27} irri.	377.0	99.6	195.0	0.0	0.0	0.0	0.0	1.1

While the irrigated treatments of I_{21} through I_{27} showed no yield reduction at the three stages of 1, 2 and 3, but the situation is differed concerning the yield reduction at the growth stage No. 4. The maximum yield reduction 38.9% at such stage is prospected with net irrigation 100.0 mm of Trt. I_{23}. The slight reduction 1.1% at growth stage No. 4 could be resulted from irrigation regime I_{27} of watering each 21 days with seasonal net irrigation of 195.0 mm.

Treatment I_{21} represents the excess irrigation of seasonal net irrigation 400.0 mm. which might be resulted in 143.0 mm as irrigation losses. The irrigation regime of this treatment (I_{21}) is watering each 21 days with 50.0 mm each irrigation. In spite of no yield reduction at any stage of growth could be attained under Trt. I_{21}, but water losses of 143.0 mm could be resulted. So, from the tabulated data in Table (3), it is clear that by applying a seasonal net irrigation of 245.0 mm as described under treatments I_{25} and I_{26} could be directed to no irrigation losses. Moreover, either of the two irrigation regimes of both treatments are enough to provide the growing plants with maximum evapotranspiration (ETm). implementation of any irrigation regime of the two treatments is depending upon the availability of irrigation water. Therefore, under sufficient irrigation water a seasonal net irrigation depth of 245.0 mm is enough to achieve the target of no yield reduction at any growth stage. While, under the shortage of irrigation water which is normally occurred at Kafr El-Sheikh Governorate especially during the second half of the beet growing seasons, irrigation regime of I_{27} could be practiced. This means watering each 21 days and unfixed irrigation depth which match with the crop water needs. In the same direction, applying 400.0 mm as net irrigation (Trt. 21) is out of recommendation due to its high excess amount of about 143.0 mm as irrigation losses.

Doorenbos and Kassam (1979) and Ainer *et al.* (1999) came to similar direction.

B. Under 1st Nov. sowing date:

Rainfall in the studied area provides enough water to sustain the plant during initial and development stages (I_{28}) or as shown in Table (4) growth stages 1 and 2. On the other hand, a yield reduction accounted with 31.7 and 88.7% at the mid-season (stage 3) and late-season(stage 4), respectively. While the irrigated treatments of I_{29} through I_{35} obtained no yield reduction at the three stages of initial, development and mid-season or stages 1, 2 and 3 as shown in Table 4. On the other hand, the situation is differed regarding the yield reduction at the growth stage of late-season or identify No. 4. The maximum yield reduction 53.2% at such stage is prospected with net irrigation 150 mm of Trt. I_{29}. Although under this treatment I_{29}, the maximum yield reduction of 53.2% could be occurred at stage No. 4 which obtained from the least seasonal net irrigation of 150.0 mm, the highest amount of irrigation losses of 27.9 mm might be resulted. This irrigation losses could be attributed to watering each 30 days, with fixed amount of 30 mm each. The slight reduction 0.5% at growth stage No. 4 could be resulted from irrigation regime of I_{30} of watering each 30 days with seasonal net irrigation of 370.5 mm.

Treatment I_{32} represents the highest level of seasonal net irrigation 375.0 mm which might be resulted in no irrigation losses. The irrigation regime of this treatment (I_{32}) is watering each 20 days with 100% of readily soil water each irrigation. No yield reduction at any growth stage could be attained under I_{32}.

In addition from the tabulated data in Table (4), it is cleared that by applying a seasonal net irrigation of 370.5 and 375.0 mm as described under treatments I_{30} and I_{32} could be directed to no irrigation losses. Moreover, either of the two irrigation regimes of both treatments are enough to provide the growing plants with maximum evapotranspiration (ETm), as well as no yield reduction. Implementation of any irrigation regime of the two treatments is depending upon the availability of irrigation water. Therefore, under sufficient irrigation water, a seasonal net irrigation depth of 375.0 mm is enough to achieve the target of no yield reduction at any growth stage. While, under the shortage of irrigation water which is normally occurred at Kafr El-Sheikh Governorate especially during the second half of the beet growing season, irrigation regime of I_{33} could be practiced. This means watering each 21 days and unfixed irrigation depth which mach with the crop water needs.

In the same direction, applying 150.0 mm as net irrigation (Trt. I_{29}) is out of recommendation due to its excess amount of about 27.9 mm as irrigation losses.

Similar trend was obtained by El-Marsafawy and Eid (1999) and Ainer *et al.* (1999).

Table (4): Prospected yield reduction at different growth stages of sugar beet as affected with sowing date, consumed and applied water.

Treatments	ETc mm	ETc/ETm (%)	Net Irri. (mm)	Irri. losses (mm)	Yield reduction (%)			
					Growth stage # 1	Growth stage # 2	Growth stage # 3	Growth stage # 4
I_{28} rainfed.	235.7	51.4	0.0	0.0	0.0	0.0	31.7	88.7
I_{29} irri.	351.4	76.6	150.0	27.9	0.0	0.0	0.0	53.2
I_{30} irri.	457.9	99.8	370.5	0.0	0.0	0.0	0.0	0.5
I_{31} irri.	447.7	97.5	279.9	0.0	0.0	0.0	0.0	5.6
I_{32} irri.	459.0	100.0	375.0	0.0	0.0	0.0	0.0	0.0
I_{33} irri.	451.1	98.3	265.0	8.8	0.0	0.0	0.0	3.9
I_{34} irri.	439.6	95.8	245.0	8.8	0.0	0.0	0.0	9.6
I_{35} irri.	407.3	88.7	195.0	8.8	0.0	0.0	0.0	25.6

C. Under 1st Dec. sowing date:

As shown in Table (5) rainfall in the studied area is enough to sustain the plant growth during initial and development stages (Trt. I_{36}), i.e. growth stages 1 and 2. On the other hand, a yield reduction accounted with 56.0 and 96.6% could be attained at the mid and late-season i.e. growth stages 3 and 4, respectively.

The irrigation treatments of I_{37} to I_{43} showed no yield reduction at the two stages of 1 and 2, as of the rainfed treatment I_{36}, but the situation differ concerning the yield reduction at the growth stages No. 3 and 4. The maximum yield reduction 22.4 and 80.5% at this stages are prospected with net irrigation 150.0 mm of Trt. I_{37}. The slight reduction 9.1% at growth stage No. 4 could be resulted from irrigation regime of I_{38} of watering each 30 days with seasonal net irrigation of 475.9 mm. Treatment I_{40} represents the seasonal net irrigation 502.4 m. which resulted in no irrigation losses. The irrigation regime of this treatment (I_{40}) is watering each 20 days with 100%

readily soil water of each irrigation. No yield reduction at any stage of growth could be attained under Trt. I_{40}.

Table (5): **Prospected yield reduction at different growth stages of sugar beet as affected with sowing date, consumed and applied water.**

Treatments	ETc mm	ETc/ Etm (%)	Net Irri. (mm)	Irri. losses (mm)	Yield reduction (%)			
					Growth stage # 1	Growth stage # 2	Growth stage # 3	Growth stage # 4
I_{36} rainfed.	231.8	39.7	0.0	0.0	0.0	0.0	56.0	96.6
I_{37} irri.	338.1	57.9	150	36.4	0.0	0.0	22.4	80.5
I_{38} irri.	561.2	96.1	475.9	0.0	0.0	0.0	0.0	9.1
I_{39} irri.	527.5	90.3	348.6	0.0	0.0	0.0	2.0	21.0
I_{40} irri.	584.1	100.0	502.4	0.0	0.0	0.0	0.0	0.0
I_{41} irri.	435.4	74.5	230	20.8	0.0	0.0	5.5	54.9
I_{42} irri	439.4	75.2	245	20.8	0.0	0.0	8.7	50.8
I_{43} irri.	402.0	68.8	195	20.8	0.0	0.0	8.7	65.7

In addition from the tabulated data in Table (5),it is obvious that by applying a seasonal net irrigation of 502.4 mm is described with treatment I_{40} could be directed to no irrigation losses. Moreover, the irrigation regime of this treatment is enough to provide the growing plants with maximum evapotranspiration (ETm). Implementation of irrigation of this treatment is depending upon the availability of irrigation water. Therefore, under sufficient irrigation water a seasonal net irrigation depth of 502.4 mm is enough to achieve the target of no yield reduction at any growth stage. While, under the shortage of irrigation water which is normally occurred at Kafr El-Sheikh Governorate especially during the second half of the beet growing season, irrigation regime of I_{38} could be practiced. This means watering each 30 days and irrigation to 100% readily soil water which mach with the crop water needs. In the same direction, applying 150.0 mm as net irrigation (Trt. I_{37}) is out of recommendation due to its excess amount of about 36.4 mm as irrigation losses.

Similar findings are in agreement with that resulted by Doorenbos and Kassam (1979), Ainer *et al.* (1999) and El-Marsafawy and Eid (1999).

Conclusion

Three scenarios are provided form this study according to the different common suitable sowing dates of sugar beet which quoted from the experimental trials in Kafr El-Sheikh Governorate. They are 1st Oct., 1st Nov. and 1st Dec. The main findings can be summarized as follows:

a. For 1st Oct.:

- Rainfed agriculture resulted in 35.6% and 76.1% yield reduction at mid and late season stages, respectively.
- Under water shortage supply, water regime of net irrigation 160.0 mm with irrigation interval 40 days as described for treatment (I_{24}), will be resulted in 10.8% yield reduction at late-season stage.

- Water supply at least 245.0 mm as net irrigation(1029.0 m^3/fed.) should be applied (Trt. I_{25} and I_{26}) no yield reduction will be obtained.

b. For 1st Nov.:

- Rainfed agricultural resulted in 31.7% and 88.7% yield reduction at mid and late-seasons stages, respectively.
- Under short water supply, water regime of net irrigation 279.9 mm, with irrigation interval 40 days as described for treatment (I_{31}), will be resulted in 5.6% yield reduction at late-season stage.
- Abundant of water supply at least 375.0 mm. as net irrigation (1575.0 m^3/fed.) should be applied (Trt. I_{32}), no reduction yield will be obtained.

c. For 1st Dec.:

- Rainfed agricultural resulted in 65% and 96.6% yield reduction at mid and late-season stages, respectively.
- Under water shortage supply, water regime of net irrigation 475.9 mm. with irrigation interval 30 days as descried for treatment (I_{38}), will be resulted in 9.1% yield reduction at late-season stage.
- Water supply at least 502.4 mm as net irrigation (2110.1 m^3/fed.) should be applied (Trt. I_{40}), no yield reduction will be resulted.

These different scenarios are just data base of policy maker and decision autherities towards maximizing crop yield per unit of water applied e.g. more crop per drop.

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تغير المناخ وإنتاج بنجر السكر

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أجريت هذه الدراسة التحليليه لتغير المناخ والتي إعتمدت أساسا على بيانات حقلية تحصل عليها في محافظة كفرالشيخ (منتصف شمال دلتا النيل) وذلك لفترة ٣٠ سنة (١٩٧٢ الى ٢٠٠٢) لمعرفة تأثير تغير المناخ على إختيار ميعاد الزراعة المناسب وكمية المياه المضافه وأنسب فترة بين الريات وكذلك بغرض التنبؤ بالنقص في المحصول تحت المستويات المختلفة من نقص المياه في مختلف مراحل النمو لبنجر السكر. وقد اشتملت الدراسة على ثلاث مواعيد شائعة في الزراعة وهي اول اكتوبر ، اول نوفمبر ، اول ديسمبر على التوالى وقد أوضحت النتائج الاتى:

- نتج من الزراعة على الامطار نقصا في المحصول مقداره ٣٥,٦ ، ٧٦,١% (أول أكتوبر) ، ٣١,٧و ٨٨,٧% (أول نوفمبر) و ٥٦,٧ ، ٩٦,٦% (أول ديسمبر) في مرحلتى النمو المتوسطة والمتأخرة على التوالى ويعنى ذلك أن مياه الأمطار الساقطة تكون غير كافية لإنتاج بنجر السكر في المنطقة.
- تحت ظروف نقص مياه الرى المستخدمة فقد نتج عن صافي مياه الرى المضافة ١٦٠,٠مم عندما كانت الفترة بين الريات ٤٠ يوم للميعاد الأول (أول أكتوبر) نقصا في المحصول مقداره ١٠,٨% في مرحلة النمو المتأخرة. بينما نتج نقص في المحصول مقداره ٥,٦% خلال نفس المرحلة للميعاد الثاني (أول نوفمبر) عندما كان صافي مياه الرى المستخدمة ٢٧٩,٩ مم والفترة بين الريات ٤٠ يوم. في حين كان النقص في المحصول ٩,١% للميعاد الثالث (أول ديسمبر) عندما بلغ صافي مياه الرى المستخدمة ٤٧٥,٩ مم والفترة بين الريات ٣٠ يوم خلال المرحلة ذاتها.
- تحت ظروف توفر مياه الرى المستخدمة أى عدم وجود نقص في المحصول خلال مرحلتى النمو المتوسطة والمتأخرة فقد سجلت أقل كمية لمياه الرى في الميعاد الأول (أول أكتوبر) ٢٤٥,٠ مم مع فترة ٢١ يوم بين الريات ، ٣٧٥,٠ مم مع فترة ٢٠ يوم بين الريات للميعاد الثاني (أول نوفمبر) و ٥٠٢,٤ مم وفترة ٢٠ يوم بين الريات للميعاد الثالث (أول ديسمبر).

وعليه فإن الدراسة المشار إليها تفيد صانعى القرار في إتخاذ مايلزم من ناحية ما يحدث بالنسبة لميعاد الزراعة والعلاقات المائية لبنجر السكر في محافظة كفرالشيخ ، المنطقة الأساسية لإنتاج بنجر السكر في مصر.