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Performance Evaluation of Some Earlier Yielding Mutant Cotton (*Gossypium spp.*) Varieties in the East Mediterranean Region of Turkey

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Abstract: This study was carried out in 1997-2000 in the east Mediterranean region of Turkey (in Kahramanmaras province) in order to determine earliness, yield and yield components and fiber technological traits of some early maturing mutant cotton varieties from Azerbaijan belonging to *Gossypium hirsutum* L. (Agdas-3, Agdas-6, Agdas-7, Agdas-17) and *Gossypium barbadense* L. (Agdas-21) according to randomized block design with four replications. Maras-92 and Sayar-314 (*G. hirsutum* L.) which are local standard varieties were used as standard varieties. According to four year's results, Agdas-3, Agdas-7, Agdas-17 and Agdas-21 of the mutant varieties have germinated 2 days earlier than standard varieties. Also, the mutant varieties have opened bolls 3-6 days earlier than standards. Furthermore, Agdas-3, 6, 7 and 17 were the earliest yielding varieties with 83, 82, 83, 84% of first harvest ratio respectively. Also even though Agdas-21 belongs to *G. barbadense* L. it yielded at the same time with Maras-92 (81%) and earlier than Sayar-314 (78%) and it opened its bolls almost at the same time with standards. Moreover, it was determined that Agdas-7 (3314 kg ha^{-1}) and Agdas-17 (3491 kg ha^{-1}) were better than standard varieties from the seed cotton yield point, while Agdas-21 showed better characteristics for fiber length (33.31 mm), fineness (4.16 micronaire) and strength (34.42 g tex $^{-1}$) compared to standard varieties. As a result, Agdas-7 and Agdas-17 due to their earliness and higher seed cotton yield and in spite of its lower yield Agdas-21 due to its earliness and superior fiber quality were found promising for this region.

Key words: Cotton, earliness, fiber technological traits, *Gossypium* ssp., yield, yield components

INTRODUCTION

By the side of the fact that cotton is an important fiber plant in the world it is an important raw material of the oil industry due to higher seed oil and of the feed industry due to pulp with higher protein. Cotton sowing area of the world is 33.5 million ha and 21.4 million ton of lint cotton has been produced in the world. Turkey is in 6th order for cotton production by the rate of 4.7% and for sowing area Turkey is in 8th order with 684.000 ha. among about 80 cotton grower countries[1]. *G. hirsutum* L. cottons are the most cultivated cottons among four cotton species (*G. hirsutum* L., *G. barbadense* L., *G. herbaceum* L. *and G. arboreum* L.) because of higher yield and adaptation ability and all of our cotton supplies and 91% of world cotton supplies are from *G. hirsutum* L.[2]. However, *G. barbadense* L. cottons containing Giza varieties with extra long staple (longer than 34.9 mm) cover approximately 5.1% of the world cotton production and they have been produced at most in Egypt, Sudan and USA owing to their long, fine and strong fibers[3]. In several countries which are near the equator within the cotton grower countries in the world, by the side of *G. hirsutum* L. varieites, the varieties of *G. barbadense* L. which are known as "silk cotton" or "Egyptian cotton" are also sown. In spite of the fact that the *Barbadense* cottons are superior to *Hirsutum* cottons with respect to fiber technological traits they has given lower yield than *G. hirsutum* L. because these cottons need longer growing season and higher temperatures. Their bolls open later and autumnal rains catch cotton due to these cottons need longer sowing-boll opening duration. Therefore, *Barbadense* cottons could not be grown in Turkey and these cottons having desirable traits in textile industry such as fibre length, fiber fineness and fiber strength has been imported from abroad. For many years, breeders have used various breeding methods to obtain new, early maturing varieties of *G. barbadense* L. species. Particularly for recent 10-15 years in major cotton producing countries new early maturing cotton varieties having high yield and high fiber technological traits have been obtained by using various chemical and physical mutagens and have been sown in large areas. There are a great number of researches in this subject[4-6]. For

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instance, Raafat[5] reported that seed cotton yields were higher than those of the untreated in the M_2 generation in the varieties of Giza 81 and Giza 85 (*G. barbadense* L.) with treatments of gamma radiation (10 k.r.) and Dimethylsulphate (0.02%). Nejad and Rastegari[7] noted that gamma radiation (150-350 grey) had a positive effect on lint percentage and had no bad effect on the fiber quality of the cotton lines (*G. hirsutum* L.). The early yielding mutant cotton variety of Agdas-3 (*G. hirsutum* L.) obtained by complete effecting of colchicine (0.05) and gamma rays (200 Grey) can also be shown for example[6]. Now this variety has been sown in Azerbaijan in area of over 100.000 ha. Since 1990, Agdas-3 cotton variety has been tested in Cotton Research Institutes of Nazilli and Antalya, Station of Production of Cotton Seed in Adana and in Kahramanmaras Sutcu Imam University, Agricultural Faculty[8] and it has been determined that Agdas-3 has matured 7-10 days earlier than local standard varieties. Furthermore, breeders working in some institutes used this variety as a early maturing parents in hybridisations. Moreover, Mustafayev *et al.*[9] reported that the mutant cotton variety Agdas-21 (*G. barbadanse* L.) was similar to local standard varieties for earliness and that it is suitable to plant at the same time with *G. hirsutum* L. in Kahramanmaras and under similar ecological conditions and that it seems promising for region because it has maintained other usefull properties and superiority for fiber traits and it has given high yield. Therefore it can be said that Agdas varieties can provide benefit to agriculture and farmers of the region because of earliness, superior fiber traits and higher yield.

The aim of this study was to determine earliness, yield and yield components and fiber technological traits of some early maturing mutant cotton varieties from Azerbaijan belonging to *G. hirsutum* L. (Agdas-3, Agdas-6, Agdas-7, Agdas-17) and *G. barbadense* L. (Agdas-21) in 1997-2000 in east Mediterranean region of Turkey (in Kahramanmaras province) .

MATERIALS AND METHODS

In this study seven cotton varieties were used as material. Five of these [Agdas-3, Agdas-6, Agdas-7 and Agdas-17 (*Gossypium hirsutum* L.) and Agdas-21 (*G. barbadense* L.)] were early maturing mutant varieties obtained in Azerbaijan by using mutation method in 1975-1990. The other two [Sayar-314 and Maras-92 (*G. hirsutum* L.)] were standard varieties in the Kahramanmaras province. Some agronomical and technological characteristics of the varieties tested were given in Table 1.

The study was conducted in 1997-2000 at the Kahramanmaras Sutcu Imam University Agricultural Faculty's experimental field according to randomized block design with four replications. The climatic data of the experiment location and the chemical properties of the experiment location soil were given in Table 2 and 3, respectively.

The seeds were sown by experimental mechanical planter in four-row plots of 10 m length at a planting space of 70 cm in 1997, 1998, 1999 and 2000 on 23 May, 5 May, 26 April and 2 May respectively. Plants were thinned to 20 cm in rows. During growing season plants were hoed 3-4 times with hoe and 4-5 times with harrow. In each year, composed fertilizer of 20:20:0 was applied presowing at a rate of 8 kg da^{-1} N and P_2O_5 26% of ammonium nitrat was treated at a rate of 5 kg da^{-1} N by using fertilizer spreader in inter-rows prior to first and second irrigation. After treatment plants were irrigated by furrow method 5-7 times until bolls open up to 60%. Plants were harvested in each year between 10 September and 02 October two times by hand. At harvesting time samples of 20 bolls were taken from each plot.

In the study sowing-germination interval was recorded as days at the time of emergence of approximately 50% of the seeds in each plot. First boll

Table 1: Some agronomical and technological characteristics of the varieties tested

Varieties	First boll opening interval (day)	Plant height (cm)	Seed cotton yield (kg ha^{-1})	Seed cotton weight per boll (g)	100 seed weight (g)	Ginning Outturn (%)	Fiber length (mm)	Fiber Fineness (micronaire)	Fiber Strength (g tex^{-1})
Agdas-3	112	95-100	3410	6.0	11.2	37.5	33.5	4.9	29.3
Agdas-6	119	90-95	3870	5.8	11.0	37.0	32.6	4.8	28.8
Agdas-7	118	85-95	3930	6.9	11.6	39.3	33.5	4.5	29.0
Agdas-17	124	90-100	3650	6.3	12.7	38.6	34.8	4.8	27.0
Agdas-21	122	80-90	2800	4-4.5	11.5	36.5	35-37	4.1	35.0
Maras-92	---	90-100	3500-4000	6.0	9-10	39	29-30	3.6	31.0
Sayar-314	---	95-100	3500-4000	5.8-6.0	10	41-42	29.5-31.5	4.4-4.5	25.7-26.7

Anonymous (1978), Anonymous (1979), Anonymous (1982), Anonymous (1983), Anonymous (2001), Harem (2000).

Table 2: The climatic data of the experiment location in 1997-2000 cotton season

Months	Average temperature (°C)	Minimum average temperature (°C)	Maximum average temperature (°C)	Total rain (mm)	Average relative humidity (%)
1997					
April	12.0	7.2	17.3	105.3	62.5
May	21.7	15.0	28.7	88.2	55.1
June	24.6	18.4	31.6	14.9	51.3
July	27.6	22.3	34.5	----	48.6
August	26.2	21.6	32.6	1.6	60.6
September	23.2	16.7	30.7	28.9	48.5
October	18.3	13.3	24.3	57.4	63.0
1998					
April	16.6	10.8	22.5	166.7	57.8
May	19.8	14.3	25.7	39.4	57.0
June	25.9	19.5	33.4	15.6	54.9
July	29.8	23.1	37.8	2.0	55.6
August	31.0	23.5	39.5	---	46.6
September	25.3	18.9	32.7	9.6	48.7
October	20.2	12.9	28.1	42.0	44.5
1999					
April	15.7	9.9	22.0	50.2	54.5
May	22.2	15.1	29.7	9.9	44.6
June	25.5	19.5	32.4	---	49.6
July	28.6	22.8	36.0	5.3	49.6
August	28.8	22.3	36.7	3.4	59.1
September	25.1	18.3	32.9	1.0	56.3
October	20.9	14.9	28.0	10.8	56.7
2000					
April	16.9	11.8	22.4	36.5	63.8
May	20.9	14.8	27.4	4.7	59.2
June	26.5	19.6	33.4	0.1	51.8
July	31.1	23.3	39.2	---	51.3
August	28.6	22.2	36.3	3.0	56.9
September	24.9	18.6	31.9	30.2	59.5
October	17.8	12.5	24.2	37.2	64.9

Source: TR. Ministry of Environment, General Directorate of Turkish State Meteorological Service, Station of Kahramanmaras.

Table 3: The chemical properties of the experiment location soil

Depth (cm)	Salt (%)	Saturation (%)	pH	$CaCO_3$ (%)	Organic matter (%)	P (kg da^{-1})	K (kg da^{-1})
0-20 cm	0.03	37	7.7	17.61	1.5	7.05	29.09
20-40 cm	0.02	29	7.6	17.24	1.5	9.80	25.63

Source: KSU, Agricultural Faculty, Soil Science Department Laboratory.

opening interval was days-interval between sowing and the time of first boll opening of 50% of plants in each plot. Firstly, plants were counted in each plot. At boll opening time, in each day in each plot, plants which opened first boll were counted until reaching to 50% of plants. This interval between sowing and the day on which was reached 50% boll opening was recorded as first boll opening interval. The other morphological and agronomical characteristics were determined according to methods shown by Gencer *et al.*[10]. Fiber technological traits were determined using HVI (High Volume Instruments) analyser. Obtained data were analysed over four years according to randomized block design by using MSTAT C statistical package. The means were compared by LSD test.

RESULTS AND DISCUSSION

According to four year's results, for all traits except 100 seed weight varieties, years and year x variety interaction were statistically significant. For first harvest ratio only years were found significant. The means of varieties for each year, four year's means of varieties and means of years for investigated traits were given in Tables 4, 5, 6, 7, 8, 9 and 10.

Sowing-germination interval: Sowing-germination interval, first boll opening interval and first harvest ratio were important earliness criteria. Earliness is important issue concerning the harvesting of the cottons before autumn rains, minimizing the product lost and the saving the fibre quality. In addition, Agdas-21 belongs to the species of *Barbadense* which needs long vegetation period. For this reason *Barbadense* cottons (also named as "silk cotton") can not be grown in Turkey and so it is imported. Agdas-21 was genetically modified to be able to grow earlier so if it was grown in the east Mediterranean region, it will lead to significant economical earn.

Sowing-germination intervals of the investigated varieties were given in Table 4. According to four year's results sowing-germination intervals of the varieties were between 6 days and 8 days (Table 4). Agdas-3, 7, 17 and 21 germinated about 2 days earlier than two standards. But Agdas-6 germinated almost at the same time with standards. Agdas-3 among the mutant varieties had the shortest germination interval (6 days). Therefore, it can be said that Agdas-3 was the early germinating variety among Agdas varieties. These findings are similar to those of Mustafayev *et al.*[8,9].

First boll opening interval: When four year's results were investigated, it can be seen that Agdas-3 and Agdas-6 opened their bolls 3 days earlier than Maras-92, 6 days earlier than Sayar-314 (Table 4). Also Agdas-7 and Agdas-17 opened their bolls 2 days earlier than Maras-92, 5 days earlier than Sayar-314. Agdas-3 among the mutant varieties had the shortest boll opening interval (114 days). But among the mutants, Agdas-21 had longer interval (119 days) because it belongs to *G. barbadense*. Generally it can be seen that the mutants except Agdas-21 opened their bolls 3-6 days earlier than standards. Only Agdas-21 opened its bolls about 3 days later than Maras-92, but at the same time with Sayar-314 in spite of belonging to *G. barbadense*. Therefore, it can be said that Agdas varieties are promising for this region in terms of earliness. Mustafayev *et al.*[8,9] also reported similar results. In cotton production total 5-8 days earliness is remarkably important advantage.

Table 4: Means for sowing-germination interval (day) and first boll opening interval (day)

Traits	Sowing-Germination Interval (day)					First Boll Opening Interval (day)				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	6	5	7	6	6.0	112	113	120	109	114
Agdas-6	8	6	7	7	7.0	112	113	120	110	114
Agdas-7	5	5	7	8	6.3	112	113	121	110	114
Agdas-17	5	7	7	7	6.5	115	113	119	110	114
Agdas-21	6	6	7	7	6.5	126	114	121	116	119
Maras-92	8	7	9	8	8.0	118	114	122	112	117
Sayar-314	8	6	9	8	7.8	118	124	124	112	120
LSD (%1)	---	---	---	---	--- ---	---	---	---	---	
CV (%)	---	---	---	---	--- ---	---	---	---	---	

Table 5: Means for first harvest ratio (%) and seed cotton yield (kg ha^{-1}) and arised groups

Traits	First Harvest Ratio (%)					Seed Cotton Yield (kg ha^{-1})				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	69a	62b	95a	97a	83a	2220c	3906ab	2305cd	3438d	2966cd
Agdas-6	58ab	67ab	96a	97a	82a	2164c	3558b	2434c	3556c	2928d
Agdas-7	53ab	64ab	95a	97a	83a	3253a	3745b	2362cd	3894b	3314b
Agdas-17	59ab	66ab	97a	95a	84a	2541b	4259a	3276a	3887b	3491a
Agdas-21	53ab	62b	96a	97a	81ab	1096d	2349d	2141d	3850b	2359f
Maras-92	62ab	74a	96a	91a	81ab	2234c	3051c	2994b	4157a	3109c
Sayar-314	50b	72a	96a	93a	78b	2303c	3021c	2455c	3207e	2746e
LSD(%5)	92.8	132.3	4.6	56.2	29.1	(%1)19.12	49.23	22.51	10.43	14.77
Means of Years	57a	67b	96c	95c		2258d	3413b	2567c	3713a	
CV (%)	16.80	14.73	1.51	5.32	22.29	4.16	7.09	4.31	1.38	5.30

Table 6: Means for plant height (cm) and sympodia number and arised groups

Traits	Plant Height (cm)					Sympodia Number				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	61.67cd	77.92bc	77.65a	79.60b	74.21cd	9.00d	14.52ab	11.47a	13.27ab	12.07bcd
Agdas-6	81.00b	79.97b	77.95a	82.65ab	80.39ab	13.45b	13.92ab	11.52a	12.90b	12.95b
Agdas-7	79.67b	78.72b	78.25a	80.80b	79.38bc	9.44d	13.90ab	11.37a	12.00bc	11.68cd
Agdas-17	56.55d	81.40b	77.32a	81.22b	74.12cd	11.33c	14.77ab	13.35a	12.67b	13.03b
Agdas-21	96.33a	87.75a	74.37a	82.32b	85.19a	16.22a	15.30a	11.90a	14.55a	14.49a
Maras-92	70.78bc	72.72cd	86.05a	86.02a	78.89bcd	12.78bc	13.30bc	11.42a	12.65bc	12.73bc
Sayar-314	62.78cd	69.65d	79.02a	83.02ab	73.62d	11.33c	12.17c	11.15a	11.20c	11.46d
LSD(%1)	10.49	5.36	ns	3.47	5.69	1.48	(%5)1.67	ns	1.45	1.14
Means of Years	72.69b	78.31a	78.66a	82.24a		12.04bc	13.99a	11.74c	12.75b	
CV (%)	7.09	3.37	6.88	2.07	7.82	6.12	8.07	13.33	5.59	9.65

ns: not significant.

* Means followed by the same letter are not significantly different at 5% level of probability.

First harvest ratio: From Table 5, first harvest ratio values of the varieties varied between 84% and 78%. Agdas-3, 6, 7 and 17 were the earliest yielding varieties with 83, 82, 83, 84%, respectively. Agdas-21 (81%) and Maras-92 (81%) followed them. Some researchers reported similar results[10,12]. For first harvest ratio the all Agdas varieties and standard varieties had almost same values and matured almost at the same time. Therefore, it can be said that the mutant varieties including Agdas-21 (*G. barbadense* L.) are convenient for this region for earliness.

First harvest ratio results showed that "silk cotton", which is more expensive and mainly imported, could be produced in Turkey.

Seed cotton yield: Means for seed cotton yield and arised groups were given in Table 5. As seen in Table 5, the most yield of seed cotton was obtained in 2000 (3713 kg ha^{-1}), 1998 (3413 kg ha^{-1}) and 1999 (2567 kg ha^{-1}) followed this year and the lowest yield of seed cotton was obtained in 1997 (2258 kg ha^{-1}). In all years, the lowest yield of seed cotton was obtained from Agdas-21.

From Table 5, seed cotton yields of the varieties varied between 3491 kg ha^{-1} and 2359 kg ha^{-1}. The highest seed cotton yield was obtained from Agdas-17 with 3491 kg ha^{-1}, followed by Agdas-7 with 3314 kg ha^{-1}. The lowest seed cotton yield was obtained from Agdas-21 with 2359 kg ha^{-1}. The fact that Agdas-21 having more sympodia and boll number per plant gave lower seed cotton yield is caused by necessity of a longer growing season and higher temperatures due to maturing their bolls. Therefore its seed cotton weight per boll were lower and many of its bolls couldn't open. As a result, Agdas-21 gave lower yield than cottons belonging to

Table 7: Means for boll number per plant and seed cotton weight per boll (g) and arised groups

Traits	Boll Number Per Plant					Seed Cotton Weight Per Boll (g)				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	18.89ab	15.65ab	13.25a	15.15ab	15.73ab	5.04c	5.23a	5.78a	5.56a	5.40a
Agdas-6	18.22ab	14.67ab	14.27a	13.97b	15.29bc	5.99ab	5.52a	6.05a	5.48a	5.76a
Agdas-7	20.44a	14.55ab	14.20a	13.97b	15.79ab	6.39a	5.14a	5.81a	5.30a	5.66a
Agdas-17	12.34c	16.02a	14.12a	14.15b	14.16cd	5.58b	5.49a	6.04a	5.41a	5.63a
Agdas-21	20.56a	16.10a	14.90a	16.95a	17.13a	3.81d	4.40b	4.02b	4.49b	4.18b
Maras-92	15.78b	13.92bc	12.02a	11.42c	13.29de	5.57bc	5.34a	6.02a	5.47a	5.60a
Sayar-314	11.55c	12.77c	12.37a	11.72c	12.11e	5.54bc	5.69a	5.75a	5.55a	5.63a
LSD (%1)	3.27	1.76	ns	1.86	1.42	0.54	(%5) 0.68	0.82	0.47	0.37
Means of Years	16.83a	14.81b	13.59c	13.91bc		5.42ab	5.26b	5.64a	5.32b	
CV (%)	9.55	5.86	12.47	6.57	10.67	4.75	6.81	7.19	6.79	7.44

Table 8: Means for ginning outturn (%) and 100 seed weight (g) and arised groups

Traits	Ginning Outturn (%)					100 Seed Weight (g)				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	41.52a	40.11a	42.45a	39.95a	40.93a	11.77a	11.30a	10.02b	10.59ab	10.86a
Agdas-6	38.17c	38.90a	41.28a	38.91a	39.31bc	10.86c	11.29a	10.45b	10.32bc	10.73a
Agdas-7	42.08a	40.13a	41.52a	38.22a	40.49ab	11.36ab	11.08a	10.49b	10.17bc	10.79a
Agdas-17	39.33b	38.16a	41.91a	40.53a	39.98ab	11.36ab	11.06a	10.33b	10.62ab	10.87a
Agdas-21	35.79d	38.50a	38.10b	39.83a	38.05c	11.48ab	10.70a	11.62a	10.90a	11.18a
Maras-92	39.02bc	38.63a	41.18a	41.06a	39.97ab	11.04bc	11.30a	10.42b	10.00c	10.69a
Sayar-314	39.16bc	38.50a	41.53a	40.89a	39.99ab	11.54a	11.53a	10.71b	10.37abc	11.04a
LSD (%1)	1.07	ns	(%5) 2.33	ns	0.94	0.45	ns	(%5) 0.81	(%5) 0.54	ns
Means of Years	39.28b	38.99b	41.09a	39.91ab		11.31a	11.18a	10.60b	10.43b	
CV (%)	1.36	5.35	3.82	3.84	4.33	2.07	6.01	5.13	3.48	5.49

Table 9: Means for fiber length (mm) and fiber fineness (micronaire) and arised groups

Traits	Fiber Length (mm)					Fiber Fineness (micronaire)				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	26.95d	27.55c	29.02b	29.11b	28.16c	5.27a	5.25a	4.62a	4.81b	4.99a
Agdas-6	27.75cd	28.82bc	29.75b	28.21b	28.63bc	4.75ab	4.82bc	4.57a	5.17a	4.83abc
Agdas-7	28.73bc	30.42b	29.27b	29.12b	29.39b	4.82a	4.47cd	4.67a	4.65b	4.65bc
Agdas-17	27.00d	27.22c	29.25b	29.59b	28.27c	5.07a	5.17ab	4.77a	4.88ab	4.98a
Agdas-21	34.10a	32.80a	33.37a	32.97a	33.31a	3.57c	4.30d	4.02b	4.75b	4.16d
Maras-92	29.27b	28.50bc	30.17b	28.77b	29.18b	4.02bc	4.87abc	4.57a	4.77b	4.62c
Sayar-314	29.50b	29.10bc	28.32b	30.01b	29.38b	4.80a	4.86abc	4.65a	5.19a	4.88ab
LSD(%1)	1.52	2.02	1.59	2.41	0.87	0.76	0.41	0.49	0.31	0.23
Means of Years	29.04b	29.20b	29.97a	29.68ab		4.61b	4.86a	4.56b	4.89a	
CV (%)	2.57	3.41	2.60	3.54	3.18	8.25	4.23	5.31	3.16	5.12

Table 10: Means for fiber strength (g tex^{-1}) and fiber uniformity (%) and arised groups

Traits	Fiber Strength (g tex^{-1})					Fiber Uniformity (%)				
Varieties	1997	1998	1999	2000	Means of Varieties	1997	1998	1999	2000	Means of Varieties
Agdas-3	21.42cd	18.40c	28.07b	29.67bc	24.38cd	52.72ab	52.77a	85.30a	84.59a	68.84ab
Agdas-6	22.85cd	19.17c	28.67b	27.04d	24.43cd	52.80ab	52.87a	85.20a	84.82a	68.92ab
Agdas-7	23.50c	22.42b	28.77b	29.28bcd	25.99b	53.82a	51.55ab	85.72a	84.76a	68.96ab
Agdas-17	20.63d	17.52c	28.17b	27.73cd	23.51d	53.33ab	52.65a	85.60a	85.46a	69.26a
Agdas-21	35.38a	27.17a	39.45a	35.69a	34.42a	48.33c	49.37b	84.82a	85.61a	67.03c
Maras-92	27.42b	18.45c	28.20b	28.42bcd	25.62bc	51.95b	52.57a	84.70a	85.67a	68.73ab
Sayar-314	23.83c	19.17c	28.92b	30.81b	25.68bc	51.85b	51.02ab	84.55a	85.20a	68.16b
LSD(%1)	2.42	2.96	3.85	2.45	1.33	1.77	2.64	ns	ns	0.94
Means of Years	25.07 b	20.26 c	30.04 a	29.80 a		52.11 b	51.83 b	85.13 a	85.16 a	
CV (%)	4.75	7.14	6.29	4.05	5.44	1.67	2.50	1.13	0.79	1.47

ns: not significant.

* Means followed by the same letter are not significantly different at 5% level of probability.

G. hirsutum L. This difference of yield was about 1100 kg as to the most yielding variety and about 750 kg as to high yielding standard variety. Many researchers reported that cottons belonging to *G. barbadense* L. need a longer growing season and higher temperatures[2,3]. Although the annual yield of Agdas-21 is slightly less than other varieties, its production could still be cost effective since the fibres of silk cotton is so expensive and only available

from abroad. For this purpose, economic analysis should also be included in the future investigations that will be carried out using Agdas-21.

Among the Agdas varieties belong to *G. hirsutum* L. the most promising varieties were Agdas-7 and Agdas-17. Agdas-7 and 17 passed the both standard varieties for seed cotton yield whereas Agdas-3 and Agdas-6 passed one of the standards (Sayar-314).

All varieties showed the highest performance for seed cotton yield in 2000. This situation has shown that seed cotton yield which is controlled by more than one gene pairs and had quantitative heritage can be affected by environment conditions, that different results can be obtained from different varieties[11,12].

Plant height: There is a negative relationship between plant height and earliness. Agdas-21 that is the highest variety belongs to *G. barbadense* L. As known, *Barbadense* varieties need longer growing period. But Agdas-21 matured at the same time with *Hirsutum* varieties because it is mutant for earliness. Means for plant height of investigated varieties and arised groups were given in Table 6. From this Table, it has been relized that plant height values in 1998, 1999 and 2000 were at the same group. Generally according to four year's results, Agdas-21 was the longest variety with 85.19 cm. (Table 6). Agdas-6 (80.39 cm), Agdas-7 (79.38 cm) and Maras-92 (78.89 cm) followed this. The shortest variety was Sayar-314 (73.62 cm).

Sympodia number: Sympodia number is very important in order to form yield. For higher yield more sympodia number is desired. It can be relized that the least sympodia number was taken in 1999 (11.74), but the most sympodia number was taken in 1998 (13.99). According to four year's results, Agdas-21 had the most sympodia number (14.49). Agdas-17 and Agdas-6 followed this with 13.03 and 12.95, respectively (Table 6). These varieties passed the both local standards. Because Agdas-21 is a *Barbadense* variety, it is higher and it forms many sympodia number. This situation explains the fact that Agdas-21, which yields earlier and produces silk quality fibres, is not markedly behind the standard varieties concerning the seed cotton yield.

Boll number per plant: Means for boll number per plant of investigated varieties and arised groups were given in Table 7. From Table, it has been seen that the most boll number per plant was obtained in 1997 (16.83), but the least boll number per plant was obtained in 1999 (13.59). Except 1997 in the three years of experiment the all Agdas varieties had more boll number than standard varieties. According to four year's results, Agdas-21 gave the most boll number (17.13). Agdas-7 (15.79) and Agdas-3 (15.73) followed it. The least boll number was taken from Sayar-314 (12.11) and Maras-92 (13.29). Boll number trait is one of the most important yield components. But it is not enough alone to form yield. For example, Agdas-21 had the most boll number and sympodia number but had the lowest seed cotton yield because its bolls were smaller. Same case has been also mentioned on other varieties by Mustafayev *et al.*[8], Gencer *et al.*[10].

Seed cotton weight per boll: As seen in Table 7, in all trial years Agdas-21 variety belonging to *G. barbadense* L. gave the lowest seed cotton weight per boll. In 1998, 1999 and 2000 among varieties belonging to *G. hirsutum* L. there was not statistically significant difference for this trait ($P>0.05$). When it was looked at four year's mean results, it has been relized that the situation was similar. Agdas-21 had the lowest seed cotton weight per boll and the other varieties placed in only one group. Except Agdas-21 (*G. barbadense* L.) the all Agdas varieties (*G. hirsutum* L.) did not form more different seed cotton weight per boll than standard varieties like in Mustafayev *et al.*[8,9]. One of the reasons that Agdas-21 has a low seed cotton yield is the fact that this variety forms smaller bolls which is characteristic of *Barbadense* species.

Ginning outturn: From Table 8, it has been seen that the highest value of ginning outturn was obtained in 1999 (41.09%) followed by 2000 (39.91%), 1997 (39.28%) and 1998 (38.99%). Furthermore, in 1998 and 2000 there wasn't significantly difference between ginning outturn values of the varieties. In 1997 and 1999 Agdas-21 variety had the lowest ginning outturn and in 1999 the values of ginning outturn of other varieties were similar to each other.

Among varieties, three groups formed for ginning outturn (Table 8). The highest ginning outturn was taken from Agdas-3 (40.93%) followed by Agdas-7 (40.49%), Sayar-314 (39.99%), Agdas-17 (39.98%) and Maras-92 (39.97%), respectively. Agdas-21 had the lowest ginning outturn (38.05%). As seen, Agdas-3, Agdas-7 and Agdas-17 had the most ginning outturn. Also, these varieties had the most higher seed cotton yield. This case showed that there are a positive relationship between yield and ginning outturn.

100 seed weight: In 1998 among the values of 100 seed weight of the varieties there was not significantly difference. In 1999 the most 100 seed weight was taken from Agdas-21 (11.62 g) and the other varieties were not

statistically different and placed in the same group. Also in 2000 the most 100 seed weight was obtained from Agdas-21 (10.90 g) followed by Agdas-17 (10.62 g), Agdas-3 (10.59 g) and Sayar-314 (10.37 g). When Table 8 was examined, it can be seen that for 100 seed weight there was not significantly difference among the varieties and that the all varieties placed in the same group. Similar results were also reported by Gencer[13]. Hundred seed weights of the varieties varied between 10.69 g (Maras-92) and 11.18 g (Agdas-21).

Fiber length: Agdas-21 variety (*G. barbadense* L.) had the longest fibers in all four years and this result is expected. These results show that long fibre trait of silk cotton was not lost in the east Mediterranean environmental conditions, which is highly remarkable observation. According to four year's results, Agdas-21 (*G. barbadense* L.) had the longest fibers (33.31 mm) and the shortest fibers was obtained from Agdas-3 (28.16 mm) and Agdas-17 (28.27 mm). For fiber length only one Agdas variety (Agdas-21) had longer fibers than standard varieties. The fact that Agdas-21 had longer fibers than the other varieties has been caused by genotypical structure of this variety[2,14]. Baker and Verhalen [15]; Sing and Gill[16] also studied on *Hirsutum* cottons and found almost the same fiber lengths.

Fiber fineness: Except the year 2000, the finenest fibers was taken from Agdas-21 (3.57, 4.30 and 4.02 micronaire, respectively) (Table 9). In the year 2000, fiber fineness might be affected by environment conditions. When four year's results were examined, the finest fibers were also obtained from Agdas-21 followed by Maras-92, Agdas-7, Agdas-6 and Sayar-314. Heerden *et al.*[17] reported that fiber fineness can vary according to genotypes and ecological variables in different years. However, when Agdas-21 is produced in the east Mediterranean environmental conditions its fine fibre trait which is required by textile industry will be conserved.

Fiber strength: Means for fiber strength of the varieties and arised groups were given in Table 10. Agdas-21 variety having the longest and the finenest fibers had the highest fiber strength in all trial years. According to four year's results, for fiber strength Agdas-21 was the variety having the most strong fibers with 34.42 g tex^{-1}. Agdas-7 followed this. Agdas-3, 6 and 17 varieties took place in medium class (22-24 g tex^{-1}), Agdas-7, Maras-92 and Sayar-314 varieties were in strong class (25-27 g tex^{-1}) and Agdas-21 was in very strong class (28-35 g tex^{-1}).

Fiber uniformity: In 1997 and 1998 Agdas-21 had the lowest fiber uniformity. In 1999 and 2000 the fiber uniformity values of the varieties increased on a large scale by comparison the preceding years and this increasing was observed in all varieties and there were no statistically significant difference among the fiber uniformity values of the varieties (Table 10). Similar results were also reported by Gencer[13]. According to four year's results, it has been determined that the lowest fiber uniformity was obtained from Agdas-21 and that the other Agdas varieties did not differ from standards and but Agdas-17 was more promising for this trait.

Agdas-3, 7, 17 and 21 germinated about 2 days earlier than the standard varieties. Also the mutants except Agdas-21 opened their bolls 3-6 days earlier than standards. Agdas-21 opened its bolls about 3 days later than Maras-92, but at the same time with Sayar-314 in spite of belonging to *G. barbadense* L. Furthermore, Agdas-3, 6, 7 and 17 were the earliest yielding varieties with 83, 82, 83, 84% of first harvest ratio, respectively. Agdas-21 yielded at the same time with Maras-92 (81%) and earlier than Sayar-314 (78%) in spite of belonging to *G. barbadense* L. Moreover, it was determined that for seed cotton yield Agdas-7 and Agdas-17, for fiber length, fineness and strength Agdas-21 were superior than standard varieties. Agdas-7 and Agdas-17 due to their higher seed cotton yield and in spite of its lower yield Agdas-21 due to its earliness and superior fiber quality were found promising for this region.

As concluding remarks, Agdas-21 kept its long, fine and strong fiber features under the east Mediterranean region's environmental conditions. However it was determined that Agdas-21 had lower seed cotton yield compared to standard varieties. Although this looks like a disadvantage for this variety, more studies including economical analysis should be carried out to determine whether its production is cost effective.

In Turkey, silk cotton is not cultured since it is a late maturing variety and it requires high temperature. Therefore silk cotton requirements of Turkish textile industry is met by import resulting a significant cost to the industry. This study showed that Agdas-21 can be cultured in the east Mediterranean ecological conditions.

Agdas-7 and Agdas-17 among the other studied varieties of *Hirsutum* species could be suggested as alternative to the varieties Maras-92 and Sayar-314. Agdas-7 should have priority since it showed similarity with standard varieties concerning fibre quality and in addition it showed higher seed cotton yield compared to standard varieties. Furthermore from the earliness point, Agdas-7 yielded 5.5 days earlier than standard Sayar-314 and this is a significant gain regarding conservation of fibre quality.

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