Annals of Agric. Sci., Moshtohor **ISSN 1110-0419**
Vol. 59(3) (2021), 689 – 694 **https://assjm.journals.ekb.eg**

Impact of Climate Change on Maize Productivity in Egypt

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Abstract

Two field experiments were conducted at the Experimental and Research Center, Fac. Agric., Moshtohor, Benha Univ., during 2019 and 2020 summer seasons. The aim of this work was to study the response of three yellow maize hybrids (SC 2088, SC P3444 and SC 168) to six planting dates (15th March, 1st April, 15th April, 1st May, 15th May and 1st June). The experimental design was randomized complete block design using split-plots arrangement with three replications. Planting dates were arranged in the main plots and yellow maize hybrids was arranged at random in the sub-plots. The main results were as follows: No. days to 50% tasseling and silking were significantly decreased as planting date delayed beyond the 1st of June. Planting maize seeds on 1st or 15th of May gave the highest values of studied traits and productivity compared to the other planting dates during both seasons. Meanwhile SC P3444 hybrid was significantly earlier than the other hybrids regarding 50% tasseling and silking. Also, SC P3444 hybrid was superior to the other two hybrids in all the studied traits in both seasons. Regarding the interaction effect, between planting dates and yellow maize hybrids were significant differences of 100–grain weight in both seasons and No. days to 50% tasseling, plant height, ear grains weight and grain yield fed^{-1} in the second season. It could be concluded that under the conditions of the experiment, planting SC P3444 hybrid and planting maize seeds on 1st or 15th of May is recommended.

Key Words: *Planting dates, Yellow maize hybrids, Growth, Yield and yield components.*

Introduction

Maize (Zea mays L.) is one of the most important cereal crops used in the human diet in large parts of the world and it is an important feed component for livestock. In terms of total world production and the average over the last five years , maize out ranked paddy rice and wheat **(Huma *et al,* 2019)**. Increasing maize production became one of the most important goals of the Egyptian agricultural policy to face the human and animal demands. The world production of maize has increased in the last decades, and it is expected to increase further in response to the climate change especially in the southern parts of Europe exhibiting a Mediterranean climate **(Elsgaard *et al,* 2012)**. Egypt is one of the most vulnerable regions in the world to climate change risks. Planting dates and yellow maize hybrids are critical for productivity of maize. Attempts to increase maize production could push through breeding for high yielding hybrids as well as climatic conditions.

Sowing date can play a major role in determining the grain yield, quality and understanding whole phenological stages in many regions. Some researchers pointed out that especially, **Medany *et al,* (2007)** in Egypt, this could be achieved through imply the proper management systems which could improve its productivity. **Dahmardeh (2012)** in Iran who reported that the sowing date on the 5th of August produced the maximum grain yield which was similar to sowing dates of 21th July and 20th August as compared with 6th July. **Abdrabbo *et al,* (2013)** in Egypt, reported that climate associated with different sowing dates (sunshine duration, solar radiation, air temperature) has 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. **Hassaan (2018)** in Egypt, who found that the late sowing on 10th Aug. produced the highest significant parameters of maize plants; plant height, No. of ears/plant, number of rows/ear, 1000-grains weight and grain yield. On the reverse, the lowest values were obtained at medium sown on 10th April. **Hegab *et al,* (2019)** in Egypt, indicated that the highest values of plant height, leaf area index, weight of 100 grains and grain yield fed^{-1} were obtained by the 1st May sowing date followed by the 1st of June sowing date. The lowest values were obtained by the late sowing date (1st of July). **Salama (2019)** in Egypt, sowing on 1st of May produced the highest significant amount of fresh yield (41.51 t ha^{-1} in average). However, sowing on 1st of July resulted in the production of significantly lower yield (24.54 t ha^{-1} in average). **Chisanga *et al,* (2020)** in Zambia, The simulation showed evidence of climate change and hence affect maize growth and yield. Therefore, there is a need to put in place strategies for alleviating the impact of climate change in maize production.

In this connection, maize hybrids differ in grain yield and yield attributes as reported by **El-Badawy and Mehasen (2011), Kandil (2013), Eivazi and Habibi (2013), Gomaa *et al,* (2017), Nassar *et al,* (2017), Awdalla *et al* (2018), AL-Shumary *et al,***

(2019), Khalil *et al,* (2019) and Afolabi *et al,* (2020).

The present investigation aimed to study the effect of six planting dates on yield and its attributes for three yellow maize hybrids under meddle-delta conditions in Qalubia Governorate.

Materials and Method

Two field experiments were carried out in the Experimental Field of the Faculty of Agriculture at Mashtohor, Benha Univ., during 2019 and 2020 seasons, to study the effect of six planting dates (15th March, 1st April, 15th April, 1st May, 15th May and 1st June) on yield and yield attributes for three yellow maize hybrids (SC 2088, SC P3444 and SC 168). Maize hybrids namely SC 2088 was developed by Haytic Company, SC P3444 was developed by Pioneer Company and SC 168 was developed by maize Depart. Research, ARC. The soil was clay in texture with a pH value (7.95 and 7.92), an organic matter content (17.1 and 19.3 g kg^{-1}) and total N (0.15 and 0.18%) during the first and second seasons, respectively. The experimental sites were preceded by clover in the two seasons.

The used experimental design was completely randomized block design with a split plot arrangement of treatments in three replications was used in each trial. The six planting dates were allocated with main plots and the three yellow maize hybrids were randomly distributed in the sub plots. The area of sub-plot was 10.5 m^2 (1/400 fed) consisting of 5 ridges, 3.5 m long and 70 cm width while, the distance between plants was 20 cm. At planting, super phosphate (12.5%), at a rate of 30 kg P_2O_5 fed^{-1} was applied. Maize grains were planted on 15th March, 1st April, 15th April, 1st May, 15th May and 1st June in both seasons. All other cultural practices were applied as recommended for this region in both seasons.

Days to 50% tasseling and silking were recorded. Plant height (cm) was measured after 85 days from planting as an average of 10 plants. At harvest, the following data were recorded on 10 individual plants at random: Ear length (cm), No. grains row^{-1}, ear weight (g), grains weight / ear (g) and 100-grain weight (g).On the other hands , both of fodder yield (ton fed^{-1}) and grain yield (kg fed^{-1}) were determined on whole plot basis and adjusted to 15.5% grain moisture content.

Analysis of variance was done for the data of each season by **Snedecor and Cochran (1980)** using the MSTAT-C Statistical Software package (**Michigan State University, 1983**). Mean comparisons were done by least significant difference (LSD) test at the 0.05 level of significance.

Results and Discussion

-Effect of planting dates:

Data in Table 1 illustrated the results of the influence of planting dates on days to 50% tasseling and silking, plant height, ear length, No. grains row^{-1}, ear weight, ear grains weight, 100-grain weight, fodder yield fed^{-1} and grain yield fed^{-1} in two growing seasons. Results revealed that the latest planting date (1st June) was significantly the earliest in tasseling and silking date compared with the other planting dates in the first and second seasons. While, planting date mid-May produced significantly the tallest plants (306.66 and 321.77 cm), tallest ears (20.76 and 21.30 cm), highest No. grains row^{-1} (42.74 and 46.10 grain), heaviest 100–grain weight (33.51 and 36.97 g) and heaviest fodder yield fed^{-1} (32.67 and 33.77 ton) in the first and second seasons, respectively and heaviest values of ear weight (248.33 g), grains weight/ ear (198.06 g) and grain yield fed^{-1} (3529 kg) in the second season. However, planting date first-May gave the heaviest values of ear weight (225.11 g), ear grains weight (186.12 g) and grain yield fed^{-1} (3314 kg) in the first season only. This might be due to that late sowing decreased the effective rate of grain filling, shortened the effective duration of grain filling and plant growth rate during grain filling was slower because of low daily incident radiation and radiation use efficiency. Generally, planting date mid-May or planting date first-May was significantly better than other planting dates. Planting date mid-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 **Abdrabbo *et al* (2013), Hassaan (2018), Hegab *et al* (2019)** and **Salama (2019).**

- Hybrids performance:

The results reported in Table 2 indicated clearly that, there were significant differences among yellow maize hybrids in all studied traits in the two growing seasons. SC P3444 hybrid gave the highest values of plant height, ear length, No. grains row^{-1}, ear weight, ear grains weight, 100-grain weight, fodder yield fed^{-1} and grain yield fed^{-1} compared with the other hybrids in both seasons. In addition, SC P3444 hybrid was significantly the earliest in tasseling and silking dates compared with the other hybrids in the first and second seasons. Such results could be attributed to differences in the genetic constitution of the tested hybrids. The increase in grain yield fed^{-1} might be due to superiority in ear length, No. grains row^{-1}, ear weight, grain weight/ ear, and 100-grain weight grain as shown in Table (1). These results are in harmony with those obtained by **El-Badawy and Mehasen (2011), Kandil, (2013), Eivazi and Habibi (2013), Gomaa, *et al,* (2017), Nassar, *et al,* (2017), Awdalla, *et al* (2018), Khalil, *et al,* (2019), and Afolabi, *et al,* (2020).**

Table 1. Yield and its components of yellow maize as affected by planting dates in 2019 and 2020 seasons

Characters	2019 season						LSD at 5%
	Planting date						
	15th March	1st April	15th April	1st May	15th May	1st June	
No. days to 50% tasseling	78.33	74.00	68.00	63.88	62.55	56.44	1.40
No. days to 50% silking	83.00	79.88	72.66	68.44	65.88	61.77	0.55
Plant height (cm)	274.77	278.77	288.55	302.22	306.66	278.11	2.63
Ear length (cm)	19.42	19.90	19.95	20.26	20.76	18.86	0.43
No. grains row^{-1}	38.42	39.57	40.67	42.24	42.74	39.63	0.97
Ear weight (g)	187.77	197.33	212.33	225.11	221.88	195.55	5.08
Grain weight/ear (g)	143.66	155.38	171.27	186.12	184.73	152.26	5.46
100–grain weight (g)	30.00	31.61	31.83	33.50	33.51	31.33	1.41
Fodder yield (ton fed^{-1})	29.28	29.84	30.40	32.29	32.67	29.77	0.48
Grain yield (kg fed^{-1})	2560	2770	3051	3314	3292	2713	90
Characters	2020 season						
No. days to 50% tasseling	75.44	73.55	70.33	63.77	61.55	55.33	0.82
No. days to 50% silking	81.00	76.11	73.88	71.88	63.88	60.22	0.77
Plant height (cm)	284.28	294.66	305.11	316.37	321.77	286.66	3.15
Ear length (cm)	19.02	19.02	19.40	20.48	21.30	19.07	0.37
No. grains row^{-1}	38.44	39.68	41.31	44.80	46.10	39.57	1.69
Ear weight (g)	201.00	210.33	224.11	240.22	248.33	209.00	4.71
Grain weight/ear (g)	156.66	166.84	180.76	197.22	198.06	163.35	5.11
100–grain weight (g)	30.01	32.71	33.53	35.62	36.97	31.67	1.00
Fodder yield (ton fed^{-1})	29.75	30.15	31.37	33.67	33.77	29.29	0.96
Grain yield (kg fed^{-1})	2791	2971	3220	3516	3529	2912	90

Table 2. Yield and its components of yellow maize as affected by hybrids in 2019 and 2020 seasons

Characters	2019 season			LSD at 5%	2020 season			LSD at 5%
	SC 2088	SC P3444	SC 168		SC 2088	SC P3444	SC 168	
No. days to 50% tasseling	67.16	64.88	69.55	0.64	67.16	63.77	69.05	0.61
No. days to 50% silking	71.72	69.77	74.33	0.45	71.33	69.22	72.94	0.52
Plant height (cm)	293.27	300.77	270.50	2.52	303.38	316.50	284.55	2.09
Ear length (cm)	19.83	20.77	18.97	0.21	19.50	20.78	18.86	0.36
No. grains row^{-1}	41.27	43.01	37.36	0.52	42.32	44.72	37.91	0.99
Ear weight (g)	206.77	218.88	194.33	4.13	224.00	235.27	207.22	2.90
Grain weight/ear (g)	165.83	180.93	149.95	4.24	179.50	192.38	159.57	3.12
100–grain weight (g)	32.47	34.27	30.22	0.63	33.70	35.68	30.87	0.56
Fodder yield (ton fed^{-1})	30.59	32.67	28.86	0.35	31.94	32.81	29.25	0.61
Grain yield (kg fed^{-1})	2954	3224	2672	70	3198	3428	2843	50

- Interactions effect:

The significant interaction among planting dates and yellow maize hybrids on the traits: 100–grain weight in both seasons and No. days to 50% tasseling, plant height, ear grains weight and grain yield fed^{-1} in the second season are shown in Tables 3, 4, 5, 6 and 7. The combination of planting dates with yellow maize hybrids indicated that the earliest values were obtained by planting date on first-June and planting SC P3444 hybrid for No. days to 50% tasseling, in both seasons as shown in Table 3. On the other hand, the latest values in No. days to 50% tasseling were obtained by planting date on mid-march and planting SC 168 hybrid in the first and second seasons. Meanwhile the tallest plants were obtained by planting date on mid-May and planting SC P3444 hybrid for plant height, in both seasons (Table 4). Worthily, the shortest plants in plant height were obtained by planting date on mid-march and planting SC 168 hybrid in the two growing seasons. The maximum means of grains ear weight were obtained from SC P3444 hybrid for higher when planted on mid-May in both seasons (Table).

Table 3. Effect of the interaction between planting dates and yellow maize hybrids on No. days to 50% tasseling in 2019 and 2020 seasons

Planting dates	2019 season			2020 season		
	yellow maize hybrids					
	SC 2088	SC P 3444	SC 168	SC 2088	SC P3444	SC 168
15th March	78.00	77.00	80.00	74.66	72.66	79.00
1st April	73.66	72.33	76.00	73.66	71.66	75.33
15th April	68.00	65.00	71.00	70.66	68.66	71.66
1st May	63.66	62.00	66.00	65.33	59.66	66.33
15th May	63.00	59.33	65.33	62.33	58.00	64.33
1st June	56.66	53.66	59.00	56.33	52.00	57.66
LSD at 5%	NS			1.50		

NS=No significance

Table 4. Effect of the interaction between planting dates and yellow maize hybrids on plant height (cm) in 2019 and 2020 seasons

Planting dates	2019 season			2020 season		
	yellow maize hybrids					
	SC 2088	SC P 3444	SC 168	SC 2088	SC P3444	SC 168
15th March	282.66	289.33	252.33	288.00	296.33	268.53
1st April	285.33	291.66	259.33	294.00	311.00	279.00
15th April	294.66	300.00	271.00	304.33	321.66	289.33
1st May	305.00	313.66	288.00	316.66	332.66	299.80
15th May	309.00	321.66	289.33	323.33	339.33	302.66
1st June	283.00	288.33	263.00	294.00	298.00	268.00
LSD at 5%	NS			5.13		

NS=No significance

The highest values of 100–grain weight (39.33 and 40.93 g) were obtained from SC P3444 hybrid when planted on mid-May, On the other hand, SC 168 hybrid under planting date on mid-march gave the lowest values in 100–grain weight (28.00 and 27.13 g) in the first and second seasons as shown in Table 6. Moreover the highest values of grain yield fed^{-1} (3613 and 3897 kg) were obtained by planting date on mid-May and planting SC P3444 hybrid, respectively in the first and second seasons, whereas the lowest values in these trait (2307 and 2533 kg) were exhibited by SC 168 hybrid under planting date on mid-march in the first and second seasons respectively as shown in Table 7. Late sowing dates (mid-June and July) had a negative effect on both single and three way crosses, and that could be attributed to unfavorable climatic conditions, especially air temperature, low daily incident radiation and radiation use efficiency. Also, sowing single crosses, especially white grains, in mid-May produced the highest grain yield and yield attributes **(Rahuma, 2018)**.

It could be concluded that under the conditions of the experiment, planting SC P3444 hybrid and planting maize seeds at 1st or 15th of May is recommended.

Table 5. Effect of the interaction between planting date and yellow maize hybrids on ear grains weight (g) in 2019 and 2020 seasons

Planting date	2019 season			2020 season		
	yellow maize hybrids					
	SC 2088	SC P 3444	SC 168	SC 2088	SC P3444	SC 168
15th March	143.00	158.66	129.33	154.33	173.50	142.16
1st April	154.00	172.66	139.50	171.03	182.00	147.50
15th April	167.00	187.50	159.33	182.96	193.33	166.00
1st May	193.03	202.33	163.00	204.50	210.83	176.33
15th May	182.33	202.70	169.16	195.33	218.70	180.16
1st June	155.66	161.73	139.40	168.83	175.93	145.30
LSD at 5%	NS			7.65		

NS=No significance

Table 6. Effect of the interaction between planting date and yellow maize hybrids on 100–grain weight (g) in 2019 and 2020 seasons

Planting date	2019 season			2020 season		
	yellow maize hybrids					
	SC 2088	SC P 3444	SC 168	SC 2088	SC P3444	SC 168
15th March	30.33	31.66	28.00	30.83	32.06	27.13
1st April	32.00	33.16	29.66	33.06	34.00	31.06
15th April	32.33	33.66	29.50	33.93	35.00	31.66
1st May	34.00	35.00	31.50	35.53	37.86	33.46
15th May	35.16	39.33	32.50	35.96	40.93	34.03
1st June	31.00	32.83	30.16	32.90	34.23	27.90
LSD at 5%		1.56			1.38	

Table 7. Effect of the interaction between planting dates and yellow maize hybrids on grain yield (kg fed^{-1}) in 2019 and 2020 seasons

Planting date	2019 season			2020 season		
	yellow maize hybrids					
	SC 2088	SC P 3444	SC 168	SC 2088	SC P3444	SC 168
15th March	2547	2827	2307	2750	3090	2533
1st April	2747	3077	2487	3047	3243	2623
15th April	2973	3340	2840	3260	3443	2957
1st May	3437	3603	2903	3643	3760	3143
15th May	3250	3613	3013	3480	3897	3210
1st June	2773	2883	2483	3010	3137	2590
LSD at 5%		NS			130	

NS=No significance

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تأثير التغيرات المناخية على إنتاجية الذرة الشامية في مصر

أحمد إبراهيم طه الصباغ [1] ، ناصر خميس بركات الجيزاوي[1] ، محمود مصطفي إمام الهباق [2] و صديق عبد العزيز صديق محيسن[1]

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أجريت تجربتان حقليتان بمركز البحوث والتجارب بكلية الزراعة بمشتهر– جامعة بنها خلال موسمى الصيف 2019 و 2020 م لدراسة تأثير ست مواعيد زراعة هي (منتصف مارس ، أول إبريل ، منتصف إبريل ، أول مايو ، منتصف مايو ، أول يونيو) علي المحصول وبعض مكوناتة لثلاث هجن فردية للذرة الشامية الصفراء (هايتك 2088 ، بايونيرP3444 ، 168). تم استخدام تصميم القطاعات كاملة العشوائية فى توزيع القطع المنشقة باستخدام ثلاث مكررات. تم وضع مواعيد زراعة فى القطع الرئيسية وتم وضع هجن الذرة الشامية الصفراء عشوائيا فى القطع الشقية. وكانت أهم النتائج هي:

كان هناك نقص معنوي لعدد الأيام من الزراعة حتي طرد النورة المذكرة والمؤنثة بداية من الميعاد الأول حتي الميعاد الأخير في كلا موسمي الزراعة. سجلا ميعادي الزراعة في أول مايو أو منتصف مايو أعلي القيم بفروق معنوية عن مواعيد الزراعة الأخري لكل الصفات المدروسة في كلا موسمي الزراعة.

أعطي الهجين بايونير P3444 أعلى المتوسطات وبفرق معنوي فى كل الصفات المدروسة مقارنة بالهجن الأخرى لكلا موسمي الزراعة. وأيضا سجل نفس الهجين أقل عدد أيام من الزراعة حتي طرد النورة المذكرة والمؤنثة في كلا موسمي الزراعة.

أظهر التفاعل بين مواعيد الزراعة وهجن الذرة الصفراء فروق معنوية لوزن الـ 100 حبة (جم) في كلا موسمي الزراعة ، عدد الأيام حتي طرد النورة المذكرة ، طول النبات (سم) ، وزن حبوب الكوز (جم) ومحصول الحبوب (كجم فدان$^{-1}$) في موسم الزراعة الثاني فقط.

توصي هذه الدراسة تحت ظروف تلك التجربة بأن أفضل ميعاد زراعة هو منتصف مايو أو أول مايو مع زراعة الهجين الأصفر بايونير P3444.