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GROWTH PARAMETERS, IRRIGATION REQUIREMENTS AND PRODUCTIVITY OF MAIZE IN RELATION TO SOWING DATES UNDER NORTH-DELTA OF EGYPT CONDITIONS

[26]

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ABSTRACT

Field experiments were conducted in El-Bosaily farm in the Northern Coastal of Egypt during summer seasons of 2015 and 2016 to study the response of the single Cross 10 maize (*Zea mays* L.) hybrid to three sowing dates (1st of May, 1st of June and 1st of July) and three levels of irrigation; 60%, 80% and 100% of irrigation requirements (IR) which applied by drip irrigation system. The experimental design was split plot with four replications where the sowing dates and the irrigation levels were located in the main plots and the sub-plots, respectively. Germination percentage, vegetative growth, indices yield and yield components and water use efficiency were compared under the various sowing dates and irrigation level treatments. The main results were as follows: Vegetative growth traits, yield and water use efficiency of maize were decreased as sowing date delayed beyond the 1st of May. Sowing maize seeds at 1st of July gave the lowest vegetative growth traits and productivity compared to the other sowing dates during both seasons. Meanwhile application of 60% (IR) decreased vegetative growth traits as well as grain yield. Nevertheless, the 100% (IR) irrigation treatments gave the highest vegetative traits and grain yield. In contrary, results showed that the 60% (IR) irrigation requirement gave the highest water use efficiency (WUE). Increasing irrigation water above 60% (IR) led to decrease the values of water use efficiency. Meanwhile, the highest water use efficiency was obtained from the first sowing date (1st May) followed by the second sowing date (1st June) while the lowest value was obtained by the third sowing date (1st July).

Key words*:* Maize *(Zea mays* L.*),* vegetative growth indices seed yield and its components and water use efficiency (WUE)

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops grown during the summer season in Egypt. It globally ranks the third position among cereal crops after wheat and rice **(Gerpacio and Pingali, 2007)**. Increasing maize production became one of the most important goals of the Egyptian agricultural policy to face the human and animal demands. This could be achieved through imply the proper management systems which could improve its productivity (**Medany et al 2009**).

Sowing date is particularly important vital technical operation as it determines the timing of the crop cycles as well as the earliness of the crop harvesting, thus determines the length of the growing stages period according to growing degree days (**Girardin, 1999**). Climate associated with different sowing dates (sunshine duration, solar radiation, air temperature) have a direct effects on the growth and development of maize plants. Moreover, each maize hybrid has an optimum sowing date and the greater the deviation from this optimum (early or late sowing), the greater the yield loss (**Abdrabbo et al 2013**).

Medany et al (2007) stated that optimum temperature for maize growing is between 25 and 30^o C. Maize being a crop of tropical origin requires optimum temperature of 25^{0}C for proper growth and development **(Basu, 1999)** and the prevailing sub-optimum temperatures affect the field emergence and early vegetative phase of the crop. Maize growth is affected adversely when temperature decreases to 5°C or increases beyond 32°C (**Akbar et al 2008**). Raising temperature (+30°C) increases anthesis-silking interval and resulting in poor synchronization of flowering. Further increase in temperature reduces the pollen viability and silk receptivity resulting in poor seed set and yield reduction (**Samuel et al 1986).** Normally in Egypt, maize grows and yields at optimum date from the beginning of May to 1st of June. Warmer temperature has generally a favorable effect on faster crop development. **Campos et al** (**2004)** expected significant yield losses in maize caused by drought/heat stress due to changing global climate.

Water management that maximize yield per unit of water consumed by plant is highly desired in Egypt (**Ibrahim, 1999 and Gaber, 2000**). Last decade, insufficient water supply for irrigation in many cultivated areas in Egypt is being the normal rather than the exception **(Abdrabbo et al 2012)**. Therefore, it is necessary to improve irrigation management in these areas to shift from emphasizing production per unit area towards maximizing the production per unit of water consumed which is called water productivity **(Hegab et al 2014)**. Water availability is the main yield limiting factor, where it is difficult to apply full crop water requirements to sustain maximal growth and yield **(Abdrabbo et al 2013)**. Therefore it is very important to determine how to maintain optimum crop yields under limited irrigation conditions. Recently, this has stimulated the researchers to find new irrigation technologies, systems and irrigation strategies to improve water use efficiency. The application of regulated deficit irrigation strategies is one of the most promising methods to improve irrigation efficiency for major crops **(Farag et al 2016).** A second method involves the use of the modern irrigation systems, which improve the water application efficiency to the plant. Estimating the water consumptive use for field crops in the arid pant of Egypt under different irrigation methods may help in irrigation managements of the important crops (**Phene, 1999**).

The aim of this investigation was to study the effect of three planting dates and three irrigation levels on growth, yield components, seed yield and quality of maize yield to reveal the best combination between irrigation level and sowing date that can be recommended to increase maize yield uner Northern Coastal of Delta conditions.

MATERIAL AND METHODS

Field experiments were carried out at El-Bosaily (31^o 40' N; 30° 40' E), Protected Cultivation Experimental Farm, Central Laboratory for Agricultural Climate (CLAC), Agricultural Research Center (ARC), at Behaira Governorate, in the Northern Coastal of Egypt**.** Experiments aimed to evaluate the effect of sowing dates, irrigation levels and their interaction on growth and yield of maize single cross 10 hybrid.

Data in **Table (1)** showed the measured climatic factors (maximum air temperature **°C** (Max. Temp.), minimum air temperature **°C** (Min. Temp.), Average relative humidity % (Avg. RH), average soil temperature **°C** (Avg ST 20cm.) and wind speed (Avg WS)(m/sec.) during the experimental period (1st of May till mid of September during 2015 and 2016 seasons). These data collected from automated weather station of CLAC allocated at the experimental site.

The treatments comprised three sowing dates (1st of May, 1st of June, and 1st of July of 2015 and 2016) and three irrigation levels (0.60, 0.80 and 1.00 of IR). Calculations of irrigation levels were carried out whereas the irrigation control done via manual valves for each experimental plot. The first step to calculate the amount of irrigation water was to calculate evapotranspiration based on climatic data for farm location by FAO Penman method (**Allen et al 1998).** The potential evepotranspiration was calculated as follows:

$$ET_o = \frac{0.408\Delta(R_n - G) + \gamma \frac{900}{T+273} U_2 (e_s - e_a)}{\Delta + \gamma(1 + 0.34U_2)}$$

Where

ET_o = reference evapotranspiration (mm day^{-1}),
Rn = net radiation at the crop surface (MJ m^{-2} day^{-1}),
G = soil heat flux density (MJ m^{-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 vapor pressure (kPa),
e_a = actual vapor pressure (kPa),

e_s-e_a = saturation vapor pressure deficit (kPa),
Δ = slope vapor pressure curve (kPa $°C^{-1}$),
γ = psychrometric constant (kPa $°C^{-1}$).

The second step was to obtain values of daily irrigation water requirement by cubic meter per feddan according to the next equation **(Doorenbos and Pruitt, 1977) and Keller and Bliesner (1990):**

IR = (ET_o * K_c) * (1+ LR) * 4.2 / Ea ……(m^3 / feddan/ day)

Where:

IR = irrigation requirement for crop (m^3 / feddan/ day)

K_c = Crop coefficient [dimensionless].

ET_o = Reference crop evapotranspiration [mm/day].

LR = Leaching requirement LR (%) (assumed 20% of the total applied water).

Ea = The efficiency of the irrigation system, (assumed 85% of the total applied water).

Table 1. Average monthly climatic data of El-Bosaily location during the two studied seasons of 2015 & 2016.

	Max. Temp.	Min. Temp.	Ave. RH	Soil Temp.	Wind Speed	ETo
	°C	°C	%	°C	m/sec.	mm/day
First season (2015)						
May	27.02	14.64	74	23.69	0.79	4.49
June	28.57	17.21	80	26.54	0.92	4.77
July	30.63	19.20	82	28.94	0.77	4.99
August	31.78	20.31	81	30.22	0.61	4.39
September	31.08	18.63	81	29.31	0.44	3.46
October	28.63	15.31	84	25.24	0.40	2.45
Second season (2016)						
May	28.41	15.50	77.97	25.64	1.08	4.61
June	31.69	18.98	80.08	28.99	0.75	5.15
July	31.07	20.60	85.24	29.93	0.97	5.16
August	33.62	22.25	83.95	31.10	0.64	4.62
September	32.92	20.47	81.91	29.68	0.50	3.78
October	28.73	17.41	84.85	26.41	0.38	2.54

The total amount of irrigation water was measured by water flow-meter for each treatment. **Table (2)** shows the seasonal water quantities for maize single cross 10 hybrid under different irrigation treatments for the three sowing dates at El-Bosaily site during the two seasons. Plants were irrigated by using drippers of 2 l/hr capacity. The chemical fertilizers were injected within irrigation water system.

Table 2. Seasonal drip irrigation quantities applied under different irrigation levels for maize single cross 10 hybrid under the experimental conditions of 2015 and 2016 seasons.

Irrigation	m^3 / feddan/season							
Sowing dates	Season 1				Season 2			
	60%	80%	100%	Mean	60%	80%	100%	Mean
1^{st} May.	1431	1908	2385	**1908**	1460	1947	2433	**1947**
1^{st} June.	1287	1716	2145	**1716**	1311	1748	2184	**1748**
1^{st} July.	1023	1363	1704	**1363**	1069	1425	1781	**1425**
Mean	**1247**	**1662**	**2078**	**1662**	**1280**	**1707**	**2133**	**1707**

Physical and chemical properties of the experiment's soil were analyzed before cultivation according to **Chapman and Pratt (1961)** and the results are tabulated in Tables (3-a and 3-b). The permanent wilting point (PWP) and field capacity (FC) of the trial soil were determined according to **Israelsen and Hansen (1962) and presented in Table (3-a).**

The experiment was designed in a split plot arrangement with four replications. Sowing dates were randomly distributed in the main plots, and irrigation levels allocated in the sub plots. Sub-Plot area was 15 m length x 3 m width, occupying an area of 45 m^2. Plant distances were 0.30 m apart; the distances between rows were 0.70 m. A distance of 2m was left between each two irrigation treatments as a border among the treatments.

All other agriculture practices of maize cultivation were done in accordance with standard recommendations for commercial growers by the Ministry of Agriculture (**Anonymous, 2015).**

Germination percentage was recorded after 15 days of sowing and samples of ten plants of each experimental plot were taken after 75 days from sowing to estimate number of leaves /plant and leaf area index (LAI). At harvest plant height (cm), weight of ears per plant (g), weight of 100 grains (g) and grain yield (ton/fed) were determined from each plot.

Table 3. Some physical and chemical analyses properties of the experimental soil at El-Bosaily site before cultivation.

Table 3.a. Physical analyses

Soil	*Physical properties*						
Depth cm	**Sand %**	**Clay%**	**Silt %**	**Texture**	**FC %**	**PWP %**	**Bulk density g/cm^3**
0-30	96.41	3.30	0.29	Sandy	16.68	5.75	1.46

Table 3.b. Chemical analyses

ECe	**pH**	**meq /l**							
(Mmohs/cm)		**Cations**				**Anions**			
		Ca^{++}	**Mg^{++}**	**Na^{+}**	**K^{+}**	**CO_3^{--}**	**HCO_3^{-}**	**Cl^{-}**	**SO_4^{--}**
1.58	**7.74**	**3.2**	**2.3**	**8.0**	**1.3**	**0.0**	**1.3**	**9.0**	**4.4**

The water use efficiency (WUE) was calculated according to **FAO (1982)** as follows: The ratio of crop yield (Y) to the total amount of irrigation water use in the field for the growth season (IR); WUE (kg/m^3) = Y (kg)/IR (m^3). Water use efficiency and seasonal water consumption were determined after harvesting. Harvesting time was done at maturity symptoms according to sowing date and ranged between 111 days for early (1^{st} May) sowing date and 101 days for lately (1^{st} July) sowing ones.

Analysis of data was done, using SAS program for statistical analysis. The differences among means for all traits were tested for significance at 5% level according to **Waller and Duncan (1969**). The combined analysis of variance for the data of the two seasons was performed after testing the error homogeneity. The differences among means were compared using the test of least significant difference (LSD) at 0.05 probability level.

RESULTS AND DISCUSSIONS

1- Effect of sowing dates and irrigation levels on germination % and vegetative growth traits.

Data in Tables from 4 to 7 illustrated the results of the influence of sowing dates, irrigation levels and their interaction on germination % and vegetative growth traits (plant height, number of leaves per plant and leaf area index), of maize plant as a combined of the two growing seasons.

(a) Germination percentage

Statistical analysis of data the presented in **Table (4)** revealed that sowing dates, irrigation levels and their interactions exerted a significant effect on maize germination percentage. The greatest germination percentage (**94.61**%) was achieved for **1^{st}** May sowing date followed by 1^{st} June (**89.61**%) and finally **1^{st}** July (**81.10**%). Generally, the earlier of sowing date **1^{st}** May was significantly better than other later sowing dates. Early sowing date (1^{st} May) furnished suitable environmental resources i.e climatic and edaphic factors to maize seeds to well germination and seedling establishment. These results trend agree with those obtained by **Gesch** and **Archer (2005) Hegab et al (2014)** and **Oskouei et al (2014).**

Regarding irrigation requirement (IR), 100% irrigation level treatment gave the highest germination percentage followed by 80% of IR treatment; while 60% of irrigation requirement gave the lowest germination percentage. Such finding sustained that surrounding moisture conditions of each of 60% and 80% of IR treatments were not sufficient favorable to germinate maize seeds as a carbohydrates storage seeds. These results agree with those obtained by **Farai et al (2015**).

Regarding the interaction effect, data indicated that there were significant differences among germination values of the studied treatments . Early; sowing date combined by 100% irrigation level treatment gave the highest germination percentage (**97.39%**) followed by first sowing date combined by 80% or irrigation requirement (**95.46%**) while the lowest germination percentage (**77.28%**) was obtained by the late sowing date in the current study combined by 60% of irrigation requirement. These results trend agree with those obtained by by **Russelle et al (1987) and Farai et al (2015**).

Table 4. Effect of sowing dates, irrigation levels and their interactions on germination percentage 15 days from sowing and plant height (cm) of maize hybrid at harvest at El-Bosaily Farm, Behira Governorate, as a combined of 2015 and 2016 growing seasons.

Sowing dates (D)	Combined of the two growing seasons							
	Irrigation levels (I)							
	Germination percentage				Plant height (cm) at harvest			
	60%	80%	100%	Mean	60%	80%	100%	Mean
1st May	90.99	95.46	97.39	**94.61**	232.9	254.8	264.4	**250.7**
1st June	82.61	91.68	94.55	**89.61**	225.8	241.2	252.9	**239.9**
1st July	77.28	80.38	85.66	**81.10**	221.8	231.4	244.4	**232.5**
Mean	**83.63**	**89.17**	**92.53**	**88.44**	**226.8**	**242.5**	**253.9**	**241.0**
L.S.D 5%								
D	**1.78**				**5.25**			
I	**1.12**				**7.10**			
DI	**0.65**				**4.10**			

D= sowing dates I= Irrigation levels DI= sowing dates* Irrigation levels

(b) Vegetative growth characters

Data presented in **Tables (4 and 5)** indicated that there were significant effects of sowing date and irrigation levels on plant height, number of leaves/plant and leaf area index (LAI) of maize plants**.** Regarding the effect of sowing date on plant height, number of leaves/plant and leaf area index (LAI) the early planting date (1st of May) gave the highest values of plant height, number of leaves/plant and leaf area index (LAI); the second sowing date came in the second order; while the lowest plant height, number of leaves/plant and leaf area index (LAI) values were obtained by the lately sowing date (1st of July). Early sowing date (1st of May) performed suitable climate conditions and extending plant duration and thus improves vegetative growth traits of maize plant. These results trend agree with those obtained by **El-Marsafawy et al (2012)** whom confirmed that select appropriate maize hybrid with optimum sowing date led to achieve maximum growth and productivity of this hybrid. While, **Abdrabbo et al (2013)** mentioned that late sowing date decline the vegetative growth and productivity of maize hybrids in the Northern East of Delta.

Regarding irrigation requirement (IR), 100% irrigation level gave the tallest maize plant followed by 80% of IR treatment; while 60% of irrigation requirement gave the shortest plant height. The number of leaves per plant and LAI had the same trend. Well-watered irrigation requirement level (100% of IR) stimulates number and size of plant cell and consequently increased height, number of green leaves and LAI values of maize plant. Similar trend was obtained by **Abdrabbo et al** (**2013**) who reported that the highest vegetative growth in both season were achieved form 100% of irrigation water requirements. The same authors concluded that sufficient irrigation level may be necessary to face the water consumption by maize plant in summer season which led to increase photosynthesis process and nutrient uptake of plant. The same findings was obtained by **(Beiragi et al 2011)** who revealed that sufficient irrigation water led to increase in plant growth in comparison with deficit irrigation levels.

Regarding the interaction effect among sowing dates and irrigation requirement levels, data indicated that there were significant difference among the studied treatments; first sowing date combined by 100% irrigation level gave the highest values of plant height, number of leaves/plant and leaf area index (LAI) followed by first sowing date combined by 80% of irrigation requirement; the lowest plant height was obtained by the last sowing date in the current study combined by 60% of irrigation requirement. The same trend was obtained by **Medany et al (2009).** In this respect **Babiker (1999)** confirmed that using sufficient irrigation quantity, sowing in an appropriate sowing date as well as using proper hybrid led to increase maize growth rate**.**

Table 5. Effect of sowing dates, irrigation levels and their interactions on number of leaves/plant and LAI of maize hybrid plant at El-Bosaily Farm, Behira Governorate, as a combined of 2015 and 2016 growing seasons.

Sowing dates (D)	Combined of the two growing seasons							
	Irrigation levels (I)							
	Number of leaves/plant				Leaf area index (LAI)			
	60%	80%	100%	Mean	60%	80%	100%	Mean
1st May	17.25	20.38	22.38	**20.00**	5.07	5.78	6.09	**5.65**
1st June	15.19	17.13	18.94	**17.09**	3.66	4.28	4.91	**4.28**
1st July	14.32	15.13	15.50	**14.98**	3.12	3.42	3.65	**3.39**
Mean	**15.59**	**17.54**	**18.94**	**17.36**	**3.95**	**4.49**	**4.88**	**4.44**
L.S.D 5%								
D	**0.88**				**0.23**			
I	**0.76**				**0.26**			
DI	**0.44**				**0.15**			

2- Effect of sowing dates and irrigation levels on maize yield and yield components.

Yield and yield components under investigation included: weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.). Results of the influence of sowing dates, irrigation levels and their interactions on such traits are presented in **Tables (6 and 7).**

Data showed that weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) were significantly affected by sowing dates. It is worthy to mention that yield is the quantity of economical crop material harvested per plant or per unit land area. Also, vegetative growth exactly contributed in maximizing obtained yield. So, the effect of sowing date on vegetative characters reflects firstly on yield components and then on the harvested yield. Therefore, the influence of sowing dates on the obtained maize weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) took the same trend of all the recorded yield attributes traits.

Results in **Tables (6 and 7)** cleared that the highest values of weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) were obtained by the **1st** May sowing date followed by the 1st June sowing date. The lowest weights of ears per plant (g), 100 grains (g) and grain yield /fed (ton/fed.) were obtained by the late sowing date (**1st** July) treatment.

In regard to irrigation levels the results indicated that 100% IR irrigation levels followed by 80% IR produced the highest weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.). However 60% IR treatment resulted the lowest ones.

Concerning the interaction effect between sowing dates and irrigation levels, data showed that the highest weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) were obtained by 100 % of irrigation requirement combined with **1st** May sowing date followed by 80 % of irrigation requirement with **1st** May sowing date. The lowest values of weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) were obtained by 60 % of irrigation requirement with the **1st** July sowing date. The obtained results might be due to adequate soil moisture which create favorable conditions which led to increase availability and uptake of nutrients as well as higher photosynthesis process, which might reflected on higher number of leaves per plant and then produce higher weight of ears per plant (g), weight of 100 grains (g) and grain yield /fed (ton/fed.) (**Abdrabbo et al 2013**). The obtained results are in line with tose obtained by **Erdem et al (2006**) on bean and **El-Hendawy et al (2008)** on maize. On the other hand, applying irrigation requirements by using drip irrigation in this study led to increase availability of the nutrient at root zone and increase the crop yield. **(Al-Bakeir, 2003** and **Medany et al 2009**). **Hegab et al (2014)** studied the different irrigation requirement and irrigation level on faba bean; they found that using drip irrigation with proper irrigation application and proper sowing date led to increase the yield as well as enhance the yield component.

Table 6. Effect of sowing dates, irrigation levels and their interactions on weight of ears per plant (g) and weight of 100 grains (g) of maize hybrid at harvest at El-Bosaily Farm, Behira Governorate, as a combined of 2015 and 2016 growing seasons.

Sowing dates (D)	**Combined of the two growing seasons**							
	Irrigation levels (I)							
	Weight of ears per plant (g)				**Weight of 100 grains (g)**			
	60%	**80%**	**100%**	**Mean**	**60%**	**80%**	**100%**	**Mean**
1st May	211.1	247.7	286.8	**248.5**	36.37	41.86	45.17	**41.13**
1st June	160.8	184.7	201.7	**182.4**	34.55	40.06	42.54	**39.05**
1st July	122.8	138.3	146.8	**136.0**	22.88	25.10	32.38	**26.78**
Mean	**164.9**	**190.2**	**211.8**	**188.9**	**31.27**	**35.67**	**40.03**	**35.65**
L.S.D 5%								
D	**6.49**				**1.88**			
I	**10.42**				**1.26**			
DI	**6.02**				**0.73**			

Table 7. Effect of sowing dates, irrigation levels and their interactions on maize hybrid grain yield (ton/fed.) at harvest and water use efficiency (kg/m^3) at El-Bosaily Farm, Behira Governorate, as a combined of 2015 and 2016 growing seasons.

Sowing dates (D)	**Combined of the two growing seasons**							
	Irrigation levels (I)							
	Grain yield /fed (ton/fed.)				**Water use efficiency (kg/m^3)**			
	60%	**80%**	**100%**	**Mean**	**60%**	**80%**	**100%**	**Mean**
1st May	2.63	3.23	3.98	**3.28**	1.82	1.68	1.66	**1.72**
1st June	1.90	2.35	2.70	**2.31**	1.46	1.36	1.25	**1.35**
1st July	1.37	1.64	1.84	**1.62**	1.31	1.17	1.06	**1.18**
Mean	**1.97**	**2.40**	**2.84**	**2.40**	**1.53**	**1.40**	**1.32**	1.**42**
L.S.D 5%								
D	**0.10**				**0.06**			
I	**0.17**				**0.11**			
DI	**0.10**				**0.06**			

3- Effect of sowing dates and irrigation levels on water use efficiency (WUE).

The highest WUE value was obtained by the early sowing date (1st May); while the lowest WUE was obtained by the late (1st July) sowing date as a combined of two growing seasons (Table 7). Water use efficiency (WUE) of maize was significantly responded by irrigation level treatments. In this respect the highest value of WUE was achieved by limited water irrigation (60% of IR) treatments. Contrarily, the lowest WUE value was obtained from well-watered (100%IR) treatment. Interpretation of such finding was reported by **Abdrabbo et al (2013**) who indicate that although irrigation water amounts of 100% and 80% (IR) gave the highest vegetative growth and productivity per plant, the highest water use efficiency as the relative difference in the grain yield was compensated for by the relative difference in the seasonal amount of water which applied to the lowest irrigation water amount 60% of IR. Withal, the highest WUE was obtained by the lowest irrigation level; this maybe the advantage of use drip irrigation system. The frequency of proper water application by drip irrigation is one of the most important factors in drip irrigation management (**Medany et al 2009**). Due to the differences in soil water potential and soil water distribution with depth, grain yield and WUE might differ when the same quantity of water is applied under different irrigation level **(El-Hendawy et al 2008)**. Therefore, it is essential to develop the most suitable irrigation level for different ecological regions, especially as plant water consumption during plant growth depends mostly on soil and climatic conditions (**Nath et al 2001**).

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قياسات النمو والاحتياجات الإروائية وإنتاجية الذرة وعلاقتها بمواعيد الزراعة تحت ظروف شمال الدلتا بمصر

[26]

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الموجـــــــز

أقيمت الدراسة في محطة التجارب البحثية بمنطقة البوصيلى فى محافظة البحيرة خلال موسمى 2015 و2016 وذلك لدراسة استجابة الذرة الشامية (هجين فردى 10) لثلاثة مواعيد زراعة هى (أول مايو، أول يونيو وأول يوليو) وثلاثة مستويات ري هى (60% و80% و100%) من الإحتياجات الإروائية تحت نظام الري بالتنقيط. تم استخدام تصميم قطع منشقة مرة واحدة حيث تم وضع مواعيد الزراعة فى القطع الرئيسية ومستويات الري فى القطع الفرعية. تم تقدير نسبة الإنبات وصفات النمو الخضري والمحصول ومكوناتة وكفاءة استخدام الماء. وكانت النتائج على النحو التالي: أظهرت النتائج أنه بتأخير ميعاد الزراعة عن أول مايو أدى ذلك إلى إنخفاض صفات النمو الخضري والمحصول وكفاءة استخدام المياه في الذرة الشامية. كما أعطى ميعاد الزراعة فى أول يوليو أقل قيم لصفات النمو الخضرى والإنتاجية مقارنة بمواعيد الزراعة الأخرى فى كلا الموسمين. في الوقت نفسه أدى مستوى الرى 60 % من الإحتياجات الإروائية إلى انخفاض صفات النمو الخضري وأيضا انخفاض محصول الحبوب.

بينما أعطى مستوى الري 100 % من الإحتياجات الإروائية أعلى قيم لصفات النمو الخضري ومحصول الحبوب. أظهرت النتائج أن مستوى الري 60% من الإحتياجات الإروائية أعطى أعلى قيم لكفاءة استخدام الماء. كما أدت زيادة مياه الري أعلى من مستوى الرى 60٪ من الإحتياجات الإروائية إلى انخفاض قيم كفاءة استخدام الماء. وفى نفس الوقت تم الحصول على أعلى قيم لكفاءة استخدام الماء مع ميعاد الزراعة الأول (الأول من مايو) يليه تاريخ الزراعة الثاني (الأول من يونيو)، بينما تم الحصول على أقل قيمة في ميعاد الزراعة الثالث (الأول من يوليو).

الكلمات الدالة: الذرة الشامية، صفات النمو الخضري محصول الحبوب ومكوناته وكفاءة استخدام الماء

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