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IRRIGATION SCHEDULING OF SUNFLOWER AND SOME RELATIONS UNDER SURFACE IRRIGATION IN NORTH NILE DELTA

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ABSTRACT

The present study was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh, Governorate during the two successive seasons 2006 and 2007 to investigate the effect of three irrigation intervals i.e. one, two and three weeks on the productivity and some water relations of sunflower. A slit plot design with three replicates was used. The main plots were assigned to the irrigation intervals, while the sub-plot were devoted to irrigation levels i.e. irrigation till field capacity plus 10%. In addition, three other levels based on Ibrahim, Hargareves and FAO Peman-Monteith equations. Results could be summarized as follows:

Irrigation every 7 days significantly increased stem and head diameter, the weight of 100 seed, oil content and seed yield. Irrigation according to Ibrahim equation was superior in stem and head diameter, oil content and seed yield. Irrigation every one week according to Ibrahim equation was resulted in the highest seed yield of s1348.53 kg/fed. (mean of 2 season).

Keywords: Sunflower, irrigation intervals, water applied and water efficiencies.

INTRODUCTION

In Egypt the cultivated area is about 8 million feddans depends mainly upon irrigation from the Nile water which contributes with about 95% from water of the national water supply, this dependence because negligible rainfall and we can't rely on irrigation. Sunflower (*Helianthus annus*, L.) is one of the most important edible oil crop world wide. The productivity of sunflower is greatly influenced by environmental conditions, soil fertility and irrigation regime as well as high yielding cultivars.

Ashoub *et al.* (2000) in Egypt studied irrigation interval and magnesium fertilization on water relations of sunflower. They found that irrigation every 7 days gave the maximum values of irrigation requirements; daily and seasonal ET. While, irrigation every 21 days intervals caused a maximum decrease in water use efficiency. Eredem *et al*. (2001) showed that irrigation water use efficiency (I.W.U.E) and water use efficiency (W.U.E) were found to be between 0.8-2.47 kg/da-mm and 0.82-0.92 kg/da-mm, respectively for sunflower, El-Samanody *et al.* (2004) mentioned that seed weight/plant, 100-seed weight for sunflower significantly increased by increasing available soil moisture before irrigation time. Göksoy *et al.* (2004) stated that evapotranspiration (ET) increased as an increasing amount of irrigation water applied. The highest seasonal ET as an average of 67 mm was measured in the HFM treatment (irrigation water from heading, flowering

and milking stages) to full (about 360 m) of sunflower. Soomro *et al.* (2005) repiored that the irrigation frequencies (1, 2, 3 and 4 weeks) had significant effects on plant height, seed weight and yield of sunflower. Karam *et al*. (2007) concluded that deficit irrigation at early seed formation increased the fraction of assimilate allocation to the head, compensating thus the lower number of seed/m^2 through increased seed weight. Deficit irrigation at early and mid flowering stages reduced seed yield by 25 percent and 14 percent, respectively. Sumathi and Koteswara Rao (2008) found that dry matter production, seed yield, evapotranspiration nitrogen uptake of sunflower was significantly higher with irrigation schedule of IW/CPE ratio (Irrigation water/class A pan evaporation) of 1.0, supply of 100% nitrogen through fertilizer and by their interaction.

MATERIALS AND METHODS

Two field experiments were carried out during the two successive growing summer season 2006 and 2007 at Sakha Agricultural Research Station farm, Kafr El-Sheikh Governorate, middle North Nile Delta region. The experiment was laid out in a split-plot design with three replications, and plot area was 52.5 m^2 (1/80 fed).

The main treatments (irrigation interval):

A: Irrigation every one week.
B: Irrigation every two weeks.
C: Irrigation every three weeks.

Sub-treatments (irrigation level):

I_1: Irrigation according to fill the root zone up to field capacity + 10%.
I_2: Irrigation according to Ibrahim equation.
I_3: Irrigation according to Hargraves equation.
I_4: Irrigation according to FAO Penman Monteith equation.

(I_1) Soil moisture depletion (S.M.D):

$$I.W. = \left(\frac{F.C. - \theta_1}{100} \times D_b \times d \times A) + 10\% \right)$$

Where:

I.W. = Applied irrigation water (m^3)
F.C. = Field capacity (%).
θ_1 = Soil moisture percentage on weight basis before irrigation.
D_b = Soil bulk density, kg/m^3
d = Soil wetting depth (effective root zone of 0.6 m).
A = Irrigation area (52.5 m^2 = 1/80 fed.).

(I_2) Ibrahim equation (1981):

$$ETp = 0.1642 + 0.8\ EP$$

Where:

ETp = Potential evapotranspiration (cm/day)
EP =Pan evaporation (cm/day).

(I_3) Hargreves equation:

$$ETo = 0.0023\ R_a T_D^{0.5} (T_a + 17.8)$$

Where:

Ra = Absolute radiation, Cal. cm^{-2}. day^{-1}.
T_D = Air temperature difference between max. and min., ^oC
T_a = Air temperature average, ^oC,
(I_4) FAO Penman-Monteith:

ETo =

Where:

ETo = Reference evapotranspiration ($mm.day^{-1}$)
Rn = Net radiation at the crop surface ($M_j\ m^{-2}\ day^{-1}$)
G = Soil heat flux density ($M_j\ m^{-2}\ day^{-1}$)
T = Mean daily air temperature at 2 m height (^oC)
μ_2 = Wind speed at 2 m height (s^{-1}).
es = Saturation vapour pressure (Kpa).
ea = actual vapour pressure (Kpa).
es-ea = Saturation vapour pressure deficit (Kpa)
Δ = Slope vapour pressure curve (Kpa oC-1)
У = Psychometric constant (Kpa oC-12).

Some physical and chemical properties of the soil before cultivation are shown in Table (1).

Table (1): Some physical and chemical properties of the soil before cultivation.

EC dS/m	SAR	Soil pH (1: 2.5)	Particle size distribution (%)			Bulk density (kg/m^3)	Total porosity%	Field capacity %	Available water %
			Sand	Silt	Clay				
4.39	3.8	8.48	18.50	37.60	43.90	1.15	56.60	40.03un	17.40

Studied characters:

1. Irrigation water:

Irrigation water was pumped from the main canal near the field into a settling basin with a baffle wall to maintain a constant head over the crest of a fixed rectangular weir. Discharge at 10 cm as effective head equals $0.01754 m^3$/sec or 17.54 L/sec.

2. Water consumptive use (CU):

It was calculated according to Hansen *et al.,* 1979.

$$C.U. = \frac{\theta_2 - \theta_1}{100} \times D_b \times d \times A = m^3/fed.$$

Where:

Cu = Actual water consumptive use of the growing plants.
θ_2 = Mean soil moisture percentage (W/W) for the 60 cm soil depth, 48 hrs. after irrigation.

θ_1 = Mean soil moisture percentage (W/W), before the next irrigation for the 60 cm soil depth.
D_b = Mean soil bulk density, kg/m^3 for the 60 cm soil depth.
d = Soil wetting depth i.e. effective root zone of 60 cm.
A = Irrigated area, m^2 (4200 m^2 i.e. area of 1.0 feddan).

3. Water efficiencies:

a. Water productivity:

Water productivity (W.P) or so-called irrigation water use efficiency (I.W.U.E.) was calculated according to Doorenobs and Pruitt (1975) as:

$$\text{I.W.U.E.} = \frac{\text{Yield (kg/fed.)}}{\text{Amount of water applied to crop (m}^3\text{/fed.)}}$$

b. Crop water productivity:

Crop water productivity (C.W.P) or so-called water use efficiency (WU.E) was calculated according to Doornbos and Pruitt (1975) as:

$$\text{W.U.E.} = \frac{\text{Yield (kg/fed.)}}{\text{Amount of water consumed by crop}}$$

4. Computation of reference evapotranspiration (ETo):

Values of ETo for different months were derived as the average of the three following equations:

(1) Ibrahim.
(2) Hargreves
(3) FAO Penman Monteith

Table (2): Average ETo as computed with three methods for different months of growing season of sunflower shown in Table (2).

Months	ETo (mm/day)			Average
	Ibrahim	Hargreves	FAO-Penman Monteith	
June	6.87	5.13	5.9	5.97
July	5.86	6.08	6.2	6.05
August	5.49	5.91	5.5	5.63
Sept.	5.11	5.22	4.5	4.94
Mean	5.83	5.59	5.53	5.65

RESULTS AND DISCUSSION

Water relations for sunflower crop:

The obtained results in Table (3) showed the amount of irrigation water (I.W.), water consumptive use (CU) and water efficiencies for sunflower crop. The highest values of irrigation water (1993.40 m^3/fed. i.e. 47.46 cm) was recorded with irrigation every one week and watering according to Ibrahim equation (A_2). While, the lowest value of irrigation water to replenish the extracted water from the effective soil root zone till field capacity plus 10%

was obtained by irrigation every three weeks (1517.23 m^3/fed. i.e. 36.12 cm). The values of applied irrigation water under different irrigation intervals can be arranged in descending order as: A > B > C. These results are in a good agreement with the data obtained by Ashoub *et al.* (2000).In the same direction, values of crop water consumptive use (C.U.) under different, irrigation intervals could be arranged in descending order as: 47.23 > 44.50 > 40.78 cm for treatments A, B and C, respectively.

Table (3): Average of seed yield, irrigation water depth (I.W.), water efficiencies and crop water consumptive use (CU) for sunflower crop.

Main treatment	Sub-treatment	Seed yield kg/fed.	I.W.		I.W.U.E. kg/m^3	CU		W.U.E. kg/m^3
			m^3/fed.	cm		m^3/fed.	cm	
A	I_1	1162.36	1770.73	42.16	0.66	1813.56	43.18	0.64
	I_2	1348.53	1993.40	47.46	0.68	2058.00	49.0	0.66
	I_3	1252.35	1981.78	47.19	0.63	2055.06	48.93	0.66
	I_4	1193.12	1958.27	46.63	0.61	2007.60	47.80	0.59
Mean		1239.09	1926.05	45.86	0.65	1983.56	47.23	0.64
B	I_1	935.31	1647.298	39.22	0.57	1746.78	41.59	0.54
	I_2	1081.83	1850.73	44.07	0.58	1911.84	45.52	0.57
	I_3	1037.31	1848.29	44.01	0.56	1920.24	45.72	0.54
	I_4	994.00	1819.07	43.31	0.55	1897.14	45.17	0.52
Mean		1012.11	1791.35	42.65	0.57	1869.00	44.50	0.54
C	I_1	702.85	1517.23	36.12	0.46	1681.68	40.04	0.42
	I_2	859.04	1764.84	42.02	0.49	1703.10	40.55	0.50
	I_3	825.94	1760.69	41.92	0.47	1761.90	41.95	0.47
	I_4	752.33	1733.31	41.27	0.43	1704.78	40.59	0.43
Mean		785.04	1694.02	40.33	0.46	1712.87	40.78	0.46

While, the arrangement for the irrigation water levels treatments are 41.60, 45.02, 45.53 and 44.52 cm for treatment I_1, I_2, I_3 and I_4, respectively.

Irrigation very on week gave the highest values of both I.W.U.E. and W.U.E., the mean average values for treatment A was 0.65 and 0.64 kg/m^3, respectively.

2. Crop coefficient (Kc):

Crop coefficient (Kc) is presented to account the effect of crop characteristics on crop water requirements. Results of (K_c) for sunflower under irrigation intervals of sunflower are listed in Table (4). Seasonal crop coefficient (Kc) under irrigation intervals are 0.84, 0.81 and 0.76 for treatments A, B and C, respectively.

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جدولة رى عباد الشمس وبعض العلاقات المائية تحت ظروف الرى السطحى فى شمال دلتا النيل

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**** قسم الأراضى ـ كلية الزراعة ـ جامعة المنصورة**

أقيمت الدراسة الحالية بمحطة بحوث سخا ـ محافظة كفرالشيخ خلال موسمى ٢٠٠٦ ، ٢٠٠٧م لبحث تأثير ثلاث فترات رى (أسبوع ، أسبوعين ، ثلاث أسابيع) على المحصول وبعض العلاقات المائية لعباد الشمس. وكان التصميم الإحصائى هو القطع المنشقة (مرة واحدة) وكانت القطع الرئيسية هى فترات الرى بينما القطع التحت رئيسية هى مستويات الرى (الرى حسب السعة الحقلية + ١٠% ، بالإضافة إلى ثلاث مستويات أخرى هى الرى حسب كلا من معادلة إبراهيم ، معادلة هارجريفيز ، معادلة بينمان مونتيس).

وكانت النتائج المتحصل عليها كالآتى:

- أعطى الرى كل ٧ أيام زيادة معنوية للصفات التالية (قطر الساق ، قطر القرص ، وزن الـ ١٠٠ حبة ، محتوى الزيت ومحصول الحبوب).

- تفوق الرى حسب معادلة إبراهيم فى الصفات التالية (قطر الساق ، قطر القرص ، محتوى الزيت ، محصول الحبوب).
- أعطى الرى كل أسبوع حسب معادلة إبراهيم أعلى محصول حبوب (١٣٤٨,٥٣كجم/ف)

التوصيات:

- استنتج أن الرى كل أسبوع حسب معادلة إبراهيم (خاصة بشمال وسط الدلتا تعطى أعلى محصول من عباد الشمس).
- إضافة مياه الرى بإحدى الطرق (إبراهيم ، هارجريفيز ، بينمان مونتيس) يمكن أن تستخدم لحساب مياه الرى.
- بزيادة فترة الرى لأسبوعين والرى حسب معادلة إبراهيم يستنتج الآتى:
  - حفظ مياه الرى المضافة بنسبة ٨%.
  - الحصول على ٨٠% من المحصول.
  - مساهمة الماء الأرضى فى الاحتياجات المائية بتقليل المياه المضافة فيقل الحمل على شبكة الصرف وتصبح الظروف الهوائية جيدة لنمو الجذور.
  - إيجاد معامل المحصول الخاص بعباد الشمس بالمنطقة.
  - واحد م^{3} مياه مضافة يساهم فى إنتاج (٠,٧ ـ ٠,٦كجم) عند الرى كل أسبوع وأسبوعين بمعنى أن إنتاج واحد كجم حبوب يحتاج إلى (١,٤ ـ ١,٧م^{3}) مياه مضافة لنفس الفترات.

Table (4): Crop coefficient (Kc) at different months (average of the two sunflower seasons) as affected with irrigation interval and water level.

Months	Crop coefficient (Kc)														
	A					B					C				
	S.M.D.	Ibrahim	Hargraves	FAO-Penman Monteith	Average	S.M.D.	Ibrahim	Hargraves	FAO-Penman Monteith	Average	S.M.D.	Ibrahim	Hargraves	FAO-Penman Monteith	Average
June	0.49	0.43	0.57	0.49	0.50	0.49	0.43	0.57	0.49	0.50	0.49	0.43	0.57	0.49	0.50
July	0.92	1.02	0.97	0.95	0.97	0.84	0.92	0.92	0.87	0.89	0.82	0.88	0.88	0.82	0.85
August	0.96	1.21	1.15	1.17	1.12	0.95	1.13	1.02	1.11	1.05	0.88	.93	0.90	0.91	0.91
Sept.	0.75	0.76	0.75	0.82	0.77	0.74	0.81	0.79	0.91	0.81	0.76	0.79	0.75	0.86	0.76
Mean	0.78	0.86	0.86	0.86	0.84	0.76	0.82	0.82	0.85	0.81	0.74	0.76	0.77	0.77	0.76

A- Irrigation every one week.
B- Irrigation every two weeks.
C- Irrigation every three weeks.
S.M.D. = Soil moisture depletion.