J.Soil Sci. and Agric. Eng., Mansoura Univ., Vol. 8 (4): 163 - 169 , 2017

Evaluation of Induced Microclimate Modification via Changing Planting Dates and/or Irrigation Methods on Maize Water Productivity in Two Locations in Egypt

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ABSTRACT

A field experiment was executed in2015 summer season, at Gemmeiza (Middle Nile Delta, Lat. 30.47, Long. 31.00) at El-Gharbia Governorate and Mallawi (Middle Egypt, Lat. 28.05 Long. 30.44) at El-Minia Governorate to find out the extent to which grain yield, water use and water productivity for SC10 maize hybrid were influenced by irrigation schemes and planting dates and itinteraction. Irrigation schemes (furrow and bed irrigation schemes) were combined with three planting dates (May, 15; May, 30 and June, 14), and assessed in Randomized Complete Block Design andarranged in split plot design. Irrigation schemes were tested in main plots, while the split plots were assigned to planting dates, and each treatment was replicated three times. The important findings could be summarized as follows: * Maize grain yield at Gemmeiza location insignificantly increased thatatMallawi location. The adopted irrigation schemes significantly influenced the grain yield, and furrow irrigation surpassed bed furrow irrigation by 9.15%. Maize grain yield was significantly influencedby planting dates, whereplanting on May, 15 was superior, and the grain yield was increased by 3.77 and 7.42%, comparable with May, 30 and June, 14 planting dates, respectively. * The highest consumptive use (CU) value (600.5 mm) was recorded under Mallawi conditions, which exceeded that under Gemmeiza by 17.86%. Such findings are mainly attributable to prevailing weather conditions during the growing season, which encourages higher crop water use under Mallawi conditions. Water use value under furrow irrigation scheme was higher by 22.24% more than that with bed irrigation. The lowest CU value (542.3 mm) was found for May, 15 planting date, and increased by 2.34 and 4.79%,respectively, comparable withMay, 30 and June, 14 planting dates. *Water productivity (WP) value proved that maize plants, under Gemmeiza conditions, used the irrigation water efficiently by 10.74%, higher than that recorded under Mallawi conditions. Bed irrigation scheme exhibited higher WP value than that recorded with furrow irrigation scheme by 5.15%. The highest WP value (7.74 $kgfad^{-1}mm^{-1}$) resulted from May, 15 planting date, and delaying the planting date to May, 30 or June, 14 caused reductions in WP values being13.05 and 17.05%, respectively, lower than that with May, 15 planting date. Based on the obtained results, maize production at Gemmeiza (Middle Nile Delta, Lat. 30.47 Long. 31.00), compared with Mallawi (Middle Egypt, Lat. 28.05 Long. 30.44) is preferred due to lower water use and higher water productivity as well.

Keywords: Geographic location, Maize grain yield, Water use, Water productivity.

INTRODUCTION

In Egypt, water is considered as scarce natural resource for crop production. The water demand for agriculture is about 85% of the total available water. With the rapid population increase, serious water shortage will occur and critical constrains will face the agricultural development, (FAO, 2017).

Microclimate is a climatic condition in a relatively small area, within a few meters or less above and below the Earth's surface and within canopies of vegetation. Microclimatic conditions depending on factors, such as temperature, humidity, wind and turbulence, dew, frost, heat balance, and evaporation. Microclimate could be affected due to irrigation regime and other agro – management e.g. planting method, fertilization etc. Vegetation is also important, as it controls the flux of water vapor into the air through transpiration. In addition, vegetation can protect the soil below and reduce temperature variability, where the sites of exposed soil exhibited the greatest temperature variability (Encyclopædia Britannica Inc., 2007). Across a single location, there can be a significant number of different microclimates, which have different atmospheric conditions from the areas they are next to, with variations in temperature, light and water all likely to be present. The basic environmental effects and genotype environment interaction have been introduced as the most important sources of alteration for the measured yield of crops (Dehghani *et al.,* 2006; Yan *et al.,* 2007; Sabaghnia and Sabaghpour*,* 2008). Environmental variations related with different sowing dates have an altering effect on the growth and development of corn plants, where each corn hybrid has desirable planting date, and the larger the deflection from this favorite (early or late planting), the larger the yield loss (Sárvári and Futó, 2000; Berzsenyi and Lap, 2001).

The grain yield of corn (*Zea mays* L.) is determined by different proportional contributions of the effective factors in all growth stages from emergence to maturity. On mitigating the negative effect of some abiotic and biotic stress, sowing date and cultural practices (planting method, irrigation scheme …etc.) can play a major role in determining the maize plant performance. So, intensive research that evaluates different geographic locations, genotypes and agricultural practices are needed for a better understanding of climatic and cultural effects on maize crop performance. In Egypt,Swelam and Atta (2012) planted maize in 15- day interval starting on May10th till July11th and they found that grain yield was decreased by 15.2, 10.2, 11.4 and 23.5% for May 10th, May 25th, June 26th and July 11th planting dates, respectively, comparable with June 11thdate. The authors justified such findings to different climate factors affecting on growth stages duration within each planting date, which consequently affected dry matter accumulation and translocation to reproductive organs. Furthermore, the highest value of water productivity, expressed as kg of grain m^{-3} of water consumed was achieved with June 11th planting date.

Worldwide, Koca and Canavar (2014) found that sowing date had statistically affected maize seed yield. Feyzbakhsh *et al.* (2015) planted maize on22nd of June, 6th of July and 21st of July and found that maize grain yield reduced when planting was delayed. However, water use efficiency increased when planting was delayed until 21st of July. Buriro *et al.* (2015) reported that grain yield of maize varieties was significantly affected by different sowing datese.g. 25thof October, 10thof November and 25thof November. The authors added that further delay of the sowing had negative effects on the performance of quantity and quality of maize.

Concerning irrigation schemes, Karrou *et al.* (2012) in two-season field experiment found that maize grain yield under raised bed irrigation was slightly increased, whereas WUE was higher by 29.22%, comparing with traditional farmer practice. Khan *et al.* (2012a) reported that maize grain yield under ridge sowing was increased by 19.62%, comparing with bed sowing. On the contrary,Khan *et al.* (2015) reported that, under 100% field capacity irrigation level, furrow irrigated raised bed was superior than furrow irrigated ridge to increase grain yields, reduce water consumptive use and improve water use efficiency of either spring or summer maize crops. In addition,Hussain *et al.* (2013)stated thatwater use efficiency values were improved with ridge planting, comparable with bed furrow planting. On the contrary, Kuscu and Demir (2012) stated that, according to average of two years, the highest grain yield (20.52 t ha^{-1}) was obtained from full irrigation, and grain yield significantly reduced as the amount and the number of irrigations decreased.

The present research aiming at investigating the extent to which geographic location, planting date, irrigation scheme (planting method) influencing maize crop productivity and water productivity under Gemmeiza and Malawi conditions in Egypt.

MATERIALS AND METHODS

In order to accomplish the research objectives, a field trial was executed at both Gemmeiza (Middle Nile Delta, Lat. 30.47 Long. 31.00)at El-Gharbia Governorate and Mallawi (Middle Egypt, Lat. 28.05 Long. 30.44) at El-Minia Governorate. Bulk density and some soil–water characteristic, and some weather factors of the experimental sites are shown in Table 1 and 2, respectively. Two experimental factors were under investigation e.g. irrigation schemes (furrow and bed irrigation schemes) combined with three planting dates (May 15th, May 30th and June 14th). The adopted treatments were assessed in randomized complete block designarranged in split plot design. Irrigation schemes were tested in the main plots, while the split plots were assigned to planting dates, and each treatment was replicated three times. Each split plot contained 6 ridges, 0.7m in between or 3 beds (1.4m in width). The length for both ridges and beds was 9 m. Single Cross 10 (SC10) maize hybrid was assessed, and all the recommended agricultural practices required for high maize production were done. On grain yield determination, a guarded plant area (not less than $10m^2$) of all the sub plots were harvested and maize grain yield was determined and expressed as $kgfad^{-1}$. Homogeneity test for grain yield data at Gemmeiza and Malawi locations indicated insignificant difference. So, combined analyses of seed yield of both locations were subjected to the proper statistical analyses according to Steel and Torrie (1984) and the means were compared at 0.05 significance level.

Table 1. Some soil – water characteristics of the experimental sites.

Soil depth (cm)	Field capacity (%,wt/wt)	Wilting Point (%,wt/wt)	Bulk density ($Mg\ m^{-3}$)	Available water, mm*
		Gemmeiza		
00 - 15	45.60	24.30	1.10	35.15
15 - 30	42.30	22.10	1.20	36.36
30 - 45	39.50	21.00	1.31	36.35
45 - 60	36.90	18.60	1.38	37.88
Mean	41.10	21.50	1.18	∑ 145.74
		Mallawi		
00 - 15	35.68	19.51	1.14	27.55
15 - 30	33.33	18.20	1.18	26.78
30 - 45	33.25	18.07	1.29	29.37
45 - 60	33.10	17.90	1.31	29.87
Mean	33.90	18.42	1.23	∑ 113.57

***Available water, mm/60 of soil profile**

Table 2. Some weather factors of the experimental sites, 1996-2006 mean*

Month	Temperature (Max.°C)	Temperature (Min.°C)	Wind speed (ms^{-1})	Relativehumidity (%)	Rainfall ($mmmonth^{-1}$)	Epan ($mmday^{-1}$)
			Gemmeiza			
May	32.4	17.3	4.3	57.8	0.0	6.1
June	32.6	20.9	4.2	61.0	0.0	7.2
July	33.7	22.7	4.3	65.9	0.0	7.1
August	33.7	22.9	3.9	65.1	0.0	6.6
September	32.9	22.6	4.0	62.0	0.0	5.4
			Mallawi			
May	33.6	16.9	4.4	49	0.0	7.9
June	35.3	20.6	4.5	51	0.0	8.9
July	35.6	21.2	4.2	54	0.0	9.2
August	36.1	21.7	3.9	57	0.0	8.0
September	34.3	19.8	2.4	53	0.0	7.2

***Supplied by Crop Water Requirements and Field Irrigation Research Department, Soil, Water and Environment Research Institute**

Water consumptive use (Water use):

Soil moisture percentage was determined (on weight basis) just before and 48 hours after each irrigation as well as at harvest to compute the actual consumed water as stated by Hansen *et al.* (1979) as follows:

$$\mathbf{CU = SMD =} \sum_{i=1}^{i=4} \frac{\phi_2 - \phi_1}{100} \mathbf{\ x\ D_{bi}\ x\ D_i}$$

Where:

CU = Water consumptive use (mm) in the effective root zone of 60 cm soil depth.

SMD = Soil Moisture Depletion, mm.

i = Number of soil layer (1- 4).
D_i = Soil layer thickness (150 mm).
D_{bi}= Bulk density (Mgm^{-3}) of the soil layer.
ϕ_1= Soil moisture percentage (wt/wt) before irrigation and
ϕ_2= Soil moisture percentage (wt/wt), 48 hours after irrigation.

Water productivity

Water productivity with dimensions of kg m^{-3} is defined as the ratio of the mass of marketable yield (Ya) to the volume of water used by the crop (ETa) as follows:

Water Productivity (kgm^{-3}) = Ya/ETa …… (Molden, 2003)

Where:

WP= water productivity (kgm^{-3})Ya= maizegrain yield ($kgfed^{-1}$) and
Eta = crop water use or crop evapotraspiration (m^3fed^{-1})

RESULTS AND DISCUSSION

A. Grain yield:

1. Location effect:

Data in Table 3 indicate that maize grain yield at Gemmeiza location insignificantly increased that under Mallawi location. Indubitable, a geographic location affects performance and productivity of a distinct maize genotype due to the different prevailing environmental conditions. In this respect,Leibman *et al.* (2014) stated that despite genetic improvements to hybrid maize; grain yield from distinct maize hybrids is expected to vary across growing locations due to numerous environmental factors. Accordingly, distinguished variations in the performance SC10 maize hybridare predicted due to the adopted locations because of the different prevailing weather and soil characteristics. Furthermore, such variations were reported, in a given location, from growing season to another. EL-Sharkawy *et al.* (2008) reported that maximum maize yield at Gemmeiza reached to 3430 and 3140 $kgfad^{-1}$ in 1^{st} and 2^{nd} seasons, respectively. Additionally, Mahgoub *et al.* (2013) at same location found that yield potential of maize crop amounted to 5290 and 4410 $kgfad^{-1}$, respectively, in 1^{st} and 2^{nd} seasons. Similarly, at Mallawi location, variations in maize yield potential were noticed. El-Tantawy *et al.* (2007)reported that yield potential of maize (TWC 310 Hybrid) grown under Middle Egypt conditions, and irrigated at 1.0 CPE (Cumulated Pan Evaporation) were 7320 and 7200$kgha^{-1}$ in 1^{st} and 2^{nd} seasons of the study, respectively.

Table 3. Irrigation schemes, planting dates and interaction affecting maize grain yield,$Kgfed^{-1}$, under Gemmeiza and Mallawi conditionsin2015.

Location (A)	Irrigation scheme (B)	Planting date (C) May, 15	May, 30	June, 14	Mean
Gemmeiza	Furrow Irrigation	3983	3870	3821	3891.3
	Bed irrigation	3605	3507	3470	3527.3
Mean		3794.0	3688.5	3645.5	3709.3
Mallawi	Furrow irrigation	3979	3845	3709	3844.3
	Bed irrigation	3744	3533	3402	3559.7
Mean		3861.5	3689.0	3555.5	3702.0
Irrigation schemes mean		Furrow Irrigation 3867.8		Bed irrigation 3543.5	
Planting dates mean		May, 15 3827.8	May, 30 3688.8	June, 14 3600.5	
LSD, 05		A N.S	B **37.93	C **14.94	ABC N.S

2. Irrigation scheme effect:

Data in Table 3 indicate that maize grain yield was significantly influenced by the adopted irrigation schemes, and furrow irrigation surpassed bed furrow irrigation by 9.15%. Maize is a responsive crop to the agricultural inputs *vis.* Irrigation water, N fertilizer…etc. so, higher grain yield under furrow irrigation scheme could be attributed to higher applied water, comparing with bed irrigation. In this sense, Lamm *et al.* (1995) stated that it is difficult to plan deficit irrigation for maize without causing yield reduction. Furthermore, Igbadun *et al.* (2008) reported that deficit irrigation at any crop growth stage of the maize crop led to decrease in dry matter and grain yields, seasonal evapotranspiration, deep percolation. In connection, Irmak *et al.*(2016) in 3- season study, assessed the response of maize grain yield under subsurface drip irrigation to water amounts viz. 0, 25, 50, 75 and 125 % (over-irrigation) of the fully irrigated treatment FIT (replenish the top 1.20 m soil profile to approximately 90 % of the FC) under high frequency, where irrigation was practiced approximately every day) and found that grain yield was gradually increased up to FIT and then slightly declined with over irrigation or still unchanged. Additionally, Hussain *et al.* (2013) found that maize grain yield was improved by 16.67% with ridge planting, comparable with bed furrow one. Similar trends were reported by Saqib *et al.* (2012)who reported that ridge planting appreciably increased yield of maize compared with other planting methods. In addition, Abdul Rehman *et al.* (2011) in 2-season investigation, reported that ridge sowing exhibited maize grain yield amounted to 25.0 – 24.39% higher than bed sowing. Furthermore, Khan *et al*. (2012a) found that maize grain yield under ridge sowing was increased by 19.62%, comparing with bed sowing. In addition, Zamir *et al.* (2013) reported that ridge sowing was better than bed sowing with grain yield figures amounted to 6.21 and 4.51 tha^{-1}, respectively. Furthermore, Anjum *et al.* (2014) reported that, under conventional tillage practice, ridge sowing was better than bed sowing with grain yield figures amounted to 6.01 and 5.92 tha^{-1}, respectively. In this sense, Bakht *et al.* (2011) and Khan *et al* (2012b) justified the increase in grain yield with ridge planting, in comparison with bed planting, to loose fertile layer of soil that results well developed root system and consequently higher nutrient and water uptake.

3. Planting date effect:

Data concerning plating dates affecting maize grain yield clarify significant influences due to the adopted planting dates, Table 3. Planting maize on May, 15 surpassed both May, 30 and June, 14, where the grain yield was increased, under May, 15 by 3.77 and 7.42%, comparable with May, 30 and June, 14 planting dates, respectively. In connection, Swelam and Atta (2012) planting maize in 15- days interval starting on May,10 till July,11 and found that grain yield was decreased by 15.2, 10.2, 11.4 and 23.5% for May 10, May 25, June 26 and July 11 planting dates, respectively, comparable with June 11 one. The authors justified such findings to different climate factors affecting on growth stages duration within each planting date, which consequently affected dry matter accumulation and translocation to reproductive organs. Koca and Canavar (2014) found that sowing date had statistically affected maize seed yield. Feyzbakhsh *et al.* (2015) planted maize on22 June, 6 July and 21 July and found that maize grain yield reduced when planting was delayed. Buriro *et al.* (2015) reported that grain yields of maize varieties were significantly affected by different sowing dates e.g. 25th October, 10th November and 25th November. The authors added that further delay of the sowing had negative effects on the performance of quantity and quality of maize. Anapalli *et al.* (2005) found that for optimization of corn yield, planting at the appropriate time is very critical as delay in planting date can lead to a linear decrease in grain yields.

B. Water Consumptive Use (CU):

1. Location effect:

Crop water use is impacted by many factors, including soil and crop characteristics, climate, crop phenology and physiology, agricultural practices, soil and crop nutrients status, etc. Data in Table 4 illustrate that the highest CU value (600.5 mm) was recorded under Mallawi conditions, which exceeded that under Gemmeiza by 17.86%. Data in Table 1 indicated that the value of available soil water in Gemmeiza is higher that its counterpart in Mallawi, which reflect the effect of different microclimate of both sites. This result implied that the applied water for maize in Gemmieza will be lower than Mallawi site. In addition, data in Table 2 referred that the higher water consumption in Mallawi is not only as a result of lower available soil water in, but also as a result of higher pan evaporation rate, which could be affected by the microclimate of this area represented in higher minimum and maximum temperature and lower relative humidity. These differences in the weather elements resulted in higher evaporation pan values in Malawi site, compared to Gemmiza site. This increase in the evaporation pan reflected the effect of microclimate in both sites, which reflected on water consumptive use for maize in each site.In this sense,Kranz *et al.*(2008) stated thatthe amount of daily water use by the crop will vary from season to season and location to location.El-Refaie and Khater (1996) reported that under Gemmeiza conditions, the water requirement of maize was 786 mm. In addition, El-Garhi *et al.* (2007)found that CU valuereached to 669 mmfor 1.0 (irrigation water: cumulative pan evaporation) for maize grown in Middle Egypt.Additionally, El-Tantawy *et al.* (2007)in 2-season experimentat the same both location and irrigation regime, reported thatCU for maize (TWC 310 Hybrid) ranged 5315 – 5686 m^3ha^{-1}. EL-Sharkawy *et al.* (2008)irrigating maize crop via different ET_O formulae, and reported that ETc ranged from487.7 to 530 mm in 1st season and from 427.9 to 500 mm in 2nd one.Molua and Lambi (2006) in Cameroon, found that evapotranspiration of maize crop (ETc) is 276.9mm for Ambam, 381.9mm for Bamenda and 596.4mm for Garoua, and the corresponding reference evapotranspiration (ETo) figures were 413, 570.1 and 890.1mm, respectively.

Table 4. Irrigation schemes, planting dates and interaction affecting water use for maize, mm, under Gemmeiza and Mallawi conditionsin2015.

Location	Irrigation scheme	Planting date May, 15	May, 30	June, 14	Mean
Gemmeiza	Furrow Irrigation	544.0	560.0	571.0	558.3
	Bed irrigation	450.0	462.0	472 .0	461.3
Mean		497.0	511.0	521.5	509.8
Mallawi	Furrow irrigation	649.0	660.0	680.0	663.0
	Bed irrigation	526.0	538.0	550.0	538.0
Mean		587.5	599.0	615.0	600.5
Irrigation schemes mean		Furrow Irrigation 610.7		Bed irrigation 499.6	
Planting dates mean		May, 15 542.3	May, 30 555.0	June, 14 568.3	

2. Irrigation scheme effect:

Data in Table 4 reveal that water use value under furrow irrigation scheme was higher by 22.24% more than that with bed irrigation. Such finding could be attributed to more applied water under furrow irrigation because of the greater plot area that directly contacted with the irrigation water during water supplying compared with bed furrow. So, such situation is increasing water use through canopy transpiration and soil and canopy evaporation. Additionally, data in Table 4 also refer that the attained result may be due to the interaction effect between the microclimate of the site represented by the weather elements and both soil characteristic and irrigation scheme represented by furrow and bed irrigation. In connection, Karrou *et al*. (2012) reported that applied water for maize crop was higher by 38.82% (2- season mean) with traditional furrow irrigation than with raised bed irrigation. In addition, EL-Marsafawy *et al*.(1998), found that irrigation with 140 cm apart furrows, comparable with 70 cm apart furrows, resulted in 8% reduction in evapotranspiration. Moreover, Khan *et al*. (2015) found that furrow irrigated ridge with 100% FC gave the highest evapotranspiration, that increased by 5.20 and 6.56%, respectively, with summer and spring maize, comparable with furrow irrigated raised bed.

3. Planting date effect:

Data in Table 4 indicate that maize water use tended to increase with delaying the planting date, which could be a result of the interaction between the microclimate of the site and the amount of water used by maize. The lowest CU value (542.3 mm) was noticed with May, 15 planting date, and increased by 2.34 and 4.79% under May, 30 and June, 14 planting dates, respectively, comparable with May, 15 one. Such trend may be attributed to the gradual increase in weather conditions encouraging higher evapotranspiration rate with time advancing from May, 15 towards June, 14. In contrast, a late-planted maize crop uses less water by developing more quickly during the hotter portion of the season. Yet, the quicker development leaves less time to produce yield components and generally results in lower overall productivity, Lundy (2015).

C. Water Productivity, WP:

1. Location effect:

Water Productivity (WP) of a crop defines the relationship between the economic or physical yield of the crop and its water use.The factors influencing yield production and water use substantially caused varying WP –values over time and space, Carr *et al*. 2016. Data in Table5 prove that maize plants, under Gemmeiza conditions, were capable to use the irrigation water efficiently, where WP value was higher by 10.74%, as compared with that recorded under Mallawi conditions. Such finding is mainly attributed to less water used by maize crop under Gemmeiza conditions. EL-Sharkawy *et al*. (2008)at Gemmeiza irrigating maize crop via different ETO formulae, and reported that WUE ranged 6.04 –7.16 kgfad-1mm-1 in 1st season and 5.81 – 7.34 kgfad-1mm-1 in 2nd one. In addition, Mahgoub *et al*. (2013) in 2- season experiment at the same location, found that WP for maize (SC10 Hybrid) averaged 1.71kg m-3 on applied water basis El-Tantawy *et al*. (2007)in two-- season experimentat Middle Egypt, reported that WUE for maize ranged 1.27 -1.38 kgm-3. In this sense, Zwart and Bastiaanssen (2004) stated that CWP value per unit water depletion for maize crop, on globally measured average amounted to 1.80 kg m−3. The authors added that measured maize CWP values were ranging from 0.22 kg m−3 up to a maximum of 3.99 kg m−3,which exhibits a large range of variation (CV = 0.38). Such variability of CWP can be ascribed to climate, irrigation water management and soil (nutrient) management, among others.

2. Irrigation scheme effect:

Data in Table 5 reveal thatbed irrigation scheme exhibited higher WP value than that recorded with furrow irrigation scheme by 5.15%. The present results are in parallel with that reported by Karrou *et al*. (2012) who found, in a 2 – season field experiment with maize, that WP under raised bed irrigation surpassed that of traditional farmer practice by 29.61% (2- season mean). In addition, Khan *et al*. (2015) reported that furrow irrigated raised bed showed higher WUE (7.08 and 8.39%) in case of 100% FC comparing with furrow irrigated ridge. On the contrary, Abdullah *et al*. (2008) reported that ridge planting appreciably increased WUE of maize compared with other planting methods. Furthermore, Khan *et al*. (2012b)and Hussain *et al*. (2013) found that WUE figures were improved with ridge planting, comparable with bed furrow planting. Such different trends may be attributed to differed experimentation conditions e.g., soil characteristics, agronomic practices, variety – environment interaction and prevailing weather conditions during the growing season.

Table 5. Irrigation schemes, planting dates and interaction affecting water productivity, kgfad^{-1}mm^{-1}, under Gemmeiza and Mallawi conditions, 2015.

Location	Irrigation scheme	Planting date			Mean
		May, 15	May, 30	June, 14	
Gemmeiza	Furrow Irrigation	7.34	6.91	6.69	6.98
	Bed irrigation	8.01	7.59	7.35	7.65
Mean		7.68	7.25	7.02	7.32
Mallawi	Furrow irrigation	8.48	5.83	5.45	6.59
	Bed irrigation	7.12	6.57	6.19	6.63
Mean		7.80	6.20	5.82	6.61
Irrigation schemes mean	Furrow Irrigation 6.79			Bed irrigation 7.14	
Planting dates mean	May, 15 7.74		May, 30 6.73		June, 14 6.42

3. Planting date effect:

Data in Table 5 indicate that the highest WP value (7.74 kgfad^{-1}mm^{-1}) resulted from May, 15 planting date. Delaying the planting date to May, 30 or June, 14 cause reductions in WP values comprised 13.05 and 17.05%, respectively, lower than that with May, 15 planting date. In this sense, Swelam and Atta (2012) found that the highest value of Water Productivity for maize, (kg of grain m^{-3} of water consumed) was achieved with June 11 planting date, and the value tended to be reduced under earlier planting (May 10 and May 25) or later planting (June 26 and July 11 planting).Feyzbakhsh *et al*. (2015) in 2-year experiment planted maize on22 June, 6 July and 21 July and found that WUE increased when planting was delayed until 21 July.

On conclusion and based on the obtained results, maize production at Gemmeiza (Middle Nile Delta), compared with Mallawi (Middle Egypt), is preferred due to lower water use and higher water productivity as well.

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تقييم احداث التغيرات المناخية علي مستوي الحقل علي انتاجية مياه الري للاذرة الشامية في اقليمي وسط دلتا النيل و مصر الوسطي

محمود ابراهيم بدوي ، نعمت الله مختار يوسف و تهاني نور الدين
قسم بحوث المقننات المائية و الري الحقلي – معهد بحوث الآراضي والمياه والبيئة

اقيمت تجربة حقلية في الموسم الصيفي 2015 فى كلا من محطة البحوث الزراعية بالجميزة (وسط دلتا النيل) ومحطة البحوث الزراعية بملوى (مصر الوسطي)وذلك بهدف دراسة اثر الموفع الجغرافي وطرق الزراعة (الزراعة على خطوط 70 سم أو مصاطب 140 سم) مع مواعيد الزراعة (15 مايو ، 30 مايو ، 14 يونية) والتفاعل بينهم على محصول الحبوب وانتاجية مياه الري في الذرة الشامية هجين فردي 10. اختبرت المعاملات تحت الدراسة في تصميم قطاعات كاملة العشوائية و التوزيع في قطع منشقة وذلك في ثلاثة مكررات ،و خصصت القطع الرئيسية لطرق الزراعة بينما مثلت مواعيد الزراعة بالقطع المنشقة. يمكن اظهار أهم النتائج فيما يلي:1- لم يتأثر محصول الحبوب معنويا لاختلاف الموقع، و لكن اسلوب الزراعة و ميعاد الزراعة كان تأثيرهما معنويا ، و تفوق اسلوب الزراعة على خطوط 70 سم ب 9.15% أفضل من الزراعة علي مصاطب 140 سم ، و كذا تفوق ميعاد الزراعة في 15 مايو ب 3.77 و 7.42%عن كلا من 30 مايو 14 يونيو ، علي التوالي.2- كان الاستهلاك المائي لمحصول الذرة الشامية هجبن فردي 10 بملوي أعلي ب 17.86% عنة بالجميزة، وبعزي ذلك الي الظروف الجوية بملوي والمشجعة لزيادة الاستهلاك المائي للمحصول. الاستهلاك المائي للذرة الشامية تحت الري بالخطوط أعلي ب 22.21% عنة تحت الري بالمصاطب. سجلت أعلي قيمة للاستهلاك المائي لزراعة الذرة الشامية في 15 مايو، وتأخير ميعاد الزراعة أدي الي تقليل الاستهلاك المائي للمحصول تدريجيا.3- انتاجية مياه الري كانت أفضل ب 10.74% في الجميزة مقارنة بملوي. اظهر الري بالمصاطب قيما أعلي لانتاجية مياه الري تقدر 5.15% عنها في الري بالخطوط. أعلي قيمة انتاجية مياه الري (7.74 كجم/فدان/مم) مع زراعة الذرة الشامية في 15 مايو، وتأخير ميعاد الزراعة الي 30 مابو أو 14 يونيو أدي الي خفض انتاجية مياه الري الي 13.05 و 17.05%، علي التوالي. 4- يفضل زراعة الذرة الشامية بالجميزة نظرا لقيم الاستهلاك المائي المنخفضة و أيضا لتفوق انتاجية مياه الري.