The Effect of Date and Pattern of Sowing on Growth, Productivity and Technological Characters of Cotton (*Gossypium barbadense* L.) Variety Giza 86

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ABSTRACT

Two field experiments were conducted during the 2013 and 2014 summer seasons to investigate the effect of planting dates and planting patterns on productivity and quality characters of Egyptian cotton cultivar Giza 86 (*Gossypium barbadense* L.). Effects of planting date were more pronounced on the studied phenological characters, yield and yield components than the planting patterns. The fiber technological traits including micronaire-reading, fiber maturity, fiber upper half mean length (UHML), uniformity index (UI), short fiber (SF) and fiber strength (Str.) were least affected by either planting dates or planting patterns. Results suggest that growing cotton on the 1st of April is more suitable than delayed sowing for the cultivar Giza 86 and that the standard sowing of seeds on one side of the ridge, in hills 25 cm apart, resulted in better growth characters and highest yields. Also growing cotton on the wide ridges of the preceding wheat crop is not recommended as it resulted in reduction in yield and its components.

Keywords: Cotton, Planting dates, Planting patterns and yield components.

INTRODUCTION

Cotton is the most important fiber crop in the world and in Egypt. In Egypt, it plays a prominent role in agricultural production, industry and national economy. Egyptian cotton used to be the main source of cash income for more than half a million households of farmers (Showler *et al.,* 2005 and Aasim *et al.,* 2008). At the present time, cotton is facing a serious problem, where production costs per unit area have rapidly increased while price is usually fixed and determined by the government (El-Tabbakh, 2001), which forced the majority of cotton growers to shift to growing other more profitable crops like maize or rice. This resulted in reduction in the cotton growing area by 36% to drop to 245 thousand faddan in 2015 compared to about 367 thousand faddan in 2014. One of the major reasons for the reduction in cultivated area was the decline of productivity, which fell to only four kantars per faddan, compared to about seven kantars per faddan in previous seasons (Ahmed *et al.,* 2008 and Ahmed *et al.,* 2013). Hence, it is necessary to find a way to decrease cotton production costs and increase yield per unit area, besides maintaining the fiber quality.

The high value of clover preceding cotton tempted farmers to delay cotton growing to the beginning of May, instead of the recommended 1st of April growing date. The main question raised in the present study was concerned with the negative effects of delaying cotton planting to May, because previous studies recommended that the best planting date in Egypt should be before mid-March (Shalaby, 1972, El-Hariry, 1986 and Shafshak *et al.,* 1987). Another concern raised in this study was growing cotton on wide ridges. A trend gaining interest by farmers namely; growing cotton late in summer on the same wide ridges of the preceding wheat crop. A method presumably lowering the expenses of land preparation, decreasing irrigation requirements, and permitting the growth of cotton following wheat. However, spacing between cotton plants has been shown to have important effects on plant growth and yield characters according to Baker, (1976) and Nadeem *et al.*(2010). Planting dates and planting pattern, are considered important factors for increasing seed cotton yield per unit area (Din *et al.,* 2004, Dong *et al.,* 2006 and Barradas and Lopez-Bellido *et al*., 2009).

The aim of the present study was to investigate the possibility of growing cotton on wide ridges with different patterns to adapt that for growing after wheat crop. Also, to evaluate the effect of sowing dates on seed cotton yield and fiber properties.

MATERIALS AND METHODS

Two field experiments were conducted during the 2013 and 2014 summer seasons at the Agriculture Research Station, Alexandria University. The Egyptian cotton cultivar Giza 86 (*Gossypium barbadense* L.) was employed in this study. A split-plot in randomized complete block design, with three replicates, was used in the two experiments.

The main plots were assigned to three sowing dates: April 1st (D_1), April 15th (D_2) and May 2nd (D_3) in the two seasons. The sub plots were devoted to three sowing patterns (P) and maintaining a fixed plant population of 56000 plants/faddan as follows:

1-On one side of the ridge: "60 cm" between ridges, in hills 25 cm apart and thinned to two plants/hill (P1).

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2-On both sides of wide ridges: "120 cm", in hills 25 cm apart and thinned to two plants/hill (P2).

3-On both sides and the middle of wide ridges: "120 cm" in hills 33 cm apart and thinned to two plants/hill (P3).

Seeds were hand sown on the specified dates. The area of main plots and sub-plots were made up 64.8 m^2 and 21.6 m^2, respectively, where the sub-plot was of 12 ridges or 6 wide ridges of length 3.0 meters.

Phosphorus fertilizer dose of 23.25 kg P_2O_5 per fad. (54 kg P_2O_5 per ha) in the form of calcium monophosphate (15.5% P_2O_5) was added and mixed during seed bed preparation. Nitrogen fertilization was applied at the rate of 60 kg N per fad. (144 N per ha), in the form of ammonium nitrate (33.5% N), in three equal doses. The first dose was applied after thinning, while the second and the third doses were added at four weeks intervals. All the other agricultural practices (cultivation, thinning, weeding, pest control, irrigation, etc.) were carried out as recommended by the Ministry of Agricultural and Land Reclamation (MALR) for the cultivar in the farm zone. Seed cotton picking was made by hand on two stages, at 60% boll opening and one month later.

Five plants were randomly chosen from the eight inner (guarded) ridges of each sub plot and the following characters were recorded on these plants:

1. **Phenological characters:** Plant height (cm), position of the first vegetative node from soil surface (cm), number of vegetative branches/plant, position of the first fruiting node from soil surface (cm) and earliness index, calculated as the number of bolls from the first picking/ total number of bolls X 100.
2. **Yield characters:** Seed cotton yield/plant (g), number of bolls/plant, and boll weight (g).
3. **Technological characters:** Micronaire reading (Mic.), Maturity ratio (Mat.), fiber upper half mean length (UHML) measured in mm, uniformity index percent (UI), fiber strength (Str.), measured in g/tex and percent short fiber (Sf).

Statistical analysis was carried out according to Gomez and Gomez (1984) using SAS (Statistical Analysis System) version 9.3 (2007).

RERSULTS AND DISCUSSION

I- Phenological characters:

Analysis of variance indicated that sowing date significantly affected all plant morphological characters including plant height, position of the first vegetative node and number of vegetative branches/plant (Table 1) and position of the first fruiting node and earliness index (Table 2), in both growing seasons. Planting patterns, on the other hand, had significant effects only on position of the first vegetative node and number of vegetative branches/pant in the 2013 growing season (Table 1) and earliness in both seasons (Table 2). The interaction between sowing dates and plant patterns was significant for all phenological traits (Tables 2 & 4).

In general, it could be observed that late sowing resulted in reduced plant height, lower position of the first vegetative node and first fruiting node, reduced number of vegetative branches/plant and decreased earliness index (Tables 1 & 3).

Planting patterns had very limited effects on all studied phenological characters. Regarding the interaction between sowing dates and planting patterns, it could be observed that the lowest positions of the first vegetative node (12.53 and 12.20 cm) and fruiting node (17.13 and 17.60 cm) were recorded for the late sowing date with the P_2 and P_3 planting patterns, respectively, in 2013 and any of the three planting patterns for position of the first fruiting node in 2014.

Table 1. Mean values for plant height, position of the first vegetative node and number of vegetative branches/plant as affected by sowing dates and planting pattern in 2013 and 2014 summer seasons

Treatments	Plant height (cm)		Position of the first vegetative node (cm)		Number of vegetative branches/ plant	
	S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)
Sowing dates						
D_1: 1st April	150.24 a	152.377 a	20.80 a	21.13 a	2.978 a	3.42 ab
D_2: Mid April	124.86 b	128.04 b	17.22 b	17.84 b	2.822 a	2.93 b
D_3: 1st May	81.77 c	81.66 c	14.511 b	15.2 b	1.755 b	3.84 a
$L.S.D_{0.05}$	7.31	5.41	3.28	3.02	0.72	0.8
Planting Pattern						
P_1: Rows	121.35 a	121.82 a	18.48 a	18.66 a	2.24 b	3.18 a
P_2: Wide ridge in 2 sides	117.88 a	121.28 a	16.11 b	16.75 a	2.88 a	3.64 a
P_3: wide ridges in 2 sides and the top	117.64 a	118.97 a	17.93 ab	18.75 a	2.42 ab	3.36 a
$L.S.D_{0.05}$	7.16	7.62	2.12	2.66	0.41	0.56

*, Means at the same column followed by same letter(s) are not significantly different at 0.05 probability level.

Table 2. Mean values for plant height, position of the first vegetative node and number of vegetative branches/plant as affected by the interaction between sowing dates and planting patterns in 2013 and 2014 summer seasons

Dates	Planting Pattern	Plant height (cm)		Position of the first vegetative node (cm)		Number of vegetative branches/ plant	
		S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)
D_1	P_1	162.66	162.66	21.86	21.13	2.13	2.60
	P_2	143.00	147.46	20.06	21.06	3.86	4.46
	P_3	145.06	147.00	20.46	21.20	2.46	3.20
D_2	P_1	121.93	125.80	14.80	15.20	1.93	3.16
	P_2	121.53	126.66	15.73	16.33	1.60	2.73
	P_3	131.13	131.66	21.13	22.0	1.73	2.90
D_3	P_1	79.46	77.00	18.80	19.66	2.66	3.80
	P_2	88.40	89.73	12.53	12.86	3.20	3.73
	P_3	77.40	78.26	12.20	13.06	3.06	4.00
$L.S.D_{0.05}$		12.40	13.209	3.66	4.62	0.7116	0.26

Table 3. Mean values for position of the first fruiting node, earliness (%) as affected by sowing dates and planting pattern in 2013 and 2014 summer seasons

Treatments	Position of the first fruiting node (cm)		Earliness (%)	
	S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)
Sowing dates				
D_1: 1st April	34.66 a	35.33 a	72.44 a	71.00 a
D_2: Mid April	25.55 b	25.73 b	62.88 b	60.11 b
D_3: 1st May	19.53 c	21.13 c	59.55 c	60.11 b
$L.S.D_{0.05}$	4.35	2.74	2.51	6.55
Planting Pattern				
P_1: Rows	26.288 a	26.95 a	69.00 a	69.22 a
P_2: Wide ridge in 2 sides	25.82 a	27.46 a	62.55 b	62.55 ab
P_3: wide ridges in 2 sides and the top	27.64 a	27.77 a	63.33 b	59.44 b
$L.S.D_{0.05}$	1.97	3.17	5.02	7.21

*, Means at the same column followed by same letter(s) are not significantly different at 0.05 probability level.

Table 4. Position of the first fruiting node as affected by the interaction between sowing dates and planting patterns in 2013 and 2014 summer seasons

Dates	Planting Pattern	Position of the first fruiting node		Earliness (%)	
		S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)
D_1	P_1	31.20	31.73	57.00	60.00
	P_2	37.00	38.06	61.33	65.67
	P_3	35.80	36.20	60.33	54.67
D_2	P_1	23.80	24.73	62.00	59.33
	P_2	23.33	24.46	65.67	63.00
	P_3	29.53	28.00	61.00	58.00
D_3	P_1	23.86	24.40	68.67	68.33
	P_2	17.13	19.86	80.00	79.00
	P_3	17.60	19.13	68.67	65.67
$L.S.D_{0.05}$		3.416	5.5	N.S	N.S

Earliness index was not affected by the interaction between the two studied factors. It appears that the taller plants, elevated position of the first vegetative node, the higher number of vegetative branches/ plant, elevated position of the first fruiting node and late maturity are all consequences of a relatively long growing season with cooler temperatures prevailing during seedling establishment and vegetative growth stages early in April, as compared to the late May sowing. The reduction in plant height and earliness with delayed sowing were also observed by Sultan *et al.* (2012) on Giza 86 in Egypt. Also, El-Tabbakh (2001) reported a

similar decrease in earliness index of about 16% with delayed sowing from April 1st to May 1st.

II- Yield and yield components:

Sowing dates, planting patterns and their interactions had significant effects on weight of seed cotton/plant and number of bolls/plant in both growing seasons (Tables 6 & 7). Only the main effects significantly affected weight of bolls but not their interactions (Table 6). Delayed sowing significantly reduced weight of seed cotton/plant from 58.91 g/plant in 1st April sowing to 33.95 g/plant in 1st May sowing in the 2013 growing season and from 60.79 g/plant to 36.58 g/plant in the 2014 growing season. In addition, a significant reduction in number of bolls/plant was recorded in both seasons (Table 5). The weight of bolls was least affected by the date of sowing. On the other hand, the planting pattern significantly affected seed cotton yield/plant in the first season with P_1 giving significantly high values (51.63 g) than the other planting patterns.

The highest seed cotton yield was observed for the early sowing date (1st April) using the standard growing method, with plants grown on one side of ridge only and 25 cm between hills (P_1), especially in the first season. Sowing on April 1st with the growing patterns P_1 and P_3 were superior in yield to any other growing dates and growing pattern (Table 6). However, the standard growing pattern (P_1) was 39% higher than (P_3) in the first season and 27% higher in the second season, in the 1st April sowing date. The increase in seed cotton yield/plant appears to be an outcome of an increase in number of bolls/plant rather than to boll weight (Table 5).

Table 5. Mean values for seed cotton yield (g)/plant, number of bolls/plant and boll weight (g) as affected by sowing dates and planting pattern in 2013 and 2014 summer seasons

Treatments	Seed cotton yield (g)/plant		Number of bolls/plant		Boll weight (g)	
	S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)
Sowing dates						
D_1: 1st April	58.91 a	60.79 a	25.88 a	27.6 a	2.26 a	2.40 a
D_2: Mid April	44.05 b	49.14 b	19.26 b	20.44 b	2.27 a	2.22 ab
D_3: 1st May	33.95 c	36.58 c	16.35 c	16.28 c	2.21 a	2.07 b
D_1: 1st April	7.11	9.23	3.10	3.43	0.092	0.251
Planting Pattern						
P_1: Rows	51.63 a	53.07 a	22.511 a	22.88 a	2.27 a	2.28 a
P_2: Wide ridge in 2 sides	42.38 b	43.39 a	18.57 a	19.62 a	2.28 a	2.19 a
P_3: wide ridges in 2 sides and the top	42.89 b	50.04 a	19.422 a	21.82 a	2.19 a	2.21 a
$L.S.D_{0.05}$	7.73	12.01	4.14	5.23	0.242	0.339

*, Means at the same column followed by same letter(s) are not significantly different at 0.05 probability level.

Table 6. Mean values for seed cotton yield (g)/plant, number of bolls/plant and boll weight (g) as affected by the interaction between sowing dates and planting patterns in 2013 and 2014 summer seasons

Dates	Pattern	Seed cotton yield (g)/plant		Number of bolls/ plant	
		S_1 (2013)	S_2 (2014)	S_1 (2013)	S_2 (2014)
D_1	P_1	83.36	78.77	34.73	33.86
	P_2	42.80	46.06	19.86	20.86
	P_3	50.58	57.55	23.06	28.06
D_2	P_1	40.10	51.20	19.06	20.33
	P_2	46.57	49.96	19.93	21.46
	P_3	45.48	46.26	18.80	19.53
D_3	P_1	31.45	29.26	13.73	14.46
	P_2	37.79	34.16	15.93	16.53
	P_3	32.62	46.31	16.40	17.86
$L.S.D_{0.05}$		13.40	N.S	0.703	0.855

Table 7. Mean values for technological characters as affected by sowing dates and planting pattern in 2013 and 2014 summer seasons

Treatments	Mic. reading		Mat.		UHML (mm)		UI (%)		SF (%)		Str. (g/tex)	
	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Sowing dates												
D1: 1st April	5.06 [a]	4.89[a]	0.915 [a]	0.888 [a]	33.18 [a]	30.97 [b]	86.11 [a]	85.21 [a]	6.74 [b]	7.32 [a]	39.07 [a]	37.75 [a]
D2: Mid April	4.76 [a]	4.82 [a]	0.900 [ab]	0.891 [a]	31.82 [b]	32.49 [a]	86.22 [a]	86.42 [a]	7.26 [a]	7.30 [a]	39.14 [a]	39.62 [a]
D3: 1st May	4.86 [a]	4.82 [a]	0.88 [b]	0.893 [a]	31.18 [b]	31.50 [ab]	85.5 [a]	84.8 [a]	7.53 [a]	6.66 [b]	39.28 [a]	39.27 [a]
L.S.D$_{0.05}$	0.35	0.52	0.029	0.018	0.90	1.49	2.15	2.58	0.53	0.52	1.83	2.78
Planting pattern												
P_1: Rows	4.97 [a]	4.79 [a]	0.917 [a]	0.892 [a]	32.37 [a]	31.44 [a]	86.23 [a]	84.91 [a]	7.18 [a]	7.03 [a]	39.52 [a]	39.211 [a]
P_2: Wide ridge in 2 sides	4.88 [ab]	4.85 [a]	0.894 [b]	0.890 [a]	31.34 [a]	31.60 [a]	85.36 [a]	85.36 [a]	7.33 [a]	7.32 [a]	38.32 [b]	37.63 [a]
P_3: wide ridges in 2 sides and the top	4.83 [b]	4.89 [a]	0.887 [b]	0.891 [a]	32.48 [a]	31.93 [a]	84.91 [a]	86.23 [a]	7.04 [a]	6.93 [a]	39.66 [a]	39.811 [a]
L.S.D$_{0.05}$	0.12	0.13	0.02	0.009	1.22	1.76	2.23	2.30	0.58	0.97	0.91	4.04

*, Means at the same column followed by same letter(s) are not significantly different at 0.05 probability level.

Table 8. Mean values for technological characters as affected by the interaction between sowing dates and planting patterns in 2013 and 2014 summer seasons

Dates	Pattern	Mic. reading		Mat.		UHML (mm)	SF (%)	Str. (g/tex)
		2013	2014	2013	2014	2014	2014	2014
D_1	P_1	5.23	5.08	0.89	0.89	31.49	7.05	41.76
	P_2	5.04	5.01	0.913	0.89	30.58	7.73	37.53
	P_3	4.91	4.58	0.89	0.88	31.47	7.06	37.93
D_2	P_1	4.42	4.50	0.88	0.886	33.37	6.60	37.86
	P_2	4.72	4.75	0.87	0.890	31.61	6.90	39.73
	P_3	5.13	5.20	0.90	0.896	34.57	6.73	39.83
D_3	P_1	4.83	4.80	0.89	0.893	32.24	7.90	38.93
	P_2	4.87	4.80	0.89	0.890	31.82	7.36	37.70
	P_3	4.88	4.88	0.95	0.896	31.40	7.33	41.23
$L.S.D_{0.05}$		0.184	0.23	0.035	0.015	2.07	1.01	1.57

The results on yield and yield components presented here are in harmony with the results of Sultan *et al.* (2012). A reduction in seed cotton yield/plant between (25 and 19%) was observed in our study when sowing was delayed from 1st April to 1st May in the two seasons, respectively as compared to 6 and 17% in the study of Sultan *et al.* (2012) for the same cultivar in the two studied seasons, respectively. As to boll weight, sowing date had minimal effects on the trait in both studies. Delayed sowing causes reduction in seed cotton yield due to a reduction in the period necessary for full boll growth and maturity and also less favorable conditions for boll maturity (Nawar *et al.* 1986, Barradas and Lopez-Bellido, 2009 and Soomro *et al*., 2014) and higher bollworm infestation (El-Tabbakh, 2001).

As to the effect of sowing date and planting pattern on the technological characters of cotton fiber, it was observed that planting dates had significant effects on fiber maturity in the first season only, UHML and SF% in both seasons, while Mic. reading, UI and Strength (g/tex) were not affected. The planting pattern on the other hand, had only significant effects on Mic. reading, Mat. and strength in the 1st season only. The highest Mic. reading was observed for 1st April sowing date with the standard planting pattern (P_1) in both seasons, due to higher maturity of fibers.

Our results on technological characters of cotton fiber indicated a reduction in Mic. reading, maturity, UI and strength for both seasons with delay in sowing date (Table 7 and 8). On the other hand UHML and SF% were significantly affected by sowing date. As to planting patterns, only in the season of 2014 (Table 7 and 8) were significant variations observed for Mic. reading, maturity and strength, indicating less importance of planting pattern on technological characters. This is not in general agreement with Hons and McMichael (1986), where planting pattern affected Mic. reading and staple length. Also Soomro *et al.* (2014) and Ali *et al.* (2009), working on *G. hirsutum,* observed effects for planting pattern on Mic. reading. However, El-Tabbakh (2001), working on *G. barbadense,* and Barradas and Lopez-Bellido (2009) working on *G. hirsutum*, observed no effects of sowing date on Mic. reading.

Based on the previous results, it was observed that effects of planting date were more pronounced on the studied phenological characters, yield and yield components than the planting patterns. The fiber technological traits including micronaire reading, fiber maturity, fiber upper half mean length (UHML), uniformity index (UI), short fiber (SF) and fiber strength (Str.) were least affected by either planting dates or planting patterns. Results suggest that growing cotton on the 1st of April is more suitable than delayed sowing for the cultivar Giza 86 and that the standard sowing of seeds on one side of the ridge, in hills 25 cm apart, resulted in better growth characters and highest yields. Also growing cotton on the wide ridges of the preceding wheat crop is not recommended as it resulted in reduction in yield and its components.

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الملخص العربي

دراسة تأثير مواعيد ونظم الزراعة على النمو والإنتاجية والصفات التكنولوجية لمحصول القطن صنف جيزة ٨٦

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أجريت الدراسة فى محطة البحوث الزراعية محطة البحوث الزراعية- جامعة الإسكندرية باستخدام صنف قطن جيزة ٨٦ وذلك فى موسمى ٢٠١٣، ٢٠١٤ وذلك باستخدام تصميم القطع المنشقة مرة واحدة فى ثلاث مكررات حيث استخدمت ثلاثة مواعيد للزراعة (أول إبريل- منتصف إبريل-وأول مايو) كمستويات للعامل الرئيسى فى حين استخدمت ثلاثة نظم للزراعة (الزراعة على ريشة واحدة من الخط- الزراعة على ريشتى مصطبة ١٢٠ سم والزراعة على ريشتى وظهر المصطبة ١٢٠ سم) كمستويات للعامل الفرعى لدراسة تأثير مواعيد الزراعة ونظم الزراعة المختلفة على نمو وإنتاجية وجودة ألياف القطن للصنف جيزة ٨٦ وذلك لأنه ظهرت فى الفترة السابقة إتجاهات زراعة غير مدروسة أدت للفلاح بتأخير زراعة القطن بعد محصول القمح وكذلك زراعة القطن على مصاطب القمح دون تجهيز للتربة. ولقد أظهرت النتائج أن ميعاد الزراعة كان له التأثير الأكبر على الصفات الفينولوجية وصفات المحصول ومكوناته مقارنة بنظم الزراعة تحت الدراسة بالنسبة للصفات التكنولوجية ومنها قراة الميكرونير والنضج والطول الفعال UHML ونسبة الإنتظامية UI ونسبة الشعيرات القصيرة SF ومتانة الشعرة Str. فإنها لم تتأثر بشدة بمواعيد الزراعة أونظم الزراعة تحت الدراسة.

أوضحت النتائج أن ميعاد الزراعة المبكر (أول إبريل) هو الميعاد الأفضل عن مواعيد الزراعة المتأخرة لصنف جيزة ٨٦ وأن نظام الزراعة التقليدى (على خطوط بمسافة ٢٥ سم بين الجور) أعطى أفضل صفات للنمو والمحصول.

كذلك أوضحت النتائج أن الزراعة على مصاطب القمح لا ينصح بها كطريقة زراعة حيث أدى استخدامها إلى انخفاض المحصول ومكوناته.