Pak. J. Bot., 42(6): 3865-3873, 2010.

AGRONOMIC, FIBER AND SEED QUALITY TRAITS OF NATURALLY COLOURED COTTONS IN EAST MEDITERRANEAN REGION OF TURKEY

LALE EFE*, A. SEFER MUSTAFAYEV AND FATIH KILLI

Kahramanmaras Sutcu Imam University,
Agricultural Faculty, Field Crops Department, Kahramanmaras, Turkey.

Abstract

This study was carried out during 2002-2005 in the east Mediterranean region of Turkey (in Kahramanmaras province), at the experimental field of Agricultural Faculty of Kahramanmaras Sutcu Imam University. Four naturally coloured cotton lines (light brown, dark brown, cream and green) (*G. hirsutum* L.) brought from Azerbaijan National Academy, Genetic Resources Institute and white linted cotton varieties of Maras-92 and Sayar-314 (*G. hirsutum* L.) which are of standard varieties of the region were used as test material. Four year's field trials were established according to randomized block design with four replication.

According to four year's results, investigated coloured cotton lines have given lower yield and ginning outturn than standard varieties. However cream and light brown lines were similar to standards for plant height, sympodia, boll number per plant, seed cotton weight per boll, fiber quality characteristics, kernel oil and protein content. From results it may be concluded that cream and light brown lines are remarkable lines a those may be used for further breeding programs for improvement of desired trais.

Introduction

Cotton occures naturally in four coloures: white, brown, green and blue. White coloured cotton ranges from creamy to shinning white. Brown occurs in various shades from light Brown to dark Brown and mahogany. Green occurs in shades from light green to green , but only very light blue is available. Coloured lint usually has poor quality: the fiber is weak, it has higher micronaire and it is shorter in length (Chaudhry & Guitchounts, 2003).

Cotton fibers are chemically treated and dyed to different shades. Many dyes are of chemical origin and these are not environment friendly. The negative effects of dyeing are mitigated by naturally coloured cotton (Anon., 2002). Naturally coloured cottons are unique in that they grow in coloures and do not have to be dyed in fabric manufacturing. Dyeing can be one of the most costly steps in fabric finishing due to water and energy use, and waste production (Dickerson *et al*., 1996). Aslam *et al*., (2004) reported that textile effluents are high in toxicity not only for human beings of surroundings but also a serious threat to ground and surface water recources. Naturally coloured cotton is an attractive proposition for the textile industry as indiscriminate use of chemicals in cotton production and for dyeing and finishing of fabrics, causes considerable environmental pollution (Waghmare & Koranne, 1998).

Breeding objectives in colored cotton include improving color range, fiber quality and yield potential. Colored cotton varieties are said to be at least 10% lower yielding compared with commercially grown white varieties (Anon., 1993). With various plant breeding methods, researchers have developed long fiber and strong coloured cotton that can be used commercially. In many countries a number of researchers have studied on

yield and quality improvment of naturally coloured cottons. Joshi & Chirde (1998) initiated a study in 1993 in Mahyco, India in order to develop coloured linted cotton hybrids with high yield and superior fiber traits. They reported that selected hybrid combinations had better fiber properties than coloured cotton parents. Janbhale *et al*., (1998) initiated a genetic improvement programme for coloured lint in *G. hirsutum* L., in India. They studied generations of P_1, P_2, F_1, F_2, BC_1 ve BC_2 followed by crossing in two sets between parents with white, brown and green lint. Mustafayev *et al*., (1999) noted that seed cotton yields of naturally coloured cottons were not statistically different from those of white linted standard cotton varieties. Researchers also reported that fiber fineness of naturally coloured cottons were similar to those of standards but fiber length and strength of naturally coloured cottons were lower than standards. Sofuoglu & Gencer (2000) also reported that the investigated agricultural and technological properties could be linked to directly the coloured fiber gene by the side of the other genes and that the fiber qualities and yields of coloured lint cottons could be improved through traditional plant breeding methods. Zhang *et al*., (2000) noted that coloured cotton breeding using conventional breeding techniques to improve fiber quality is somewhat problematic. These difficulties include high wax content in fibres of green coloured cotton, which affects fibre specific strength and causes colour changes due to the optical sensitivity. Another problem is that the colour intensity of brown cotton is negatively correlated with quality in genetic linkage. Gurel *et al*., (2001) investigated cultivation possibilities of naturally coloured cottons under Aegean region conditions. Six coloured cotton lines (4 brown and 2 green) and 3 white coloured lines were evaluated in a study conducted in Turkey in 1997 and 1998. Researchers reported that the light brown line had fiber length in the range 33.9-30.2 mm and seed cotton yield between 2900 and 2190 kg ha $^{-1}$ and that the dark brown line had a fiber length of 26.0-25.9 mm and seed cotton yield of 4580-3761 kg ha $^{-1}$ and that green cotton had poorer quality compared to the others. Thawari *et al*., (2003), reported that seeds of naturally coloured cotton (*G. hirsutum* L.) were exposed to 15 and 20 kR of gamma radiation and/or 0.5% ethyl methanesulfonate (EMS). Selection pressure was applied in M_2 generation and selected M_2 mutants were studied for their fibre quality. Researchers also reported that EMS was effective in improving the maturity coefficient in the crop and there are significant differences in the treatment means for uniformity ratio, maturity coefficient and ginning outturn.

Materials and Methods

This study was carried out during 2002-2005 in the east Mediterranean region of Turkey (in Kahramanmaras province), at the experimental field of Agricultural Faculty of Kahramanmaras Sutcu Imam University. Four naturally coloured cotton lines (ligth brown, dark brown, cream and green) (*G. hirsutum* L.) brought in 1999 from Azerbaijan National Academy, Genetic Resources Institute and white linted cotton varieties of Maras-92 and Sayar-314 (*G. hirsutum* L.) which are of standard varieties of the region were used as test material. Field trials were established according to randomized block design with four replication during the course of study.

Kahramanmaras is a province in the East Mediterranean Region of Turkey (37° 35' N latidute and 36° 56' E longitude). In the cotton growing regions Mediterranean climate conditions which are hot and dry in summers and warm and rainy in winters dominate. Soils of field of experiment was clay-loam, pH was 7.5, lime was 20.24%, organic matter was 0.95%.

The seeds were sown by experimental mechanical planter in four-row plots of 10 m length at a planting space of 65 cm in 2002, 2003, 2004 and 2005 on 07 May, 13 May, 21 May and 06 May respectively. Plants were thinned to 20 cm in rows. During the growing season plants were hoed 3 to 4 times and harrowed 4-5 times. Each year, composed fertilizer (20:20:0) was applied presowing at the rate of 8 kg/da N and P_2O_5. Ammonium nitrate26% was applied at the rate of 7 kg/da N by using a fertilizer spreader in inter-rows prior to first and second irrigation. Plants were furrow irrigated 5-7 times until bolls open up to 60%. Plants were hand-harvested on 27 September 2002, 30 September 2003, 12 September 2004 and 30 September 2005 at two times each year. At harvesting time samples of 20 bolls were taken from each plot.

In this study plant height, sympodia number, boll number per plant, seed cotton weight per boll, ginning outturn, seed cotton yield, fiber length, fiber fineness, fiber strength, fiber uniformity, kernel oil content and kernel protein content were investigated. The morphological and agronomical characters were determined according to methods shown by Gencer *et al*., (1992). Fiber technological traits of fiber samples were determined using HVI (High Volume Instruments) analyser. Kernel oil contents were found out by using Soxhlet oil extraction method. Protein contents were analysed by using Kjeldahl method. Kernel oil and protein analyses of the naturally coloured cotton lines and white linted standard varieties were determined only in 2005.

The data obtained were analysed by experimental desing of randomized block design with four blocks for each year seperately and then combined analysis of variance over four years was done by using the SPSS package program (Efe *et al*., 2000) and the means were compared by using Duncan multiple comparison test (Bek & Efe, 1995).

Results and Discussion

The results of combined analysis of variance for four years (2002-2005) of coloured cotton lines and standard varieties for agronomic characteristics are given in Table 1, fiber and seed quality characteristics are given in Table 2.

According to the four year's results, the differences among naturally coloured cotton lines and white linted standard varieties were statistically significant for seed cotton weight per boll, seed cotton yield, ginning outturn, 100-seed weight, fiber length, fiber fineness, fiber strength, fiber uniformity and kernel oil content (Table 1 and 2). Similarly years were significant for all the investigated traits except plant height. Year x line/variety interaction was statistically significant for seed cotton yield, ginning outturn, fiber length, fiber fineness, fiber strength and fiber uniformity. The means of coloured cotton lines and standard varieties for investigated traits are given in Table 3 and 4.

Plant height: No statistically significant differences in plant height were observed among naturally coloured cotton lines and standard varieties over four years. But there were three groups for this traits. The green cotton line was the longest with 95.2 cm. Cream and light brown lines and Maras-92 (std) variety followed it with 90.4 cm, 88.9 cm. respectively. The shortest lines/varieties were deep brown line (87.4 cm) and Sayar-314 variety (std) (87.7 cm).

Sympodia number: Sympodia number is one of the important yield components. From Table 3, it is evident that the sympodia numbers of naturally coloured cotton lines and white linted standard varieties were not statistically different and they took place at the same group. The sympodia numbers of naturally coloured cotton lines and white linted standard varieties varied from 12.5 to 13.5.

Table 1. Results of combined analysis of variance for four years (2002-2005) of coloured cotton lines and standard varieties for agronomic characteristics.

Source of variation	df	Mean square						
		Plant height	Sympodia number	Boll number per plant	Seed cotton weight per boll	Seed cotton yield	Ginning outturn	100-Seed weight
Block	3	40.131	5.726	12.364*	0.220	3496.769	0.514	0.180
Year	3	538.383	106.992**	25.139**	1.353**	87037.560**	38.851**	2.463**
Line/Variety	5	130.593	2.890	4.427	4.311**	36890.915**	124.291**	2.861**
Yearx line/Variety	15	119.947	2.429	2.445	0.197	23446.938**	38.981**	0.566
Eror	69	81.734	2.506	3.238	0.159	1968.109	3.705	0.483
CV(%)		10.07	12.29	15.48	7.09	17.52	5.11	6.26

(*)p<0.05; (**)p<0.01

Table 2. Results of combined analysis of variance for four years (2002-2005) of coloured cotton lines and standard varieties for fiber and seed quality characteristics.

Source of variation	df	Mean square					
		Fiber length	Fiber fineness	Fiber strength	Fiber uniformity	Kernel oil content	Kernel protein content
Block	3	1.357	0.193	1.714	1.589	7.443	21.052
Year	3	9.291**	2.626**	175.673**	6790.969**	----	----
Line/Variety	5	60.560**	6.274**	56.655**	9.899**	31.875*	29.792
Yearx line/Variety	15	4.601*	0.809**	9.137**	7.762**	----	----
Eror	69	2.168	0.324	2.677	1.427	7.852	13.613
CV(%)		5.41	12.53	6.09	1.58	9.08	11.34

(*)p<0.05; (**)p<0.01

Table 3. Four year's means (2002-2005) of coloured cotton lines and standard varieties for agronomic characteristics and arised groups.

Traits / Lines/Varieties	Plant height (cm)	Sympodia number	Boll number per plant	Seed cotton weight per boll (g)	Seed cotton yield (kg ha^{-1})	Ginning outturn (%)	100-Seed weight (g)
Cream	90.4 ab	13.5 a	12.2 a	5.9 a	2032 c	38.0 b	11.2 ab
Green	95.2 a	13.3 a	11.5 a	4.8 c	2331 bc	34.1 d	10.6 c
Deep brown	87.4 b	12.9 a	12.3 a	5.2 b	2494 b	36.0 c	11.7 a
Light brown	88.9 ab	12.5 a	11.6 a	5.8 a	2104 c	36.3 c	11.4 a
Maras-92 (std. cv.)	88.9 ab	12.5 a	11.0 a	6.0 a	3086 a	40.9 a	10.7 c
Sayar-314 (std. cv.)	87.7 b	12.6 a	11.2 a	6.1 a	3141 a	40.9 a	10.9 bc

Table 4. Four year's means (2002-2005) of coloured cotton lines and standard varieties for fiber and seed quality characteristics and arised groups.

Traits / Lines/Varieties	Fiber length (mm)	Fiber fineness (micronaire)	Fiber strength (g tex^{-1})	Fiber uniformity (%)	Kernel oil content (%)	Kernel protein content (%)
Cream	27.8 b	4.9 bc	27.9 ab	76.0 a	30.7 a	33.9 ab
Green	26.2 c	3.3 a	25.1 c	73.7 c	33.1 a	31.5 ab
Deep brown	23.9 d	5.0 c	24.1 c	75.2 ab	31.0 a	29.1 b
Light brown	27.2 b	4.9 bc	26.7 b	75.4 ab	33.8 a	31.2 ab
Maras-92 (std. cv.)	28.9 a	4.5 b	28.6 a	75.7 ab	25.7 b	37.1 a
Sayar-314 (std. cv.)	29.3 a	4.6 bc	28.7 a	75.0 b	30.8 a	32.5 ab

Boll number per plant: Boll number per plant is very important in order to form yield. Means for boll number per plant of naturally coloured cotton lines and white linted standard varieties and arised groups are given in Table 3. It is evident from Table 3, that boll number per plant of naturally coloured cotton lines and white linted standards varied from 11 to 12.3. The coloured lines and standard varieties were not statistically significant for boll number per plant and the all lines and varieties were in the same group.

Seed cotton weight per boll: Statistically significant differences were observed among naturally coloured cotton lines and white linted standard varieties for seed cotton weight per boll over four years. The maximum seed cotton weight per boll was obtained from standard varieties Sayar-314 variety (6.1 g), Maras-92 (6.0 g), while cream (5.9 g) and light brown (5.8 g) remain almost smilar to both standard varieties. The least seed cotton weight per boll was in green and deep brown lines with 4.8 g and 5.2 g respectively.

Seed cotton yield: Over four years, significant seed cotton yield differences were found among naturally coloured cotton lines and white linted standard varieties. Seed cotton yields of the naturally coloured cotton lines and white linted standard varieties varied between 2032 kg ha $^{-1}$ and 3141 kg ha $^{-1}$ (Table 3). The maximum seed cotton yield was obtained from standard varieties of Maras-92 (3086 kg ha $^{-1}$) and Sayar-314 (3141 kg ha $^{-1}$) followed by deep brown (2494 kg ha $^{-1}$). It can be said that naturally coloured cottons were behind the standard varieties for seed cotton yield.

Ginning outturn: Ginning outturn differences were highly significant between naturally coloured cotton lines and white linted standard varieties over four years. It has been seen that ginning outturn values of naturally coloured cotton lines and white linted standard varieties varied from 40.9% and 34.1% (Table 3). The highest ginning outturn was taken from standard varieties of Maras-92 and Sayar-314 (40.9%). Among coloured cotton lines cream cotton had the most ginning outturn value (38.0%). But all coloured cottons were behind of standards.

100-seed weight: In four years, statistically significant differences were observed among naturally coloured cotton lines and white linted standard varieties for hundred-seed weight. 100-seed weight values of naturally coloured cotton lines and white linted standard varieties varied between 10.6 g (green) and 11.7 g (deep brown). The maximum 100-seed weight values were taken from deep brown and light brown lines with 11.7 g and 11.4 g respectivelly. Cream cotton line, Sayar-314, Maras-92 varieties and green cotton line followed them (Table 3).

Fiber length: Quality of end product depends on quality of raw material. Also length, fineness and strength of cotton lint are very important fiber traits in order to produce best quality textile products. Statistically significant differences were observed among lines/varieties for fiber length over four years. From Table 4, it has been seen that fiber length values of the investigated coloured lines and white linted standard varieties varied from 29.3 mm to 23.9 mm. The longest fibers were obtained from standard varieties Sayar-314 (29.3 mm) and Maras-92 (28.9 mm). Cream (27.8 mm) and light brown (27.2 mm) cotton lines followed them. The shortest fibers were observed from deep brown (23.9 mm) and green (26.2 mm) cotton lines. It may be pointed out that naturally coloured cotton lines had shorter fibers than standard varieties with white fibres. These results were similar to those of Mustafayev *et al*., (1999).

Fiber fineness: Over four years, significant differences for fiber fineness were found among lines/varieties (Table 4). Micronaire readings of the naturally coloured cotton lines and white linted standard varieties varied from 3.3 micronaire to 5.0 micronaire. The finest fibers were taken from green cotton line (3.3 micronaire). Mustafayev *et al*., (1999) reported similar results. It can be said that green cotton line had the finest fibers and that cv. Maraş-92, cv. Sayar-314, cream and light brown cotton lines followed it with 4.5, 4.6, 4.9 ve 4.9 micronaire respectively. Deep brown cotton line gave the thickest fibers (5.0 micronaire).

Fiber strength: Statistically significant differences were observed among lines/varieties for fiber strength (Table 4). The means of fiber strength of the naturally coloured cottons and white linted standard varities varied from 28.7 g tex^{-1} to 24.1 g tex^{-1}. The comparision of fiber strength between naturally coloured cotton lines and standard varieties it is evident that the strongest fibers were taken from Sayar-314 (28.7 g tex^{-1}) followed by Maras-92 (28.6 g tex^{-1}). Cream and light brown cotton lines followed them (27.9 g tex^{-1} and 26.7 g tex^{-1} respectively). The least strong fibers were taken from deep brown and green cotton lines with 24.1 g tex^{-1} and 25.1 g tex^{-1}. The naturally coloured cotton lines were less strong than standard varieties. Our findings were similar to findings of Mustafayev *et al*., (1999).

Fiber uniformity: Statistically significant differences were observed among naturally coloured cotton lines and white linted standard varieties for fiber uniformity over four years. The means of lines/varieties varied from 76.0% to 73.7% (Table 4). The most uniform fibers were taken from cream cotton line (76.0%). Standard cv. Maras-92, light brown and deep brown cotton lines and standard cv. Sayar-314 followed it with 75.7%, 75.4%, 75.2%, 75.0% respectively. The least uniform fibers were taken from green cotton line (73.7).

Kernel oil content: Statistically significant differences were observed among naturally coloured cotton lines and white linted standard varieties for kernel oil content in 2005. But there were two groups for this traits. The all naturally coloured cotton lines and standard cv. Sayar-314 took place at the same group (Table 4). In this group kernel oil contents varied between 33.8% (light brown) and 30.7% (cream). The least content of kernel oil was found in standard cv. Maras-92 (25.7%).

Kernel protein content: Statistically significant differences in kernel protein content were observed among naturally coloured cotton lines and white linted standard varieties in 2005 (Table 4). Kernel protein contents of naturally coloured cottons and white linted standard varieties varied between 37.1% and 29.1%. The maximum content of kernel protein were found in standard cv. Maras-92 (37.1%). Cream cotton line, std. cv. Sayar-314, green and light brown cotton lines followed it with 33.9%, 32.5%, 31.5% and 31.2 respectively (Table 4). The least content of kernel protein were found in deep brown cotton line (29.1%).

Conclusion

According to four year's results, plant heights of naturally coloured cotton lines were similar to white linted standards or longer than them. It can be said that naturally coloured cottons were similar to standard varieties for sympodia and boll number per

plant. Moreover, seed cotton weights per boll of cream and light brown were similar to standards. However, seed cotton yields of naturally coloured cottons were lower than standard varieties. Also ginning outturn values of coloured cottons were lower. But 100-seed weight values were higher than standard varieties. Green cotton line had the finest fibers. However, cream and light brown cotton lines were close to standard varieties for all the fiber quality characteristics. Kernel oil contents of naturally coloured cotton lines were similar to one of the white linted standard varieties and higher than the other standard variety. For kernel protein content naturally coloured cotton lines were similar to white linted standard varieties except deep brown cotton line.

As a result, investigated coloured cotton lines have given lower yield and ginning outturn than standard varieties. However, cream and light brown lines were similar to standards for plant height, sympodia, boll number per plant, seed cotton weight per boll, fiber quality characteristics, kernel oil and protein content. In conclusion, it can be said that cream and light brown lines are remarkable lines.

References

Anonymous. 2002. http://www.hindu.com/thehindu

Anonymous.1993. International Conference on Organic Cotton. *The ICAC RECORDER*, December 1993.

Aslam, M.M., M.A. Baig, I. Hassan, I.A. Qazi, M. Malik and H. Saeed. 2004. Textile wastewater characterization and reduction of its COD & BOD by oxidation. *Electronic Journal of Environmental, Agricultural and Food Chemistry*, 3(6): 1-9.

Bek, Y. and E. Efe. 1995. *Experimental Methods*. Cukurova University, Course Book of Agricultural Faculty, Publication No:71, Adana-Turkey.

Chaudhry, R. and A. Guitchounts. 2003. *Cotton Facts*. International Cotton Advisory Committee. Technical Paper No:25 of the Common Fund for Commodities. Washington D.C., USA.

Dickerson, D.K., E.F. Lane and D.F. Rodriguez. 1996. Evaluation of selected performance characteristics of naturally colored cotton knit fabrics. *California Agricultural Technology Institute Research Publications No*: 961003.

Efe, E., Y. Bek and M. Sahin. 2000. *Statistical Methods with Solutions Using SPSS*. Course Book of The Rectorate of Kahramanmaras Sutcu Imam University, Publication No: 73, Kahramanmaras-Turkey.

Gencer, O., S. Sinan, D. Yelin, M.A. Kaynak and O. Gormus. 1992. Determination of cotton varieties high yielding and having superior fiber technological properties in GAP region. Çukurova University, Agricultural Faculty, *The Final Reports of The Package of Project of GAP Agricultural Research, Investigation and Development*. Project No: 5.2.1, Publication No: 31, Publications of GAP, No: 60, Adana-Turkey.

Gurel, A., H. Akdemir and H.B. Karadayı. 2001. Cultivation possibilities of naturally coloured cottons under Aegean region conditions. *Anadolu*, 11(1): 56-70.

Jambhale, N.D., R.M. Paralkar, N.V. Yadav, R.S. Darade, M.D. Yadav and S.S. Mehetre. 1998. Genetics and improvement of lint characters in naturally coloured cotton (*G. hirsutum* L.). World Cotton Research Conference-2. "*New Frontiers in Cotton Research*". September 6-12, 1998, Athens-Greece. Proceedings, p. 233-234.

Joshi, K.A. and S.S. Chirde. 1998. Color cotton research in Mahyco, India. World Cotton Research Conference-2. "*New Frontiers in Cotton Research*". September 6-12, 1998, Athens-Greece. Proceedings, p. 186-187.

Mustafayev, S., L. Efe, B. Gokkaya and K. Alaskerov. 1999. Naturally coloured cottons and their future perspectives. In Proceedings of 1st symposium on cotton production, fiber technology and textile in Turkish world. (Eds.): M. Oglakcı and B. Cicek, 28 September-01 October, 1999, Kahramanmaras-Turkey, Proceedings, p. 315-324.

Sofuoglu, S. and O. Gencer. 2000. A research on the genetic analysis of the fibre colour. The Inter-Regional Cooperative Research Network on Cotton. In *Proceedings of a joint workshop and meeting of the all working groups*, (Eds.): O. Gencer, R. Derici and F. Göktepe, 20-24 September, 2000, Adana-Turkey, pp. 55-57.

Thawari, S.B., L.D. Meshram and J.P. Khatod. 2003. Response of induced mutagenesis for fibre quality in naturally coloured cotton (*Gossypium hirsutum* L.). *Annals of Plant Physiology*, 2002, publ. 2003, 16(2): 153-156.

Waghmare, V.N. and K.D. Koranne. 1998. Coloured cotton: present status, problems and future potentials. *Indian Journal of Genetics and Plant Breeding*, 58(1): 1-15.

Zhang, B.X., G.X. Wang, B.X. Zhang and G.X. Wang. 2000. A preliminary discussion on the development of coloured cotton in China. *China Cottons*, 27(12): 6-7.

(Received for publication 1 August 2009)