BREEDING OF NEW EARLY-MATURED COTTON VARIETIES WITH IMPROVED FIBER QUALITY

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Abstract

In last years considerable progress was achieved in the Bulgarian cotton breeding regarding the earliness and fiber quality. The varieties Colorit, Darmi and Natalia are new achievement in succession. These three varieties have been obtained from the crosses of *G. hirsutum L.* and bred lines of *G. hirsutum L.* × *G. barbadense L.* origin. In earliness and productivity they were equal to the variety Chirpan-539 (standard for earliness and productivity) and in fiber length they were equal to the variety Avangard-264 (standard for fiber quality). Natalia and Darmi distinguished by higher lint percentage than Avangard-264. Hierarchical cluster analysis, based on six agronomic traits, showed that the variety Natalia was very similar to the standard variety Avangard-264, whilst the variety Darmi was genetically more distant. A breeding useful stability was found in all genotypes for different agronomic traits.

Key words: cotton, G. hirsutum, fiber length, yield, cluster analysis, phenotypic stability.

Introduction

The cotton breeding programs in Bulgaria are focused on the development of cultivars with high genetic potential for yield over 4500-5000 *kg/ha* as well as on the creation of cultivars with improved fiber qualities, especially in terms of length. In 1996 the cultivars Chirpan-539, Chirpan-603 (early and high yielding) and Avangard-264 (by 3 *mm* longer fiber than the standard variety Beli izvor) were created and introduced in the production (Bozhinov et al., 1996; Koynov, Stoilova, 1996). The cultivars Beli Iskar and Beli Lom were the next new achievements in the breeding of earliness and productivity (Bozhinov et al., 2004), while the cultivars Perla-267 and Vega were the next new achievements in the fiber quality breeding – (Stoilova, Saldzhiev, 2000, 2004). Three new cotton varieties resulting from the breeding of fiber quality – Colorit, Darmi and Natalia were recognized by IASAS (Executive Agency for Variety Testing, Approbation and Seed Control) in 2007-2008.
The aim of this study was to establish the productive potential and quality fiber indexes of the new cotton cultivars in comparison with the standard cultivars, as well as the combination of other valuable properties.

Material and Methods

The new three cultivars have been obtained from the crosses of *G. hirsutum L.* and bred lines of *G. hirsutum L.* × *G. barbadense L.* origin: Natalia – line 65 × T-073; Darmi – line 268 × C-9070 and Colorit – line 266 × Balkan. In 2002-2006 they were included in competitive cultivar trials, set up by the standard method, in four replications, with

harvesting plots of 30.6 m^2 (2002-2005) and 20 m^2 (2006), and planting density of 60×10×1. The cultivars were evaluated on the base of the obtained data for the most important agronomic traits – September and total yields, boll weight, length and lint percentage of fiber. The fiber length was determined after the "butterfly" method. Ten plants from each replication were analyzed. Two standards were used – the variety Chirpan-539 for earliness and productivity and the variety Avangard-264 for fiber quality. Statistical program ANOVA was applied for the data statistical processing. Hierarchical cluster analysis based on the agronomic traits was also applied. The varieties were clustered using the Ward's method (Ward 1963). The program STABLE (Kang and Magari, 1995) was used to estimate genotype x environment interaction and stability parameters σ_i^2, and S_i^2 (Shukla, 1972) as well as Kang`s YS_i (Kang, 1993).
Colorit was included in the state cultivar testing in the period 2001-2003, Darmi – in 2002-2004 and Natalia – in 2004-2007.
The period of study (2001-2007) included years of various temperature and rainfall supply: 2001 (warm and very dry) was exceptionally unfavorable in regard to the rainfall supply; 2002 and 2003 (warm and moderately wet) were very favorable for cotton; 2004 was cool and wet: 2005 - moderately cool and wet; 2006 - moderately warm and moderately dry and 2007 – very hot and moderately wet.

Result and Discussion

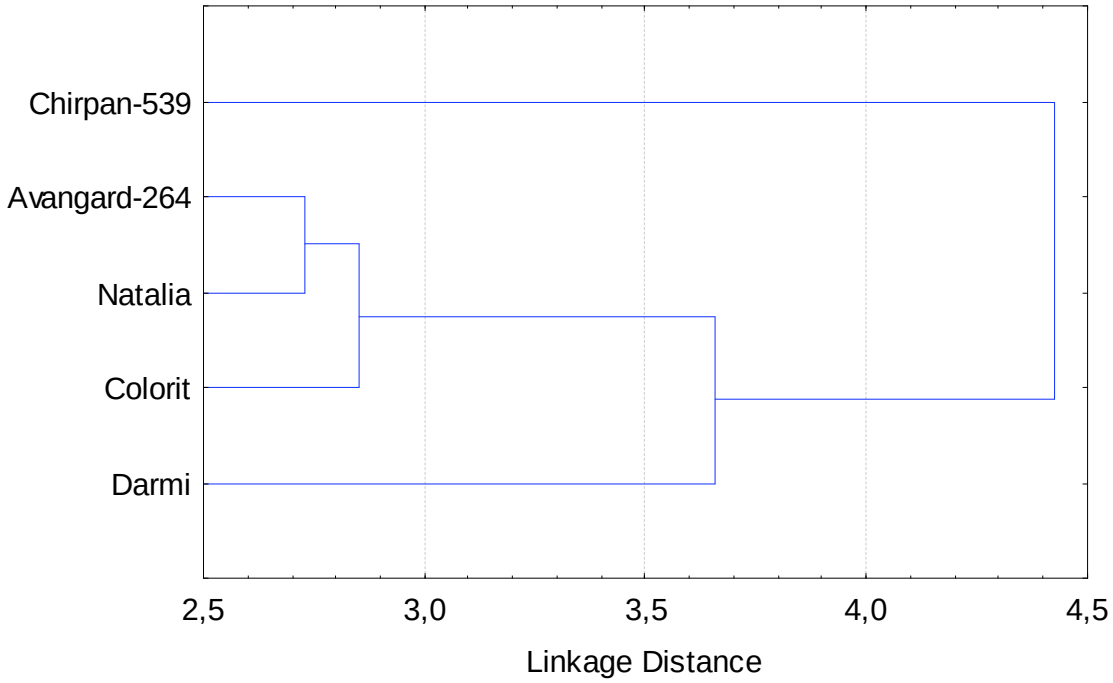
The averaged results from the competitive cultivar testing of the new cultivars over the period 2002-2006 are given in Table 1. Average for the five-year period, the new cultivars Natalia, Darmi and Colorit and both standards - Chirpan-539 and Avangard-264 did not differ in total yield of seed cotton. In terms of September yield, which is used as a criterion of earliness, Natalia and Darmi were inferior by 7.0-7.2 % to Chirpan-539 (standard for earliness and productivity), but the differences being statistically insignificant.

Table 1. Agronomic properties of Natalia, Darmi and Colorit for a five-year period (2002-2006)

Cultivars	Seed cotton yield, *kg/ha*	In % to Chirpan–539	September Yield, *kg/ha*	In % to Chirpan–539	Boll weight, *g*	Fiber length *mm*	Lint percentage %	Height of first fruit branch, *cm*
Chirpan-539 (St.)	2355	100.0	1740	100.0	5.6	26.5	40.1	18.9
Avangard-264 (St.)	2350	99.8	1784	102.5	5.8^{+}	28.4^{+++}	36.8^{000}	18.5
Natalia	2353	99.9	1619	93.0	5.8^{+}	28.9^{+++}	38.7^{00}	19.1
Darmi	2300	97.7	1615	92.8	5.6	28.7^{+++}	38.5^{00}	19.8
Colorit	2330	98.9	1715	98.6	5.8^{+}	28.8^{+++}	37.2^{000}	21.0^{++}
GD 5 %	245	10.4	214	12.3	0.2	0.8	1.0	1.4
GD 1 %	337	14.3	295	16.9	0.3	1.1	1.4	2.0
GD 0.1 %	464	19.7	406	23.3	0.5	1.5	1.9	2.8
Average for trial	2338		1695		5.7	28.2	38.2	19.4

As for the boll weight Darmi was equal to Chirpan-539, while Natalia, Colorit and Avangard-264 had higher boll weight by 0.2 *g*. The average fiber length for the five-year period was by 0.3-0.5 *mm* insignificantly longer than that of Avangard-264 (standard for fiber quality). In fiber length (28.7-28.9 *mm*) they exceeded by 2.2-2.4 *mm* Chirpan-539. In terms of lint percentage Natalia and Darmi surpassed Avangard-264 by 1.7-1.9 %, but by this property they gave way (by 1.4-1.6 %) to Chirpan-539. Colorit had lower lint percentage and was about equal with Avangard-264, and considerably inferior (by 2.9 %) to Chirpan-539. The longer fiber of this variety was combined with a higher set of first fruit branch – 21.0 *cm* at 18.9 *cm* for Chirpan-539 and 18.5 *cm* for Avangard-264 which makes it very suitable for machine picking of cotton.
The cluster analysis on the data in Table 1 shows that the new cultivars and the two standards were in one basic cluster which subdivided into three smaller clusters (Fig. 1). It means that at lower level they had some genetic differences. Natalia and Colorit proved to be very similar to Avangard-264.

Fig. 1. Cluster analysis of 5 cotton varieties by 6 traits
Ward`s method
Euclidean distances



The two factor analysis of variance of the studied traits (Table 2) showed that the effect of genotypes was insignificant for the total and September yields. Genotypes may differ in stability at non-significant mean values. The effect of years was significant for all traits. The genotype × environment interaction was significant for both the total and September yields as well as for the fiber length and lint percentage. Among these traits a significant heterogeneity was establish only for fiber length.
In terms of seed cotton yield the variance stability indices (σ_i^2 and S_i^2) determined as stable the varieties Avangard-264, Darmi and Colorit (Table 3).

Table 2. Analysis of variance of studied characters for stability

Sources of variation	Degree of freedom	Mean squares			
		Seed cotton yield	September yield	Lint percentage %	Fiber length mm
Genotypes	4	10775^{ns}	112456^{ns}	35.87^{++}	20.42^{++}
Environments	4	12089680^{++}	6174913^{++}	23.53^{++}	3.56^{++}
Interaction	16	133047^{++}	102192^{++}	2.27^{++}	1.30^{++}
Heterogeneity	4	19557^{ns}	156950^{ns}	3.87^{ns}	2.74^{+}
Residual	12	170877^{++}	83940^{++}	1.74^{++}	0.82^{++}
Pooled error	60	33360	25548	0.57	0.33

Table 3. Stability parameters by Shukla (σ_i^2 and S_i^2) (1972) and Kang (YS_i) (1993) for four traits of 5 genotypes

Cultivars	σ_i^2	S_i^2	YS_i
Seed cotton yield			
Chirpan-539 (St.)	1394.033^{++}	1733.498^{++}	0
Avangard-264 (St.)	-12.811^{ns}	-0.988^{ns}	6+
Natalia	4966.800^{++}	6460.990^{++}	-1
Darmi	-89.706^{ns}	-121.740^{ns}	-2
Colorit	394.180^{ns}	472.076^{ns}	-3
September yield			
Chirpan-539 (St.)	1094.928^{++}	992.177^{+}	-1+
Avangard-264 (St.)	349.822^{ns}	601.599^{ns}	6+
Natalia	1722.301^{++}	1575.065^{++}	-9
Darmi	1632.465^{++}	1211.426^{++}	-10
Colorit	310.363^{ns}	-183.280^{ns}	4+
Lint percentage			
Chirpan-539 (St.)	6.736^{++}	5.259^{++}	0
Avangard-264 (St.)	-0.114^{ns}	0.154^{ns}	-2
Natalia	5.249^{++}	3.177^{++}	-1
Darmi	-0.187^{ns}	0.137^{ns}	6+
Colorit	-0.347^{ns}	-0.048^{ns}	-1
Fiber length			
Chirpan-539 (St.)	0.070^{ns}	0.361^{ns}	-2
Avangard-264 (St.)	0.001^{ns}	0.260^{ns}	5+
Natalia	1.912^{++}	2.194^{++}	0
Darmi	2.720^{++}	0.593^{ns}	-2
Colorit	1.804^{++}	0.705^{ns}	-1

The YS_i index that enables the simultaneous estimation for yield and stability, showed the highest breeding value for the standard variety Avangard-264. The varieties Avangard-264 and Colorit were stable also in September yield on the base of the variance stability indices (σ_i^2 and S_i^2). The YS_i index determined as the most stable Avangard-264 followed by Colorit. As for the lint percentage breeding useful stability based on the σ_i^2 and S_i^2 values was found for Avangard, Darmi and Colorit. Based on the YS_i index, the most valuable was Darmi. In fiber length the variance stability indices (σ_i^2 and S_i^2) determined as stable both standards – Chirpan-539 and Avangard-264. The YS_i index determined as the most valuable Avangard-264.

Within the state cultivar testing of cultivar Colorit in the period 2001-2003, a total yield of 2260 *kg/ha* was realized as an average for all stations included, by 4.1 % over Avangard-264 (standard for fiber quality) and did not differed from Chirpan-539. In lint yield it also surpassed by 4.6 % Avangard-264, but was inferior to Chirpan-539 by 3.6 %. In modal and staple length (29.0-31.3 *mm*) it surpassed by 1.2 and 0.6 *mm*, respectively that of Avangard-264 and distinguished by higher uniformity. The cultivar Darmi average for tree years (2002-2004) realized a total yield of 2500 *kg/ha*, by 6.8 % over Avangard-264 and 2.0 % over Chirpan-539. In lint yield it surpassed Avangard-264 by 7.4 % and was about equal to Chirpan-539. Natalia average for four year period (2004-2007) yielded 2330 *kg/ha* and exceeded both standards (by 4.5 % Avangard-264 and 3.5 % Chirpan), in lint yield surpassed Avangard-264 by 7.1 % and was inferior to Chirpan-539 by 2.4 % (IASAS, 2007-2008).

Conclusions

The cultivars Natalia, Darmi and Kolorit are new achievements in the breeding of fiber quality. With them is achieved a fiber length increase of 0.6 *mm*.

The longer fiber of Natalia and Darmi was combined with higher lint percentage of than that of Avangard-264, at Kolorit – with higher first fruit branch.

Within the state cultivar testing the new cultivars had higher productivity than Avangard-264. Darmi and Natalia exceeded also Chirpan-539 in total yield by 2.0-3.5%.

The new cultivars and both standards were in one basic cluster, but at lower level they had some genetic differences.

The cultivar Avangard-264 had superior combinations of yield and stability simultaneously as well as of fiber length and stability, the new variety Darmi - of fiber lint percentage and stability.

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