Egypt. J. Plant Breed. 25(1):59– 70(2021)

EVALUATION OF THE PROMISING LONG STAPLE COTTON CROSS [(G83 × G80) × G89] × A 107

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ABSTRACT

A new promising cotton cross {(G83 × G80) × G89} × A 107 belonging to G. barbadense L., was developed by Cotton Breeding Department, Cotton Research Institute, Agricultural Research Center, Giza, Egypt. It is under the varietal approval process and will be named Giza 98 for general cultivation. It was developed through artificial pollination of diversified parents utilizing pedigree selection technique. F_1 population resulting from the parental cross ways advanced by using pedigree method and selection beginning in the F_2 generation. It is accompanied with combinations of excellent fiber traits and higher yield potential and possessing strong tolerance to heat and Fusarium wilt. The superior families were selected from F_5 generation based on yield potential, fiber quality and overall better performance over standard varieties. The regional trial conducted of four growing seasons from 2011 through 2014 in different five locations representing the cultivated zone of this cotton category, the promising cross ({(G83 × G80)× G89}× A107) surpassed all the standard varieties. The new cross is widely adapted and fulfills the requirements of both cotton growers by high yielding and spinners by high lint percentage and good fiber quality as a long staple cotton variety. The new cross was recommended to be released as a new cotton variety.

Keywords***: Gossypium barbadense, new variety, pedigree selection, regional trial.***

INTRODUCTION

The concept of modern cotton breeding is to exploit the global gene pool, create novel variation through hybridization, select and stabilize new varieties for local adaptation. The overall goal of most breeding programs is similar, addressing quantity and quality of output, and then regional production constraints. Breeding to improve cotton cultivation involves a systematic method of observation, data collection and statistical analysis of plant performance in a number of different growing environments.

Egyptian cotton breeder has used artificial hybridization and pedigree method to develop Egyptian cotton varieties (Awad *et al* 2004, Mahrous *et al* 2015, Baker *et al* 2015 and El-Adly *et al* 2018), the first cross between Ashmouni and Sakel to produced Wafer. Since this date all the Egyptian varieties have originated from artificial hybridization except Dandara which was produced *via* selection from Giza 3 field (Ware, 1959 and Al Didi, 1972 and 1982).

The objectives of Egyptian cotton breeding program is the development of cotton varieties characterized by high yield, early maturity, resistance to diseases and pests, homogeneity in lint color and seeds fuzz, fiber length, fiber strength, fiber fineness and lint percentage (Al-Didi, 1972 and 1982). The promising cross produced by artificial pollination then used pedigree selection method. Evaluation in regional trial was done during four growing seasons to study genotype x environment interaction and to assess the adaptability and superiority against the commercial cultivars of this category. Also, to produce enough breeder seeds from isolated field.

MATERIALS AND METHODS

The promising cross {(G83 × G80)× G89}× A107 is a result of crossing between two cotton genotypes belonging to *Gossypium barbadense* L., {(G83 × G80)× G89} as the female parent that characterize by high seed cotton yield. The male parent was the line A 107 which is superior by lint percentage in 2004 season at Cotton Research Institute. Then all the later generations, isolated field and production of breeder seeds were grown at El-Mattana Experimental Station, Luxor Governorate.

The F_1 generation was planted in 2005 as individual plants and self pollination was done to obtain selfed seeds. The F_2 seeds were planted in 2006 as individual plants to produce F_2 plants. Also, self pollination was done. At maturity, self and natural pollinated bolls of desirable single plants were picked. After laboratory work, selection was done based on high yielding and good fiber quality. The natural bolls of the selected F_2 plants were planted as bulked families and selfed bolls of the same plant were planted as individual plants to produce F_3 generation in 2007 season. At maturity, all self and natural pollinated bolls of desirable single plants and a bulk family of the selected F_3 population were picked. After laboratory work, the superior families were selected beside their individual plants based on high yielding and good fiber quality. Then, the selected individual plants from each family as individual plants from selfed bolls and open-pollinated bolls as bulk families were planted to produce F_4 generation. The cotton breeder repeated the same selection process to promote for next generations. Bulk family grown in a plot consisted of three rows set of 4m length, 60 cm apart and distance between plants within rows was 20 cm. While, individual plants grown in two replicates each one consists of two rows set of 4 m length, the distance between rows and plants was 70 cm.

The preliminary trial A (LA) was planted to compare this new promising cross with the commercial varieties in a randomized complete block design (RCBD) with six replications at Sids experimental station, Beni-Suif Governorate. The seeds of the selected lines from this experiment were sown in the advanced or regional trial in the next season. Regional or advanced trial B (LB) was undertaken during the growing seasons from 2011 to 2014 at five Egyptian governorates. The experimental design was RCBD with six replications in each location. Each entry was grown in a plot of five rows set of 4m length, distance was 60 cm between rows and 20 cm between plants. General agronomic and agricultural practices were done as recommended for cotton crop production.

From the results of regional or advanced trials (LB), the superior families from this cross for the two successive seasons (2013 and 2014) were selected to be the nuclei of the isolated field. The isolated field was at least 500 meters distance from other cotton fields from all directions to avoid cross pollination and started only with the selfed seeds of the selected families as individual plants. The selected plants were divided into two groups. The first one the selfed seeds to achieve individual plants and natural seeds make bulk families and in the second group, the selfed seeds make self nucleolus and the natural seeds make natural nucleolus. Each the selfed and natural nucleolus was grown as bluk families in three rows set of 4m length, 60 cm apart and distance between plants within rows was 20 cm. The best natural nucleolus was selected to establish the experimental yield trial. The experimental yield trial design was RCBD with four replications. Each entry was grown in a plot of five rows set of 4m length, distance was 60 cm between rows and 20 cm between plants.

At maturity, fifty bolls were collected from the two outer rows to measure average boll weight (BW). While, the three inner rows were dinning to estimate seed cotton yield (SCY) and lint cotton yield (LCY) which was expressed in kantar/feddan (kantar of seed cotton yield =157.5 kg, kantar of lint cotton yield=50 kg and feddan=4200m^2). Fiber quality characters were estimated according to ASTM designation (1998) at Cotton Technology Laboratory, Cotton Research Institute.

Data were subjected to analysis of variance (ANOVA), which was done for each location separately. Also, combined analysis of variance was done using the mean data of each location for regional or advanced trial (LB) was calculating by using the method mentioned by Snedecor (1965) and LeClerg *et al* (1952).

RESULTS AND DISCUSSION

Cotton Research breeding section, Cotton Research Institute developed a new promising cross namely {(G83 × G80)× G89}× A 107 belonging to long staple cotton category. It will be recommended for general cultivation in Upper Egypt for its high yield productivity, high lint percentage, early maturity, good fiber quality, heat tolerance and resistance to *Fusarium* wilt.

The cotton breeders select the superior plants from F_2 populations to form the F_3 families. During the segregating generation's starting from F_3 to F_5 selection was done among families to select the higher yielding families with good fiber quality traits, then selection within families to select the most superior plants within each family. Starting from replicated trials, selection for superior families was depending on the cross superiority over the two commercial varieties Giza 80 and Giza 90. Selection of individual plants is continued till the progenies show no segregation. At this stage selection was done among families, because there would be no genetic variation within families (Fehr 1987). El-Mansy (2005 and 2015) reported that selection within families is more efficient in early segregating generations and selection between families is the main target for cotton breeder in later generations among some Egyptian cotton crosses.

A. Yield performance from trials B (LB)

A.1. Means and comparatives

A regional or advanced trial (LB) was conducted during the four growing seasons (2011 to 2014) at farmer's fields. The new cross was compared with the two commercial varieties Giza 80 and Giza 90 in five locations represented the cultivated area of this cotton category in Egypt. The results obtained from Table 1 showed that the selected family had higher yield than the commercial variety Giza 80 during the four growing seasons. In 2011 season, the selected family had surpassed the commercial variety Giza 80 in seed cotton yield by 1.21 k/fed, lint yield (by 1.59 k/fed), lint percentage was surpassed (by 0.1%)from commercial variety Giza 80 and 50 boll weight (by 1 gram) over the same variety. Also, in season 2012 the superior family had higher performance than the commercial variety Giza 80 in seed cotton yield (by 1.8 k/fed), lint yield (by 2.9 k/fed) and lint

Table 1. Comparison data between the new cotton cross and other genotypes and two the check varieties in regional or observed trial during the growing seasons from 2011 to 2014 across five locations.

Entry	Origin	YIELD (C/F)		L%	BW	Mic	+b	UHM	Streng.	Matur.
		SCY	LY							
2011										
H^5 112/2009	[(G83xG80) x G89)] x A 107.	12.14	15.1	39.8	149	4.0	11.5	29.7	2270	0.90
Breeder 1	[G83x(G75x5844)xG80	11.47	14.48	39.9	152	4.0	11.4	29.4	2120	0.90
Breeder 2	G90 x A 107	12.78	15.83	39.6	150	4.1	11.9	29.8	2185	0.92
Giza 90	G 83 x Dandera	11.89	14.35	38.7	150	3.9	11.7	29.8	2285	0.89
Giza 80	G 66 x G73	10.93	13.51	39.7	148	4.1	12.1	30.5	2285	0.91
Mean		12.26	15.14	39.5	154	4.0	11.6	29.3	2215	0.90
L.S.D. 5 %		0.96	1.19		3.28					
L.S.D. 1 %		1.28	1.58		4.35					
2012										
$H^6$177/2010	[(G83xG80) x G89)] x A 107.	8.6	11.2	39.5	144	4.1	11.5	30.1	2155	1.00
Breeder1	[G83x(G75x5844)xG80	8.5	10.4	38.8	147	4.1	11.6	30	2175	1.00
Breeder3	G90 x A 107	8.7	10.8	39.4	147	4.3	12.3	29.5	2125	1.00
G90	G 83 x Dandera	8.5	10.2	38.0	149	4.0	11.4	29.8	2195	1.00
G80	G 66 x G73	6.8	8.3	38.8	151	4.2	12.4	31.6	2335	1.00
Mean		8.27	10.16	38.9	148	4.1	11.84	30.2	2197	1.00
L.S.D. 5 %		0.85	1.11		4.57					
L.S.D. 1 %		1.12	1.45		6.01					
2013										
H^7 215/2011	[(G83xG80) x G89)] x A 107.	10.35	13.37	40	154	4.3	13	30.3	2052	0.91
Breeder3	[G83x(G75x5844)xG80	9.57	12.23	40.2	157	4.2	12	28.1	1948	0.92
Breeder4	G90 x A 107	8.44	10.95	41.3	149	4.2	13	29.6	2047	0.92
G90	G 83 x Dandera	9.16	11.23	38.0	150	3.9	12	29.2	2002	0.88
G80	G 66 x G73	8.65	11.04	39.9	154	4.1	12	30.2	2005	0.90
Mean		9.33	11.89	39.9	153	4.1	12.4	29.5	2011	0.91
L.S.D. 5%		1.25	1.58		6.63					
L.S.D. 1%		1.64	2.08		8.71					
2014										
H_7 240/2012	[(G83xG80) x G89)] x A107.	10.28	13.3	41.6	149	4.4	11.9	30.5	2140	0.93
Breeder 4	[G83x(G75x5844)xG80	10.02	12.64	40.4	147	4.1	11.4	30.6	2080	0.92
Breeder 4	G90 x A 107	9.55	11.99	40.6	148	4.2	11.9	30.5	2100	0.93
Giza 90	G 83 x Dandera	8.78	10.7	39.2	146	4.3	11.7	31.2	2175	0.93
Giza 80	G 66 x G73	7.62	9.35	39.6	148	4.2	11.2	31.1	2190	0.91
Mean		9.64	12.14	40.3	148	4.3	11.7	30.4	2125	0.92
L.S.D. 5 %		0.85	1.07		5.18					
L.S.D. 1 %		1.12	1.41		6.81					

percentage by 0.7%, but had less than Giza 80 in 50 boll weight (by 7 gram). In season 2013 similar trend in the results of the promising cross compared to Giza 80 were obtained in seed cotton yield (by 1.7 k/f), lint cotton yield (by 92.33 k/fed), lint percentage by 0.1%, and also did not surpass in 50 boll weight. While, in 2014 season the selected family surpassed Giza 80 in most the studied traits. On the other hand, the selected family of the new cross maintains fiber quality traits as long stable cotton category.

Hence, on the basis of regional trial, it was indicated that this cross has good performance in the different ecological zones.

A.2. Response to selection

The response to selection as percentage from the two commercial varieties from regional trials during four growing seasons is presented in Table 2. The selected families had surpassed the two commercial varieties Giza 80 and Giza 90 in seed cotton yield by 11.75, 2.1% and 26.47, 1.18% and 19.65, 12.99% and 34.91, 17.08% in the four growing seasons, respectively. Increasing ratio in lint cotton yield trait was from the two varieties 11.77, 5.23% and 34.94, 9.80% and 21.11, 19.06% and 42.25, 24.30% in the four growing seasons, respectively. On the other hand, positive and negative less response to selection was achieved from the two varieties in 50 boll weight trait in the four growing seasons.

Table 2. Response to selection% from the two check varieties in regional or advanced trial (LB) during the growing seasons from 2011 to 2014.

Seasons	Family	Seed cotton yield (k/fed)		Lint yield (k/fed)		50 boll weight (g)	
		Giza 80	Giza 90	Giza 80	Giza 90	Giza 80	Giza 90
2011	H^5 112/2009	11.75	2.10	11.77	5.23	0.68	-0.67
2012	$H^6$177/2010	26.47	1.18	34.94	9.80	-4.64	-3.36
2013	H^7 215/2011	19.65	12.99	21.11	19.06	0.00	2.67
2014	H^8 240/2012	34.91	17.08	42.25	24.30	0.68	2.05

Based on the regional or advanced trial (LB) results the cotton breeders decided to isolate this cross. The isolated field starting with selfed seeds only of the selected families in the growing season 2019. The main task of isolation is to produce breeder seeds and maintain purification and uniformity. At this stage the breeder should have no variation between or within families.

A. Yield trial

The first replicated experimental yield trial for the selected family of the new cross was grown in 2019. The mean performance of the two experimental yield trials in the growing seasons 2019 and 2020 is presented in Tables (3 and 4). The nuclei had higher seed cotton yield, lint yield, lint percentage and boll weight coupled with good fiber quality for this cotton category (*i.e.* long stable).

Table 3. Mean performance for the eight nuclei of the new promising family of the cross during the growing season 2019.

Nucleus	Origin	Parent	SCY	LCY	Arr.	LP	50 BW	L.	Uni.	MIC.	Str.	+b	Mat.
H^{15} 1/2019	H^{14} 2/2018	H^{9} 261/2013	11.68	14.26	2	38.75	144.55	31.10	85.40	4.20	1910	11.20	0.94
H^{15} 2/2019	H^{14} 6/2018		9.72	11.20	4	36.61	143.45	30.80	86.50	4.30	2070	11.30	0.94
H^{15} 3/2019	H^{14} 7/2018		6.42	7.46	5	36.93	123.75	30.40	85.50	4.20	2030	11.40	0.94
H^{15} 4/2019	H^{14} 8/2018		6.11	6.80	7	35.33	131.70	30.30	85.30	4.30	1990	11.60	0.94
H^{15} 5/2019	H^{14} 9/2018		5.45	6.34	8	36.91	147.25	29.70	85.30	4.20	2110	11.70	0.94
H^{15} 6/2019	H^{14} 8/2018		12.34	14.89	1	38.29	175.55	29.70	84.70	4.30	1870	11.90	0.94
H^{15} 7/2019	H^{14} 20/2018		11.63	14.19	3	38.71	163.00	30.40	83.60	4.20	1910	11.90	0.94
H^{15} 8/2019	H^{14} 21/2018		6.07	6.96	6	36.44	137.85	30.60	84.00	4.20	1910	11.20	0.94
Mean			8.68	10.26		37.25	145.89	30.38	85.04	4.24	1975	11.53	0.94
LSD 0.05			1.88	2.20			ns						
LSD 0.01			2.74	3.21			ns						

L. = Length, Uni. = Uniform, Str. = Strength, Mat. = Maturity
ns = non-significant

Table 4. Mean performance for the twelve nuclei plus breeder seed 1 of the new promising family of the cross during the growing season 2020.

Nucleus	Origin	Parent	SCY	LCY	Arr.	LP	50 BW	L.	Uni.	MIC.	Str.	+b	Mat.
H^{16} 1/2020	H^{15} 1/2019	H^{14} 2/2018	9.38	12.48	6	42.21	156.50	28.60	85.50	3.8	1870	13.10	0.94
H^{16} 2/2020	H^{15} 3/2019	H^{14} 3/2018	9.73	12.51	5	40.81	154.13	30.90	83.80	4.1	2030	13.00	0.92
H^{16} 3/2020	H^{15} 4/2019	H^{14} 3/2018	10.08	13.26	2	41.79	157.88	30.40	82.70	3.9	1750	12.90	0.92
H^{16} 4/2020	H^{15} 21/2019	H^{14} 18/2018	9.52	12.62	4	42.07	159.13	30.70	84.60	3.9	1910	12.60	0.92
H^{16} 5/2020	H^{15} 22/2019	H^{14} 18/2018	8.58	11.64	12	43.07	155.38	29.90	84.40	3.7	1990	11.30	0.93
H^{16} 6/2020	H^{15} 23/2019	H^{14} 18/2018	9.82	12.74	3	41.18	144.38	29.40	85.90	3.8	1910	12.60	0.90
H^{16} 7/2020	H^{15} 24/2019	H^{14} 20/2018	9.03	11.67	11	41.05	147.63	28.90	84.70	4	1910	13.20	0.93
H^{16} 8/2020	H^{15} 26/2019	H^{14} 20/2018	10.47	13.77	1	41.77	151.38	29.60	85.70	4	2070	12.40	0.93
H^{16} 9/2020	H^{15} 27/2019	H^{14} 20/2018	9.26	12.30	8	42.20	148.00	28.10	83.60	4	1830	13.40	0.93
H^{16} 10/2020	H^{15} 30/2019	H^{14} 20/2018	9.54	12.37	7	41.15	146.63	28.60	82.40	3.7	2020	13.30	0.89
H^{16} 11/2020	H^{15} 31/2019	H^{14} 20/2018	9.18	11.97	9	41.38	157.75	28.70	81.80	3.6	1990	13.60	0.90
H^{16} 12/2020	Breeder 1	Mixed nucleus	8.99	11.79	10	41.63	167.25	29.30	85.20	4.3	1990	13.60	0.96
Mean			9.47	12.43		41.69	153.83	29.43	84.19	3.9	1939	12.92	0.92
LSD 0.05			ns	ns			ns						
LSD 0.01			ns	ns			ns						

L. = Length, Uni. = Uniform, Str. = Strength, Mat. = Maturity
ns = non-significant

The mean squares for these trials showed non-significant differences between these nuclei as shown in Table 5 during 2020 season. So, the cotton breeders selected the best four nuclei and mix them to produce breeder seed

1 in the first season and breeder seed 2 in the next season (*i.e.* 2020), respectively. These nuclei showed homogeneity in seed fuzz, lint color and uniformity in plant type in the field coupled with high yield and good fiber quality traits. These results indicated that the cotton breeder successes to hide genotypic variation and increase homogeneity between these nuclei. The same results obtained by Awad *et al* (2004) for the new long staple cotton variety Giza 90, Mahrous *et al* (2015) and Baker *et al* (2015) for the new promising long staple cotton crosses (Giza 90 x Austral) and (Giza83 x (Giza 75 x 5844)) x Giza 80, respectively, and El-Adly *et al* (2018) for the new long staple cotton variety Giza 95.

Table 5. Mean sum of squares of experimental yield trial for the new promising family of the cotton cross **during the two growing seasons 2019 and 2020.**

Seasons	SOV	df	SCY	LCY	BW
2019	Rep.	3	506,195 ns	71,852 ns	866.13 ns
	Geno.	7	7,081,239 **	1,163,156 **	1,100.98 ns
	Err.	21	481,159	66,432	675.46
2020	Rep.	3	986,929 **	61,586 **	51.33 ns
	Geno.	11	77,344 ns	4,309 ns	169.20 ns
	Err.	33	81,819	5,100	103.74

ns, non significant, * and ** significant at 0.05 and 0.01 probability levels, respectively

The estimation of Fusarium wilt incidence rate in Cotton and Fiber Disease Department, Plant pathology Institute, was done annually to all the breeding families started from F_3 generation. The breeding families showed good genetic tolerance to *Fusarium* wilt. Regarding to fiber quality traits measured by Cotton Technology Laboratory, Cotton Research Institute proved that fiber quality is acceptable (29-30m fiber length, 4.2-4.4 fiber fineness and 9.8 fiber strength. These traits are in the same trend of the long staple cotton category for spinner desire.

The promising family of the cross {(G83 × G80) × G89}× A107 is characterized by:

1. Circular erect main stem.
2. The leaf is green with medium lobes, it has ears and a pike nectar gland on the middle vein.
3. The node of the first fruiting branch ranged from 6 to 7.
4. Boll weight 3.5g.
5. Lint percentage 40-41%.
6. Fiber characters: fiber length 29-30 mm, micronaire reading 4.3 and yarn strength reached to 2000 unit.
7. Creamy lint color.
8. Heat tolerance (Upper Egypt).
9. Resistance to *Fusarium* wilts and pest.

CONCLUSION

It could be concluded that the promising cotton cross {(G83 × G80)× G89}× A 107 is extremely early maturing, heat tolerant and producing higher seed and lint cotton yield than the commercial variety Giza 90 and had the same characteristics of long staple cotton grown in Upper Egypt, therefore it my be a good substitution for Giza 95 in Upper Egypt.

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تقييم الهجين المبشر[(جـــ٨٣ x جـــ٨٠) x جـــ٨٩] x A 107 من طبقة الاقطان طويلة التيله

صلاح الدين رشاد نصر سعيد واحمد مصطفى محمد سليمان

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اجريت هذه الدراسة بهدف انتاج صنف جديد متميز محصوليا لطبقة الاقطان طويل التيله قبلى ويعتبر الهجين المبشر[(جـــ٨٣ x جـــ٨٠) x جـــ٨٩] x A 107 والذي ينتمى إلى نوع الباربادنس. هجين متميز وواعد. يتميز الهجين بوجود العديد من الصفات الممتازة من حيث الانتاجية العالية وصفات الجودة المتميزة، وتحمل الحرارة العالية ، كما انه مقاوم لمرض الذبول الفيوزاريومي. تم استنباط هذا التركيب الوراثي من خلال قسم بحوث تربية القطن، معهد بحوث القطن، مركز البحوث الزراعية، الجيزة، مصر. كما ان هذا الهجين المبشر يخضع حاليا لاجراءات تسجيل الأصناف وسوف يتم تسميته بالصنف جيزة ٩٨. تم انتاج هذا الهجين عن طريق التلقيح الصناعي لآباء متباعدة وراثيا بعدها تم اجراء الانتخاب المنسب له في جميع الاجيالالأنعزاليه. تم الحصول على الجيل الاول كنتيجة للتهجين بين التركيب الوراثي [(جيزة٨٣ x جيزة٨٠) x جيزة ٨٩] كأم والذي يتميز بصفات المحصول العالى وبين السلالة A 107 كأب والذي يتميز بصفات المحصول العالية وبخاصة صفة تصافي الحليج، ثم بدات عملية الانتخاب بداية من الجيل الثانى باستخدام طريقة النسب. ثم بدأت اجراءات عزل الهجين بمحطة بحوث المطاعنة بمحافظة قنا للوقوف على افضل العائلات، ثم تم اختيار العائلات المتميزة من الجيل الخامس لتقييمها فى التجربة الاولية (أ) ثم فى التجارب المتقدمة (ب) فى بيئات مختلفة تمثل خمسة محافظات هي الفيوم، بنى سويف، المنيا، اسيوط و سوهاج. وهذه المحافظات تمثل المدى البيئى لزراعة هذه الطبقة من الاقطان في مصر. وتم ذلك خلال اربعة مواسم متتالية بداية من ٢٠١١ إلى ٢٠١٤. وقد اثبت هذا الهجين تفوق ملحوظ بشكل كبير على الصنفين التجاريين لهذه الطبقة وهما جيزة ٩٠ وجيزة ٨٠. الهجين الجديد له قدرة عالية على التأقلم على نطاق واسع في العديد من البيئات، مبكر النضج ومتحمل للحرارة العالية ومقاوم لمرض الذبول الفيوزاريومى الي جانب احتفاظه بصفات جودة التيلة العالية التي تلبى الاحتياجات الصناعية والانتاجية العالية التي تلبي احتياجات المزارع.

المجلة المصرية لتربية النبات ٢٥(١): ٥٩- ٧٠ (٢٠٢١)