IRRIGATION MANAGEMENT FOR SOME MAIZE CULTIVARS UNDER DIFFERENT PLANT POPULATION

SELIM , m. m

F ield Crop Research Department, National Research Centre ,Dokki, Cairo , Egypt Tel: 02012-4140060 Fax: 0202-3370931 E-mail: selim_nrc11@yahoo.com or selim_family@hotmail.com

Abstract

Throughout, the world fresh water supplies are being depleted and irrigated farmlands are undergoing salinization. Under Egyptian condition most of the cultivated area are depends upon flood irrigation. Recently, the demand for irrigation water increases due to the cultivation of new lands available for horizontal expansion. Therefore the management of irrigation assumes great importance to improve water use efficiency. The optimum irrigation interval is one of the methods that have been used to manage water application. Maize plant is considered as the most sensitive grain crop to water stress. Two field experiments were carried out at clay loam soil in middle Egypt to study the effect of different irrigation interval (10 – 15 and 20 days) under different plant populations (15 – 20 and 30 thousand plants/feddan) on growth, yield and yield component characters as well as grain chemical composition of three maize cultivars, i.e., single cross-10 , three way cross – 310 and open pollinated variety Giza-2. The results obtained reveal that significant differences were found among the tested maize cultivars under different plant populations with respect to growth patterns, yield and yield component characters. Moreover, results also revealed that soil moisture stress have a serious effect on final grain yield.

1 INTRODUCTION

Management of irrigation assumes great importance to improve water use efficiency. The optimum irrigation interval is one of the methods that has been used to mange water application. Maize plant is considered as the most sensitive grain crop to water stress. However, the injury depends on the developmental stage which plants are exposed to drought conditions Grant et al., 1989 and Atta Allah,1996.Inthis respect. Kostandi and Soliman,1998, demonstrated that grain yield was markedly reduced when maize plants were subjected to water stress. Such depressing effect were comparatively high at grain-filling intermediate at tasselling and silking and low at vegetative sensitive to water deficit during the period beginning approximately at tasselling and continuing to grain- filling.

Maize as many other crops is affected by the competition between plants for environmental factors i.e., light, water and mineral nutrients. The reports of Tantway et al., 1998, El-Deep 1990 and Esmail.,1996 showed that increasing plant population significantly increased grain yield per unit area but decreased ear characters and yield components .

Therefore, the objective of the present study was to investigate the response of some maize cultivars to different soil moisture levels (representative here in irrigation intervals) and plant populations to produce the maximum economic grain yield.

2 MATERIAL AND METHODS

Two field experiments were carried out during the two successive seasons of 2000 and 2001 in the extension farm of the Central Administration of the Agricultural Extension at EL-Fashn District,Beni-Sweef Governorate, Egypt to study the effect of different irrigation interval (10 –

15 and 20 days) under different plant populations (15 – 20 and 30 thousand plants/feddan) on growth, yield and yield component characters as well as grain chemical composition of three Plot size was 21 m^2 (6 maize cultivars, i.e., single cross-10 , three way cross – 310 and open pollinated variety Giza-2.The experimental design was split - split with four replications . rows of 5 meters long and 0.7 m. apart). To avoid the effect of lateral movement of irrigation water, the plots were isolated by borders of 1.5 m in width from all sides .The main plots were devoted to irrigation treatments and the sub plots were assigned for plant population .Whereas the three maize cultivars were randomly distributed in the sub -plots . The preceding crop was wheat in both seasons. The chemical and mechanical analysis of the experimental soil sites are presented in Table 1 . The common agricultural practices for growing maize were followed as recommended from the extension services in the region . Two representative plant samples after 70 and 90 days from sowing were collected from three replications of each treatment in which plant height (cm),stem diameter(cm) and ear leaf area (cm^2) were determined . At harvesting, the outer two rows were left to eliminate any border effects and the remaining rows were used for determing the yield and its components i.e., grain yield /plant (g), grain yield /fed. (ton), ear length and diameter (cm), number of rows/ear and 100-kernel weight (g). Total carbohydrate content % in the harvested grain was determined using the methods adopted by Dubois et al . Crude protein and oil percentages were measured according to the methods described by A.O.A.C.

Statistical analysis of data for the two seasons was carried out and results showed nearly the same trend ,thus a combined analysis was done according to Gomez and Gomez 1984 and treatments means were compared by using L.S.D. test.

Table .1 : Mechanical and chemical analysis of the experimental soil sites

Item	2000 season	2001 season
Coarse sand %	**2.30**	**2.48**
Fine sand %	**28.78**	**29.85**
Silt %	**40.47**	**38.07**
Clay %	**28.47**	**29.60**
Texture	**Clay Loam**	**Clay Loam**
Organic matter %	**1.28**	**1.16**
Soluble nitrogen (ppm)	**36.00**	**38.00**
Available phosphorus (ppm)	**8.17**	**8.22**
Total potassium (ppm)	**399.00**	**401.00**
pH	**8.10**	**7.90**

3 RESULTS AND DISCUSSION

3.1 Effect of irrigation intervals:

Data presented in Table 2 and 3 clearly show that decreasing the amount of available soil moisture by extending the interval between successive irritations led ,generally , to a progressive significant reduction in plant height, stem diameter and ear leaf area in the two sampling dates i.e., after 70 and 90 days from sowing . The results indicated further that irrigation maize plants every 10 days exceed significantly, at both samples the other two irrigation intervals (15 and 20 days apart) in most of growth patterns investigated . Similar results were recorded by Ibrahim et al 1995 , Khedr et al 1995 and jun and Ying 1996 .The decrease in vegetative growth criteria as a result of soil moisture stress may be attributed to the loss of turgor which reduces the rate of cell division and cell enlargement. This, in turn, decrease growth rate , stem elongation and leaf expansion . The effect of water stress on cell division and enlargement has carefully discussed by Kramer and Boyer 1995.

Concerning the yield and its components, the data in Tables 4 and 5 reveal that yield component characters as well as final grain yield of maize plants were consistently decreased by extending the irrigation intervals up to 20 days . However, the differences between maize plants irrigated every 10 and / or 15 days on ear length and diameter as well as number of rows/ ear did not reach the significance level .The reduction in maize grain yield resulting from prolonging irrigation intervals , could be ascribed to the effect of inadequate water for many of metabolic and physiological processes. Since nutrients uptake is closely linked to soil water status, it is expected that a decline in available soil moisture might decrease the diffusion rate of nutrients from soil matrix to root Marais and Weirsma 1975. Data presented in Table 6 clearly show that total carbohydrate, crude protein and oil percentages of maize grain were significantly affected by irrigation intervals .It could be noticed that the contents of these chemical constituents were raised by increasing the irrigation intervals from 10 to 15 days. On the other hand ,a reverse trend was observed by delaying the irrigation up to 20 days . the reduction was significant as for total carbohydrate content .The decrement in total carbohydrate content resulting from drought condition may be due to the reduction in photosynthetic activity Jun and Ying 1996 .and / or the inhibition in translocation of stored assimilate into the grain Grand et al . 1989 .

3.2 Effect of plant population:

Data recorded in Table 2 and 3 clearly indicate that increasing plant population from 15 to 20 and /or 30 thousand plant / fed. caused a gradual significant reduction in stem diameter and ear leaf area after 70 and 90 days from planting. An opposite tendency could be noticed regarding plant height at both sampling dates. These results might be attributed to the higher competition between maize plant under high densities in order to obtain light, water and mineral nutrients .The adverse effect of increasing plant population on vegetative growth patterns was previously reported by Soliman et al 1995 and Atta Allah 1996.

Concerning final grain yield and its components. Table 4 and 5 reveal that grain yield / plant, ear length and diameter as well as number of rows / ear were significantly decreased by increasing plant population up to 30 thousand plants/ fed.It is worthy to mention that 100-kernel weight was insignificantly affected by such treatment . The decrease in grain yield/ plant and its components due to increasing plant population might be attributed mainly to great effect of competition among maize plant which negatively effected vegetative growth, as clearly evidenced from Tables 2 and 3 and consequently depressed final grain yield . On the other hand , a significant increase in grain yield/fed. was observed as a result of increasing plant population from 15 to 20 and 30 thousand plants/ fed. The increments in this trait were directly proportional with the level of plant density . Such positive effect could be apparently due to the increase in number of ears per unit area , a concept which is confirmed by the findings of Tantawy et al 1998 . The results of the present study are in full agreement with those published by EL-Deep 1990 ; EL-Bially 1995 ; Esmail 1996 and Tantawy et al 1998. Data presented in Table 6 show that total carbohydrate and crude protein percentage were significantly decreased by increasing plant population up to 30 thousand plant/ fed. The present results are similar with that obtained by Esmail, 1996 and contrasted with those found by Tantway et al., 1998 .

3.3 Effect of varital differences :

Data recorded in Table 2 and 3 reveal that the studied maize cultivars exhibited among themselves significant differences in all growth patterns in both sampling dates (i.e., after 70 and 90 days from sowing). In this concern , SC10 surpassed significantly the two other cultivars (TWC 310 and Giza 2). In addition , Giza 2cultivar had the lowest values in growth criteria .These findings might be attributed to the genetic make up of cultivars and particularly to the large amount of heterogentic effect in hybrids. Concerning yield and yield component of the tested cultivars. It could be noticed from the data in Table 4 and 5 that significant differences between varieties and SC 10 was suerior the other ones, as it recorded the highest

grain yield 3.61 ton/fed. against 3.45 and 3.27 for TWC310 and Giza2 respectively. The superiority of the hybrid cultivars in general and the single cross in particular may be attributed mainly to the increase in yield component characters i.e., ear length and diameter ,number of rows /ear ……. so and so .

3.4 Effect of interactions :

Concerning the interaction effects between the different factors under investigation (irrigation intervals, plant populations and cultivars), it could be clearly noticed from Tables 2 and 3 that all interactions significantly affected growth patterns of maize plants at both sampling dates .

Data recorded show that the interaction effect between the aforementioned factors on yield components are inconsistent, varying from significant to insignificant .

From the data recorded under investigation , it is worthy to note that soil moisture stress has a serious effect on grain yield . Therefore, the application of irrigations every 10 days beginning from the second one combined with planting SC 10 or TWC310 cultivars at density of 30 thousand plants/ fed. could be recommended to obtain the best grain yield .

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Table2 : Effect of irrigation management and plant population as well as their interactions on growth characters of some3 maize cultivars, after 70 days from sowing (average of two seasons).

Irrigation intervals	Plant population Thous./fed	Plant height (cm)			Mean	Stem diameter (cm)			Mean	Eear leaf area (cm)2			Mean
		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2	
Every 10 days	30	277.5	268.7	254.9	267.0	1.85	1.75	1.32	1.64	693.1	685.4	679.2	685.9
	20	254.6	252.7	239.7	249.0	1.95	1.83	1.42	1.73	699.2	689.7	681.7	690.2
	15	244.8	248.2	225.4	239.4	2.13	2.10	1.86	2.03	740.7	721.2	698.4	720.1
Mean		258.9	256.5	240.0	251.8	1.96	1.89	1.53	1.80	711.0	698.8	686.4	698.7
Every 15 days	30	252.9	263.7	224.8	247.1	1.80	1.63	1.19	1.54	700.0	690.8	682.5	691.1
	20	243.7	218.7	209.7	224.0	1.87	1.72	1.44	1.68	710.7	696.7	691.5	699.6
	15	238.2	210.8	200.5	216.5	1.99	1.92	1.54	1.82	725.8	715.6	698.7	713.4
Mean		244.9	231.1	211.7	229.2	1.89	1.76	1.39	1.68	712.2	701.0	690.9	701.4
Every 20 days	30	236.7	242.7	219.2	232.9	1.72	1.58	1.14	1.48	687.5	681.5	679.7	682.9
	20	227.2	221.6	216.6	221.8	1.82	1.62	1.26	1.57	690.5	690.8	688.7	690.0
	15	217.5	201.7	197.8	205.7	1.84	1.75	1.53	1.71	715.2	700.6	690.7	702.2
Mean		227.1	222.0	211.2	220.1	1.79	1.65	1.31	1.58	697.7	690.9	686.4	691.7
General mean of cultivars		243.7	236.5	220.9	233.7	1.89	1.77	1.41	1.69	706.9	696.9	687.9	697.3
General mean of plant population	30	255.7	258.4	232.9	249.0	1.79	1.65	1.22	1.55	693.5	685.9	680.5	686.6
	20	241.8	231.0	222.0	231.6	1.88	1.72	1.37	1.66	700.1	692.4	687.3	693.3
	15	233.5	220.2	207.9	220.5	1.99	1.92	1.84	1.85	727.2	712.5	695.9	711.9
LSD for:													
Irrigation intervals (A)			8.5				0.08					2.50	
Plant popuulation (B)			10.8				0.20					4.60	
Culltivars (C)			4.6				0.12					6.70	
Interaction: (AxB)			6.5				0.05					2.30	
(BxC)			4.3				0.09					3.40	
(AxC)			3.9				0.15					10.30	
(AxBxC)			5.2				0.05					7.20	

Table 3：Effect of irrigation management and plant population as well as their interactions on growth characters of some3 maize cultivars, after 90 days from sowing (average of two seasons).

Irrigation intervals	Plant population Thous./fed	Plant height (cm)			Mean	Stem diameter (cm)			Mean	Eear leaf area (cm)2			Mean
		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2	
Every 10 days	30	289.4	292.7	265.9	282.7	2.15	2.00	1.53	1.89	735.8	725.9	719.4	727.0
	20	279.2	285.6	258.7	274.5	2.22	2.10	1.74	2.02	744.6	731.7	722.3	732.9
	15	266.4	273.8	247.8	262.7	2.31	2.29	1.97	2.19	783.7	765.4	742.6	763.9
Mean		278.3	284.0	257.5	273.3	2.23	2.13	1.75	2.03	754.7	741.0	728.1	741.3
Every 15 days	30	277.9	285.7	243.6	269.1	2.10	1.98	1.47	1.85	748.3	733.5	692.7	724.8
	20	262.4	235.5	239.7	245.9	2.17	2.00	1.68	1.95	756.2	747.2	705.3	736.2
	15	256.7	230.7	224.6	237.3	2.26	2.29	1.84	2.13	775.2	759.8	731.2	755.4
Mean		265.7	250.5	235.9	250.7	2.18	2.09	1.66	1.98	759.9	746.8	709.7	738.8
Every 20 days	30	258.7	263.8	238.2	253.6	1.98	1.85	1.38	1.74	702.8	700.5	677.5	693.6
	20	244.6	246.5	236.9	242.8	2.00	1.88	1.54	1.81	719.6	709.2	698.7	709.2
	15	237.5	220.8	214.2	224.2	2.12	2.00	1.80	1.97	724.3	713.6	705.7	714.5
Mean		246.9	243.7	229.7	240.1	2.03	1.91	1.57	1.84	715.6	707.8	693.9	705.8
General mean of cultivars		263.6	259.5	241.1	254.7	2.15	2.04	1.66	1.95	743.4	731.9	710.6	728.6
General mean of plant population	30	275.3	280.7	249.2	268.4	2.08	1.94	1.46	1.83	728.9	719.9	696.5	715.2
	20	262.1	255.9	245.1	254.3	2.13	1.99	1.65	1.93	740.1	729.4	708.8	726.1
	15	253.5	241.8	228.9	241.4	2.23	2.19	1.87	2.10	761.1	746.3	726.5	744.6
LSD for:													
Irrigation intervals (A)				9.5				0.10					30.00
Plant popuulation (B)				11.7				0.17					8.70
Culltivars (C)				18.0				0.21					10.60
Interaction: (AxB)				3.2				0.05					9.30
(BxC)				5.0				0.12					2.90
(AxC)				7.0				0.13					7.20
AxBxC)				6.8				0.18					5.40

Table 4 : Effect of irrigation management and plant population as well as their interactions on yield component characters of some maize cultivars,.(average of two seasons)

Irrigation intervals	Plant population Thous./fed	Ear length (cm)			Mean	Ear diameter (cm)			Mean	No. of rows/ear			Mean
		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2	
Every 10 days	30	20.0	20.2	20.3	20.2	3.73	3.82	3.48	3.68	45.60	44.50	42.20	44.10
	20	20.9	20.4	20.5	20.6	4.82	4.00	3.98	4.27	42.20	43.20	43.40	42.93
	15	21.4	20.9	20.8	21.0	4.91	4.40	4.30	4.54	44.70	43.50	40.50	42.90
Mean		20.8	20.5	20.5	20.6	4.49	4.07	3.92	4.16	44.17	43.73	42.03	43.31
Every 15 days	30	21.0	20.4	20.0	20.5	3.80	3.90	3.52	3.74	42.50	38.20	40.50	40.40
	20	21.3	20.8	20.2	20.8	4.20	4.50	3.94	4.21	41.20	40.80	39.90	40.53
	15	21.7	21.3	20.5	21.2	4.50	4.80	4.20	4.50	43.30	37.90	40.60	40.60
Mean		21.3	20.8	20.2	20.8	4.17	4.40	3.89	4.15	42.33	38.97	40.33	40.54
Every 20 days	30	18.9	18.7	18.0	18.5	3.00	3.20	2.93	3.04	38.90	35.20	37.30	37.13
	20	19.4	19.5	18.8	19.2	3.40	3.80	3.00	3.40	40.00	37.50	38.20	38.57
	15	20.3	19.8	19.0	19.7	3.60	3.70	3.20	3.50	39.80	38.20	38.50	38.83
Mean		19.5	19.3	18.6	19.1	3.33	3.57	3.04	3.31	39.57	36.97	38.00	38.18
General mean of cultivars		20.5	20.2	19.8	20.2	4.00	4.10	3.62	3.88	42.02	39.89	40.12	40.68
General mean of plant population	30	19.9	19.7	19.4	19.7	3.51	3.64	3.31	3.49	42.33	39.30	40.00	40.54
	20	20.5	20.2	19.8	20.2	4.14	4.10	3.64	3.96	41.13	40.50	40.50	40.71
	15	21.1	20.6	20.1	20.6	4.34	4.30	3.90	4.18	42.60	39.87	39.78	40.78

LSD for:			
Irrigation intervals (A)	1.22	0.62	2.40
Plant popuulation (B)	0.43	0.20	N. S
Culltivars (C)	0.22	0.33	1.30
Interaction: (AxB)	0.93	N.S	2.99
(BxC)	0.96	N.S.....	1.22
(AxC)	1.20	N.S	N.S
(AxBxC)	0.85	N.S	N.s

Table 5 : Effect of irrigation management and plant population as well as their interactions on grain yield of some maize cultivars,.(average of two seasons)

Irrigation intervals	Plant population Thous./fed	100-Kernel weight (gm.)			Mean	Grain Yield / plant (gm.)			Mean	Grain Yield / feddan (ton)			Mean
		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2	
Every 10 days	30	45.60	44.50	42.20	44.10	239.0	225.0	209.0	224.3	4.60	4.39	4.08	4.36
	20	42.20	43.20	43.40	42.93	254.0	242.0	232.0	242.7	3.67	3.63	3.48	3.59
	15	44.70	43.50	40.50	42.90	278.0	254.0	241.0	257.7	3.13	3.13	2.71	2.99
Mean		44.17	43.73	42.03	43.31	257.0	241.3	227.3	241.7	3.80	3.72	3.42	3.65
Every 15 days	30	42.50	38.20	40.50	40.40	221.0	212.0	203.0	212.0	4.31	4.13	3.96	4.13
	20	41.20	40.80	39.90	40.63	243.0	234.0	220.0	232.3	3.85	3.51	3.30	3.49
	15	43.30	37.90	40.60	40.60	256.0	247.0	231.0	244.7	2.88	2.78	2.80	2.75
Mean		42.33	38.97	40.33	40.54	240.0	231.0	218.0	229.7	3.61	3.47	3.29	3.46
Every 20 days	30	38.90	35.20	37.30	37.13	209.0	200.0	197.0	202.0	4.19	3.90	3.84	3.88
	20	40.00	37.50	38.20	38.57	225.0	208.0	205.0	212.7	3.38	3.12	3.07	3.19
	15	39.80	38.20	38.50	38.83	236.0	221.0	209.0	222.0	2.85	2.49	2.38	2.50
Mean		39.57	36.97	38.00	38.18	223.3	209.6	203.6	212.2	3.41	3.17	3.09	3.22
General mean of cultivars		42.02	39.89	40.12	40.68	240.1	227.0	216.3	227.8	3.61	3.45	3.27	3.44
General mean of plant populatio n	30	42.33	39.30	40.00	40.54	223.0	212.33	203.0	212.8	4.37	4.14	3.96	4.16
	20	41.13	40.50	40.50	40.71	240.7	225.0	219.0	229.2	3.57	3.42	3.28	3.42
	15	42.60	39.87	39.87	40.78	256.7	240.7	227.0	241.4	2.89	2.80	2.56	2.75
LSD for:													
Irrigation intervals (A)					2.40				10.50				0.17
Plant popuulation (B)					N.S				11.70				0.54
Culltivars (C)					1.30				8.60				0.16
Interaction: (AxB)					2.99				5.30				0.22
(BxC					1.22				8.20				0.14
(AxC)					N.S				4.60				0.18
(AxBxC)					N.S				6.20				0.24

Table 6: Effect of irrigation management and plant population as well as their interactions on grain chemical composition of some maize cultivars,.(average of two seasons)

Irrigation intervals	Plant population Thous./fed	Total carbohydrate (%)			Mean	Crude protein (%)			Mean	Oil content (%)			Mean
		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2		S.C 10	T.W 310	D.C G. 2	
Every 10 days	30	70.40	71.85	71.96	71.96	6.67	6.89	6.89	6.82	10.59	11.37	11.09	11.02
	20	71.54	79.02	72.13	72.13	6.98	6.91	6.95	6.95	10.42	10.96	10.85	10.74
	15	72.40	75.55	74.96	74.30	7.20	7.00	7.13	7.11	10.32	10.54	10.74	10.53
Mean		71.45	73.47	73.02	72.65	6.95	6.93	6.99	6.96	10.44	10.96	10.89	10.76
Every 15 days	30	71.52	72.15	72.66	72.11	6.95	7.42	7.00	7.12	11.42	11.88	11.92	11.74
	20	72.31	74.12	73.61	73.35	7.22	7.22	7.12	7.19	11.64	12.10	12.46	12.07
	15	73.52	75.89	75.77	75.06	7.52	7.14	7.25	7.30	11.89	12.52	12.72	12.38
Mean		72.45	74.05	74.01	73.51	7.23	7.26	7.12	7.20	11.65	12.17	12.37	12.06
Every 20 days	30	69.27	69.18	69.17	69.21	6.43	6.54	6.66	6.54	10.31	10.21	10.68	10.40
	20	69.54	69.22	69.82	69.53	6.92	6.66	6.25	6.61	10.82	10.30	10.45	10.52
	15	70.22	70.12	70.61	70.32	7.12	6.67	6.13	6.71	11.00	10.35	10.81	10.72
Mean		69.68	69.51	69.87	69.68	6.82	6.69	6.35	6.62	10.71	10.29	10.65	10.55
General mean of cultivars		71.19	72.34	72.30	71.94	7.00	6.96	6.82	6.93	10.93	11.14	11.30	11.12
General mean of plant populatio n	30	72.40	71.08	71.26	70.91	6.68	6.95	6.85	6.83	10.77	11.15	11.23	11.05
	20	71.13	72.12	71.85	71.70	7.04	6.93	6.77	6.91	10.96	11.12	11.25	11.11
	15	72.05	73.85	73.78	73.23	7.28	7.00	6.84	7.04	11.07	11.14	11.42	11.21

LSD for:			
Irrigation intervals (A)	0.90	0.52	1.20
Plant popuulation (B)	0.50	0.10	N.S
Culltivars (C)	1.20	N.S	0.25
Interaction: (AxB)	0.80	0.20	N.S
(BxC)	0.50	N.S	N.S
(AxC)	0.50	N.S	0.13
(AxBxC)	0.70	N.S	N.S