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RESPONSE OF TEN COTTON GENOTYPES (*G. barbadense and G. hirsutum*) TO LATE PLANTING STRESS

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ABSTRACT

Ten cotton genotypes, Giza 83, Giza 85, Giza 87, Giza 88, Giza 89, Giza 90, Giza 92 Pima S-6 ‹Sea Island and Tamcot (nine belong to G. barbadense and one belongs to G. hirsutum), were evaluated under three planting dates (28 March, 18 April and 9 May) in the Agric. Exp. Sta. of Fac. of Agric., Cairo University, Giza in two seasons (2003 and 2004). The objectives were to examine the differential responses of these genotypes to late planting stress, identify the magnitude of stress effect and estimate genetic variance (σ_g^2) *and heritability* (h_b^2) *under late and conventional planting dates. Performance of genotypes varied with planting date. Late planting stress caused significant reductions in seed cotton yield per feddan (SCY), boll weight (BW), mean maturity date (MMD), production rate index (PRI) and earliness index (EI) in both seasons; with maximum reduction in SCY (16.16% in 2003 and 47.14% in 2004).*

Results suggested that the local cultivars Giza 83, and Giza 85 (G. barbadense) and the exotic cultivar Tamcot CE (G. hirsutum) were the most tolerant to late planting stress, while Sea Island cv. (G. barbadense) was the most sensitive one, in this experiment. SCY showed a strong and positive genetic correlation coefficient (r_g) *with BW, seed index and PRI under late planting and a strong and negative* r_g *with MMD under all planting dates. Extimates of* σ_g^2 *and* h_b^2 *were higher under late than under early (conventional) planting date for SCY, MMD and EI traits; indicating that more progress would be expected to be considerably achieved when selection was practiced for higher estimates of these traits under late planting stress.*

Key words: *Cotton, G. barbadense, G. hirsutum, Late planting stress, Genotypic differences.*

INTRODUCTION

Cultivated cotton is a perennial plant with an indeterminate growth habit that has been adapted to annual crop culture. To accomplish this adaptation, plant breeders have placed a strong selection pressure on earliness of crop maturity (Niles 1970).

Cotton cultivars adapted to Egypt have been developed for conventional full-season system, but generally not for late planting in a double cropping system. General trends for Egyptian cotton indicate that early (conventional) planting (full season tests) yielded significantly more than late planting ones (Abd El-Gawad *et al* 1986, El - Okkia *et al* 1989 and El- Kalla *et al* 1994). In the recent years, many cotton farmers in Egypt used to cultivate cotton late (April-May) in order to have a double crop system with wheat and other winter crops and to decrease production inputs of the full season of cotton.

A number of studies indicated that late planting usually resulted in reduced yield and fiber properties due to shortened fruiting period and delayed maturity relative to normal planting (Bauer *et al* 2000 Bange and Milory 2004, Davidanis *et al* 2004 and Shastry *et al* 2001). However, Munk (2001) reported that cotton was able to partially compensate for delayed planting by decreasing monopodial branch number and maintaining high vegetative growth rates in late season. Silvertooth *et al* (2001) evaluated the effects of three planting dates on yield and crop development of 13 varieties of upland cotton. Their results indicated that there was a significant interaction between planting date and variety. Overall, lint yields significantly declined with later planting dates and significantly varied among varieties within each planting date.

Short-season environments provide a challenge to the plant breeder to develop better adapted, high yielding cotton cultivars. Early crop maturity is prerequisite for cultivars grown in such environments because it enables marketable crop to be produced in short season environments (Keim *et al* 1985 and Abo El-Zahab and Amein 1996).

Development of cotton types that will produce an acceptable yield in a shorter period of time has become a major interest of many cotton growing regions of the world (Bilbro and Quisenberry 1973, Christidis and Harrison 1955 and Smith and Varvil 1982).

Genotypic difference in response to late planting dates among cotton genotypes have been reported (Meredith and Bridge 1973, Abott 1976, El-Hariry 1986, Abo El-Zahab and Amein 1996 and Silvertooth *et al* 2001). Therefore, favourable response of cotton genotypes to short–season (late planting) could be improved *via* conventional breeding methods.

The present study was conducted to examine the differential responses of ten cotton cultivars to late planting stress, identify the magnitude of stress effect and estimate genetic variance and heritability under late and conventional planting dates.

MATERIALS AND METHODS

This study was carried out during the two successive seasons 2003 and 2004 at the Agricultural Experiment Station, Fac. of Agric., Cairo Univ., Giza. Ten cotton varieties (nine belong to *barbadense* and one belongs to *hirsutum*) were evaluated across three different planting dates, viz: conventional (CN), medium (M) and late (LP) planting date. The name, origin and species of the ten cultivars of cotton used in this study are presented in Table (1).

Table 1. Name, origin and species of cotton cultivars used in the present study

Ser. No.	Cultivar name	Origin	Species
1	Giza 83	Egypt	*G.barbadense*
2	Giza 85	Egypt	*G.barbadense*
3	Giza 87	Egypt	*G.barbadense*
4	Giza 88	Egypt	*G.barbadense*
5	Giza 89	Egypt	*G.barbadense*
6	Giza 90	Egypt	*G.barbadense*
7	Giza 92	Egypt	*G.barbadense*
8	Pima S – 6	USA	*G.barbadense*
9	Sea Island 12/132	Peru	*G.barbadense*
10	Tamcot Camd E.	USA	*G.hirsutum*

The genotypes were evaluated in both seasons under three different planting dates, i.e. 28 March designated as conventional planting date, 18 April representing medium planting date and 9 May for late planting date that were referred to as D_1 , D_2 and D_3, respectively. The experimental design used was a split plot design in a randomized complete blocks arrangement. Main plots were devoted to planting dates, while subplots were allotted for cotton genotypes. Four replications were used and each sub plot consisted of 3 rows, 60cm width, 3 m length and 20 cm between hills; two plants were left per each hill. Number of surface irrigations given during the season was 8, 7 and 5 irrigations for D_1, D_2 and D_3, respectively. Plots were harvested three times, i.e. on 15 October, 1 November and 15 November.

Data collected

Yield and yield contributing variables:

For determining seed cotton yield components, a representative sample of 50 open bolls was picked from each sub-plot at the first harvest. The characters studied were: boll weight (g), seed index (weight of 100 seeds) (g) and seed cotton yield (kg/plot). Seed cotton yield/plot was determined from the accumulation of seed cotton yield/plot of the three harvests and was converted into seed cotton yield in kg/fed.

Earliness criteria

The seed cotton weights obtained from the three periodic harvests were used in calculating the following earliness criteria:

1- Earliness index (EI %): Expressed as percent of seed cotton yield of the first pick to the total yield.

2- Mean maturity date (MMD, days): The procedure used is the formula given by Christidis and Harrison (1955) and generalized by Bilbro and Quisenberry (1973) as follows:

$$MMD = \frac{\Sigma\ w_i H_i}{\Sigma\ w_i}$$

Where: w_i = weight of seed cotton, H_i = Number of days from planting to the harvest i = 1, 2, N = consecutive periodic harvest

3- Production rate index (PRI) in kg (seed cotton yield/fed/day). The general formula used for calculating this index was that modified by Bilbro and Quisenberry (1973) as follows:

$$PRI = \frac{\text{Total seed cotton weight}}{\text{MMD}}$$

Biometrial manipulation of data

Separate analysis of variance for each year, as well as combined analysis across years for each planting date were conducted as described by Snedecor and Cochran (1989). Estimates of LSD were calculated to test significance of differences between means. Genetic correlation coefficients were calculated between pairs of studied characters under each planting date across the two years according to Singh and Narayanan (2000). The expected mean squares (EMS) of each planting date across the two years (Table 2) were used to estimate the genetic (σ^2_g) and genetic X years interaction (σ^2_{gy}) variances according to Hallauer and Miranda (1988) as follows: $\sigma^2_g = (M_3 - M_2) / ry$, and $\sigma^2_{gy} = (M_2 - M_1)/ r$, where r = number of replications and y = number of years. The phenotypic variance (σ^2_{ph}) was estimated as follows: $\sigma^2_{ph} = \sigma^2_g + (\sigma^2_{gy} / r) + \sigma^2_e / ry)$.

Table 2. Expected mean squares (EMS) of the combined analysis of variance for each planting date across two years.

S.O.V.	d.f.		M.S.	E.M.S.
Years (y)	y - 1	= 1		
Years/reps	y (r-1)	= 6		
Genotypes (G)	(g – 1)	= 9	M_3	$\sigma_e^2 + r\sigma_{gy}^2 + ry\sigma_g^2$
G X Y	(g – 1) (y – 1)	= 9	M_2	$\sigma_e^2 + r\sigma_{gy}^2$
Pooled error	y (r -1) (g – 1)	= 54	M_1	σ_e^2

while the highest similarity value (0.873) was observed between Egyptian variety Sakha61 and the Yemeni Saba'a.

Dendrogram tree separated the eight varieties into two major clusters as shown in Fig. 4. The first cluster was divided into two groups for the Egyptian hexaploid entries which showed variety pairs (Giza164 and Sakha61) and (Giza168 and Sakha92). They were highly related to each others. The second cluster was divided into two groups for the Yemeni tetraploid genotypes which showed that pairs (Behows14 and Smara'a) and (Mysany and Saba'a) were remotely related to each others. However, the relationships among the studied wheat genotypes based on RAPD and ISSR analyses were in agreement with the origin ploidy level of these cultivars.

In conclusion, genetic background of the Egyptian varieties revealed that these studied cultivars were related to each other based on RAPD and ISSR analyses. Besides, the results illustrate that tetraploid cultivars could be distinguished by using molecular markers analyses. Moreover, these molecular markers could distinguish unique bands as specific markers for some Egyptian and Yemeni genotypes.

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Genotypic (GCV) and phenotypic (PCV) coefficients of variation were estimated according to Burton (1952) as follows: GCV = $(\sigma_g / \bar{x})$ 100 and PCV = $(\sigma_{ph} / \bar{x})$ 100, where $\bar{x}$ = respective mean used in calculation.

Heritability in the broad sense (h_b^2) was estimated using the following formula: $h_b^2 = (\sigma_g^2 / \sigma_{ph}^2) \times 100$. Estimates of the genetic covariance component (Cov $g_{1.2}$) between two traits were derived in the same fashion as for the corresponding variance components. These covariance components were substituted in the following formulae to calculate the genotypic (r_g) correlation coefficient as follows: r_g = Cov $g_{1.2} / \sigma_{g_1} \cdot \sigma_{g_2}$ Where, Cov. g_{12} is the genotypic covariance between the two traits, σ_{g_1} is genotypic standard deviation for the first trait (1) and σ_{g_2} is the genotypic standard deviation of the second trait (2).

RESULTS AND DISCUSSION

Analysis of variance

Analysis of variance (Table 3) showed that highly significant differences existed among genotypes for all studied traits, in both seasons (2003 and 2004). Mean squares due to planting dates were highly significant for all studied characters in both years, except for seed index in 2003 season, suggesting that late planting had a significant effect on studied traits. Mean squares due to genotypes X planting dates were highly significant for all studied traits, except for boll weight and seed index in 2003 season. Therefore, the performance of genotypes varied with planting dates for studied traits as reported by other (Abd El-Gwad *et al* 1986, Abo El-Zahab and Amein, 2000 and Shastry *et al* 2001).

Effect of late planting stress

Stress conditions imposed by late planting on 9th of May caused a significant reduction in seed cotton yield (kg) per feddan. This reduction on average of all studied genotypes was 16.16 and 47.14 % for seed cotton yield in 2003 and 2004, respectively (Table 4). Yield reduction due to late planting stress was accompanied by significant losses in boll weight of 9.39 and 9.84% in 2003 and 2004, respectively and seed index of 13.42 % in 2004 season. Late planting stress is expected to cause a reduction in seed cotton yield and its components. A similar trend was reported by Bridge *et al* (1971), Aguillard *et al* (1980) and Abo El-Zahab and Amein (2000).

Table 3. Mean squares for cotton yield, yield components and earliness indices of 10 genotypes (G) evaluated in three planting dates (D) at two seasons (2003 and 2004).

S.V.	d.f.	Seed cotton yield		Boll weight		Seed index	
		2003	2004	2003	2004	2003	2004
Planting dates (D)	2	1038995**	1512573**	0.619**	0.811**	4.98	7.05**
Error	6	398	356	0.003	0.003	1.15	0.015
Genotypes (G)	9	362027**	436521**	1.097**	1.371**	8.63**	9.83**
G × D	18	17885**	22782**	0.069	0.080**	0.991	1.841**
Error	81	583	814	0.003	0.004	0.855	0.019
		Mean maturity date		**Production rate index**		**Earliness index**	
Planting dates (D)	2	585**	5689**	41.36**	35.33**	517.20**	730.16**
Error	6	32	200	0.01	0.074	0.32	1.072
Genotypes (G)	9	87**	1418**	11.92**	19.66**	79.33**	106.51**
G × D	18	116**	679**	0.789**	1.00**	27.38**	42.14**
Error	81	27	107.24	0.02	0.08	0.315	1.176

*, ** = Significant at 5 % and % levels of probability respectively.

Moreover, late planting stress caused a significant reduction across all studied genotypes in mean maturity date (9.39 and 12.00%), production rate index (11.68 and 27.18%) and earliness index (8.63 and 23.36%) in 2003 and 2004, respectively (Table 4). Reductions in maturity indices in cotton as a result of late planting stress were also reported by several investigators (Bilbro and Quisenberry 1973, Kittock and Taylor 1985 and Galanopoulou – Sendouks *et al* 1980).

It worth noting that seed cotton yield followed by production rate index were the most affected traits, with late planting stress conditions, in this study.

Differential responses of genotypes to late planting

The effect of late planting stress on seed cotton yield of each genotype was assessed by two variables, i.e. absolute yield under late planting and yield reduction under late as a percent of early (conventional) planting date, as a tolerance index to late planting stress (Table 4). When an advantage in both high absolute yield under late planting stress and low percentage of reduction was taken as an index of late planting stress tolerance, the local cultivar Giza 83 (*G. barbadense*) could be regarded as the most tolerant in 2003 season and the 2nd most tolerant genotype in 2004 season. Tamcot CE cultivar that belongs to *G. hirsutum* ranked the 2nd in 2003 and the 1st in 2004 regarding tolerance to the conditions imposed by late planting date. The local cultivar Giza 85 ranked 3rd among studied genotypes with regard of its high absolute yield under late planting, high potential yield under early (conventional) planting and low percentage of reduction.

Table 4. Mean performance of seed cotton yield, yield components and earliness indices for 10 genotypes evaluated under three planting dates in two seasons (2003 and 2004).

Genotypes	D_1	D_2	D_3	Reduction %	D_1	D_2	D_3	Reduction %
	2003				2004			
	Seed cotton yield (kg/fed.)							
Giza 83	1275	1408	1245	2.40	1407	1047	927	34.10
Giza 85	1212	1433	1050	13.40	1177	825	751	36.20
Giza 87	905	1018	845	6.60	857	600	548	36.10
Giza 88	952	1103	867	8.90	971	602	571	41.20
Giza 89	1025	1133	767	25.20	848	798	700	17.50
Giza 90	937	1138	787	16.00	840	634	562	33.10
Giza 92	981	1113	765	22.00	1003	656	582	42.00
Pima S-6	1240	1385	850	31.50	1069	951	825	22.80
Sea-Island	912	1040	637	30.20	1068	572	548	48.70
Tamcot CE	1325	1471	1212	8.50	1467	1137	1019	30.50
Average	1076	1224	902	16.16	1070	782	566	47.14
LSD 5%	D=8.63	G=16.41	GD=28.44		D=8.17	G=19.39	GD=33.59	
	Boll weight (g)							
Giza 83	2.55	2.62	2.25	11.80	2.54	2.95	2.33	8.30
Giza 85	2.51	2.63	2.38	5.20	2.74	2.94	2.65	3.30
Giza 87	2.61	2.72	2.19	16.10	2.92	3.11	2.42	17.10
Giza 88	2.43	2.23	2.14	11.90	2.76	2.49	2.41	12.70
Giza 89	2.58	2.60	2.24	13.20	2.86	2.89	2.59	9.40
Giza 90	2.76	2.88	2.47	10.50	2.97	3.16	2.53	14.80
Giza 92	2.90	2.76	2.56	11.70	3.31	3.14	2.91	12.10
Pima S-6	3.05	3.08	2.99	2.00	3.27	3.43	3.26	0.30
Sea-Island	3.05	3.16	2.88	5.60	3.43	3.55	3.01	12.20
Tamcot CE	3.28	3.16	3.00	8.50	3.65	3.59	3.38	7.40
Average	2.77	2.78	2.51	9.39	3.05	3.13	2.75	9.48
LSD 5%	D=0.024	G=0.035	GD=NS		D=0.022	G=0.042	GD=0.072	
	Seed index (g)							
Giza 83	10.86	10.24	10.36	4.60	11.79	11.62	10.31	12.60
Giza 85	11.50	10.50	10.12	12.00	12.89	11.65	10.57	18.00
Giza 87	10.86	10.26	9.97	8.20	11.82	11.78	10.94	7.40
Giza 88	10.56	10.28	10.14	4.00	12.00	11.39	11.40	5.00
Giza 89	11.12	10.78	10.15	8.70	12.35	11.20	10.80	12.60
Giza 90	10.57	11.50	10.07	4.70	12.04	12.96	10.25	14.90
Giza 92	11.57	11.46	10.34	10.60	12.98	13.83	10.76	17.10
Pima S-6	12.73	10.48	11.38	10.60	14.20	11.78	10.69	24.07
Sea-Island	10.74	10.13	10.47	2.50	12.10	13.85	11.30	6. 60
Tamcot CE	13.21	13.37	12.51	5.30	14.56	14.77	12.72	12. 60
Average	11.37	10.90	10.55	7.12	12.67	12.48	10.97	13.42
LSD 5%	D=NS	G=0.63	GD=NS		D=0.05	G=0.09	GD=0.15	

Table 4. Cont.

Genotypes	D1	D2	D3	Reduction %	D1	D2	D3	Reduction %
	Mean maturity date MMD (days)							
	2003				2004			
Giza 83	177.8	175.9	161.7	9.10	171.9	149.5	150.8	12.30
Giza 85	185.6	169.7	163.4	12.00	187.8	157.8	139.2	25.90
Giza 87	176.7	176.4	162.9	7.80	170.7	148.9	148.1	13.20
Giza 88	183.9	178.2	160.7	12.60	183.9	166.7	146.9	20.10
Giza 89	190.3	184.6	166.2	12.70	184.1	176.4	176.0	4.40
Giza 90	182.9	180.2	161.1	11.90	176.9	176.9	137.8	22.10
Giza 92	186.0	182.0	165.5	11.00	181.2	184.1	171.8	5.20
Pima S-6	186.9	171.0	172.0	8.00	186.6	186.1	178.4	4.40
Sea-Island	176.4	182.6	168.8	4.30	172.0	184.0	160.4	6.40
Tamcot CE	172.6	180.6	166.0	3.80	170.8	178.5	161.5	5.40
Average	181.9	178.1	164.8	9.39	178.5	170.8	157.09	12.00
LSD 5%	D=2.4	G=3.6	GD=6.2		D=6.1	G=7.0	GD=12.2	
	Production rate index PRI (kg/fed/day)							
Giza 83	7.7	8.00	7.17	6.84	8.20	9.44	6.91	15.70
Giza 85	6.53	8.45	6.42	1.70	7.35	7.64	5.86	20.30
Giza 87	5.88	5.77	5.18	12.93	5.96	5.81	3.97	33.40
Giza 88	5.39	6.20	5.18	3.90	5.74	5.83	4.75	17.20
Giza 89	5.39	6.14	4.61	14.5	6.13	4.81	4.26	30.50
Giza 90	5.12	6.31	4.88	4.70	6.00	4.96	4.61	23.20
Giza 92	5.28	6.12	4.62	12.50	6.10	5.31	3.73	38.90
Pima S-6	6.63	8.10	4.94	25.5	7.62	6.01	5.20	31.80
Sea-Island	5.17	5.70	3.79	26.7	5.95	5.74	3.50	41.20
Tamcot CE	7.68	8.15	6.95	9.50	9.02	8.29	7.25	19.60
Average	6.08	6.89	5.37	11.68	6.81	6.38	5.00	27.18
LSD 5%	D=0.041	G=0.082	GD=0.146		D=0.118	G=0.191	GD=0.339	
	Earliness index EI (%)							
Giza 83	70.17	71.18	67.39	4.00	79.82	72.16	65.26	18.20
Giza 85	67.93	74.52	64.16	5.50	76.42	75.35	62.46	18.30
Giza 87	65.30	73.05	58.89	9.80	72.13	62.18	57.40	20.40
Giza 88	66.24	66.24	60.42	8.80	75.84	65.51	57.37	24.40
Giza 89	71.53	75.38	64.18	10.30	79.76	65.60	53.32	33.10
Giza 90	64.93	71.32	62.16	4.30	74.47	70.84	56.90	23.60
Giza 92	70.20	70.41	64.52	8.10	78.88	67.98	60.75	23.23
Pima S-6	66.09	74.81	60.37	8.70	72.37	64.16	50.57	30.10
Sea-Island	67.93	74.18	60.37	11.10	77.76	65.60	61.28	21.20
Tamcot CE	73.68	73.29	62.19	15.60	78.50	63.00	61.80	21.30
Average	68.40	72.43	62.46	8.62	76.59	67.23	58.711	23.36
LSD 5%	D=0.246	G=0.381	GD=0.659		D=0.449	G=0.74	GD=1.28	

D_1 = Sowing on 28 March, D2 = 18 April and 9 May dates of planting G = genotypes
GD= genotypes X dates of planting interaction Reduction % = 100 $(D_1 - D_3) / D_1$

It is interesting to mention that Tamcot CE followed by Giza 83 exhibited the highest potential seed cotton yield under early (conventional) planting date in 2003 season (1325 and 1275 kg/fed, respectively) and 2004 season (1467 and 1407 kg/fed, respectively) (Table 4).

On the contrary, the exotic cultivar Sea Island that belongs to *G. barbadense* could be considered as the most sensitive genotype to the late planting stress, under the conditions of this experiment.

Superiority in seed cotton yield was associated with the highest means of boll weight and seed index for Tomcat CE and production rate index for Tomcat CE and Giza 83 (Table 4).

It is worth noting that the Egyptian cultivars Giza 83 and Giza 85 that showed the best seed cotton yield under late planting stress, exhibited also the highest means with regard of earliness index (early maturity) and were among those genotypes exhibiting the lowest numbers of mean maturity date, suggesting their superiority in both yield and earliness indices (Table 4).

Interrelationships between traits

In general, seed cotton yield per feddan showed strong and positive associations with boll weight, production rate index and seed index under late planting (D_3) and seed index and production rate index under medium planting (D_2) date (Table 5). On the contrary, seed cotton yield had a low negative genetic correlation (r_g) with mean maturity date and a low positive r_g with earliness index under the 3 studied planting dates. Similar trend was reported by Tang *et al* (1996) and Navid *et al* (2004).

It is worthy to note that in general, estimates of r_g between yield and studied characters were higher under late planting than under conventional planting date.

Boll weight showed strong positive associations with seed index, production rate index and earliness index and a strong negative association with mean maturity rate under late planting (Table 5). Seed index had a strong positive genetic correlation with mean maturity date under medium and late planting and with production rate index and earliness index under medium planting date. A strong negative association was found between mean maturity date and production rate index under late planting date and strong positive associations were exhibited between production rate index and earliness index under both medium and late planting dates (Table 5).

Genetic variance and heritability

The magnitude of genetic (σ^2_g) and phenotypic (σ^2_{ph}) variances, phenotypic (PCV) and genotypic (GCV) coefficient of variability and broad- sense heritability (h^2_b) of studied traits for the ten cotton genotypes from conventional to late planting dates across two years are presented in

Table 5 .Genotypic correlation coefficients (r_g) between studied traits across seasons and genotypes in the three planting dates (D_1, D_2 and D_3)

Trait	D_1	D_2	D_3
		Seed cotton yield	
Boll weight	0.058	0.093	0.813
Seed index	0.057	0.892	0.694
Mean maturity date	-0.203	-0.314	-0.106
Prod. Rate index	0.074	1.000	0.827
Earliness index	0.034	0.367	0.237
		Boll weight	
Seed index	0.879	0.894	0.946
Mean maturity date	-0.323	0.093	-0.988
Prod. Rate index	-0.012	0.095	0.876
Earliness index	0.470	0.096	1.000
		Seed index	
Mean maturity date	0.144	0.892	1.000
Prod. Rate index	0.78	0.885	0.447
Earliness index	0.256	0.813	0.359
		Mean maturity date	
Prod. Rate index	-0.137	-0.320	-0.320
Earliness index	-0.423	0.360	0.096
		Prod. Rate index	
Earliness index	0.406	0.878	0.981

Table (6). The magnitude of σ^2_g, σ^2_{ph} , GCV and PCV was relatively higher under late than under early (conventional) planting for seed cotton yield per feddan, mean maturity date and earliness index. On the contrary, the magnitude of σ^2_g, σ^2_{ph}, GCV and PCV was larger under conventional than under late planting date for boll weight, seed index and production rate index. This indicates that selection for seed cotton yield, mean maturity date and earliness index is predicted to be more efficient under late than under early planting environments, while using conventional planting date is expected to result in more efficient selection for the remaining traits as compared with using late planting environments .

It is worth noting that σ^2_g under stressed and non-stressed environments constitutes the main part of the σ^2_{ph} , except for mean maturity date under late planting date (Table 6). These results indicate the existence of wide genetic diversity among the 10 genotypes of cotton.

Table 6. Genetic (σ_g^2) and phenotypic (σ_{ph}^2) variances, heritability (h_b^2) in the broad sense, phenotypic (PCV) and genotypic (GCV) coefficient of variability for combined analysis of studied traits under early (D_1), medium (D_2) and late (D_3) planting dates.

Trait	σ_g^2	σ_{ph}^2	h_b^2 %	PCV %	GCV%
			D_1		
Seed cotton yield	28647	36589	78.29	17.8	15.75
Boll weight	0.110	0.165	70.51	14.10	11.52
Seed index	1.02	1.21	84.00	9.22	8.46
Mean maturity date	35.10	48.31	72.64	3.80	3.24
Production rate index	1.13	1.59	71.45	19.80	16.69
Earliness index	6.85	8.59	79.7	4.07	3.63
			D_2		
Seed cotton yield	27889	33218	83.96	18.17	16.60
Boll weight	0.09	0.11	81.82	11.24	10.17
Seed index	0.89	1.05	84.78	8.72	8.26
Mean maturity date	57.54	84.27	68.28	0.52	0.03
Production rate index	1.32	1.57	84.20	18.87	17.30
Earliness index	6.86	8.00	85.75	6.67	3.35
			D_3		
Seed cotton yield	33597	37251	90.19	24.06	22.85
Boll weight	0.065	0.072	90.28	10.05	9.55
Seed index	0.516	0.592	87.16	6.85	6.40
Mean maturity date	82.68	138.94	59.50	7.36	5.68
Production rate index	0.197	0.256	76.73	9.31	8.17
Earliness index	14.79	16.28	90.80	5.80	5.53

Magnitude of broad-sense heritability (h_b^2) estimates (Table 6) under late planting stress was very high for seed cotton yield (90.19%), boll weight (90.28%), earliness index, (90.80%) and seed index (87.16%). For these traits, the magnitude of h_b^2 was higher under late (stressed) than conventional (non-stressed) planting date environments. Expected gain from selection would be higher if selection was practiced under late than under conventional planting date environments for high seed cotton yield and earliness index because of their higher estimates of h_b^2 and σ_{ph}^2 under late than under conventional planting date. Similar trend was reported by Keim *et al* (1985) and Tang *et al* (1996).

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استجابة عشرة تراكيب وراثية من القطن

(G. barbadense and G. hirsutum) لإجهاد الزراعة المتأخرة

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تم تقييم عشرة تراكيب وراثية من القطن جيزة ٨٣ ، جيزة ٨٥ ، جيزة ٨٧ ، جيزة ٨٨ ، جيزة ٨٩ ، جيزة ٩٠ ، جيزة ٩٢ ، Pima S-6 ، Sea Island ، Tamcot) تسعة منها تتبع الـ **G. barbadense** وصنف يتبع الـ **G. hirsutum**) . في ثلاث مواعيد (٢٨ مارس – ١٨ أبريل – ٩ مايو) . في الحقل التجريبي بمحطة البحوث الزراعية بكلية الزراعة – جامعة القاهرة في موسمين (٢٠٠٣ ، ٢٠٠٤). كانت أهداف الدراسة هي اختبار الاختلاف في استجابة أصناف القطن تحت الدراسة لإجهاد الزراعة في المواعيد المتأخرة ، وتحديد مقدار تأثير هذا الاجهاد وتقدير التباين الوراثي وكفاءة التوريث تحت الظروف الناشئة عن الزراعة في مواعيد مختلفة (الميعاد التقليدي والمواعيد المتأخرة) . أختلف أداء التراكيب الوراثية من القطن باختلاف ميعاد الزراعة . سبب إجهاد التأخير في الزراعة نقصاً معنوياً في محصول القطن الزهر للفدان ووزن اللوزة ومتوسط فترة التضج ودليل معدل الإنتاج ومعامل التبكير في كلا الموسمين ، ووصل النقص لحده الأقصى في محصول القطن الزهر (١٦,١٦% موسم ٢٠٠٣ ، ٤٧,١٤ % موسم ٢٠٠٤) . اقترحت النتائج أن الأصناف المحلية جيزة ٨٣ وجيزة ٨٥ (التابعة للـ **barbadense**) والصنف الأجنبي Tamcot CE (التابع لـ **hirsutum**) كانت أكثر الأصناف تحملاً لإجهاد الزراعة المتأخرة بينما كان الصنف Sea Island (التابع للـ **barbadense**) هو الأكثر حساسية ، تحت ظروف هذه التجربة . أظهر محصول القطن الزهر ارتباطا وراثياً قوياً وموجباً مع وزن اللوزة ومعدل البذرة ودليل معدل الإنتاج تحت ظروف الزراعة المتأخرة وارتباطا قوياً وسالباً مع متوسط فترة النضج تحت كل مواعيد الزراعة . كانت تقديرات التباين الوراثي وكفاءة التوريث بالمعني العام أعلي تحت ميعاد الزراعة المتأخر عنها تحت ميعاد الزراعة التقليدي (المبكر) بالنسبة لصفات محصول القطن الزهر ومتوسط فترة النضج ومعامل التبكير ، مما يقترح أنه من المتوقع الحصول علي تقدم وراثي أكثر بالانتخاب للقيم العالية لهذه الصفات تحت ظروف الاجهاد الناتجة عن الزراعة المتأخرة من لو أجري تحت ظروف الزراعة التقليدية .

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2- Mean maturity date (MMD, days): The procedure used is the formula given by Christidis and Harrison (1955) and generalized by Bilbro and Quisenberry (1973) as follows:

$$MMD = \frac{\Sigma\ w_i H_i}{\Sigma\ w_i}$$

Where: w_i = weight of seed cotton, H_i = Number of days from planting to the harvest i = 1, 2, N = consecutive periodic harvest

3- Production rate index (PRI) in kg (seed cotton yield/fed/day). The general formula used for calculating this index was that modified by Bilbro and Quisenberry (1973) as follows:

$$PRI = \frac{\text{Total seed cotton weight}}{\text{MMD}}$$

Biometrial manipulation of data

Separate analysis of variance for each year, as well as combined analysis across years for each planting date were conducted as described by Snedecor and Cochran (1989). Estimates of LSD were calculated to test significance of differences between means. Genetic correlation coefficients were calculated between pairs of studied characters under each planting date across the two years according to Singh and Narayanan (2000). The expected mean squares (EMS) of each planting date across the two years (Table 2) were used to estimate the genetic (σ^2_g) and genetic X years interaction (σ^2_{gy}) variances according to Hallauer and Miranda (1988) as follows: $\sigma^2_g = (M_3 - M_2) / ry$, and $\sigma^2_{gy} = (M_2 - M_1) / r$, where r = number of replications and y = number of years. The phenotypic variance (σ^2_{ph}) was estimated as follows: $\sigma^2_{ph} = \sigma^2_g + (\sigma^2_{gy} / r) + \sigma^2_e / ry)$.

Table 2. Expected mean squares (EMS) of the combined analysis of variance for each planting date across two years.

S.O.V.	d.f.		M.S.	E.M.S.
Years (y)	y - 1	= 1		
Years/reps	y (r-1)	= 6		
Genotypes (G)	(g – 1)	= 9	M_3	$\sigma_e^2 + r\sigma_{gy}^2 + ry\sigma_g^2$
G X Y	(g – 1) (y – 1)	= 9	M_2	$\sigma_e^2 + r\sigma_{gy}^2$
Pooled error	y (r -1) (g – 1)	= 54	M_1	σ_e^2

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