



ISSN 1313 - 8820
Volume 3, Number 2
June, 2011

AGRICULTURAL SCIENCE AND TECHNOLOGY

2011

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

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Trakia University
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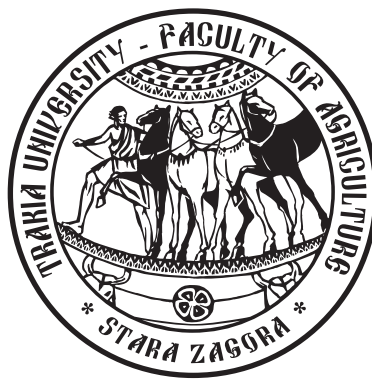
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ISSN 1313 - 8820

Volume 3, Number 2
June 2011



*AGRICULTURAL
SCIENCE AND TECHNOLOGY*

2011

An International Journal Published by Faculty of Agriculture,
Trakia University, Stara Zagora, Bulgaria

Productive and quality characteristics of brown cotton

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Abstract: Breeding of coloured cotton varieties will help to solve certain existing ecological problems concerning dyeing of yarn and tissues. In 2007-2009 competitive variety trials were conducted with brown cotton lines. The results obtained showed that, some of them in earliness and productivity were equal to the early and high yielding variety of white cotton Chirpan-539. These lines are of great importance for developing of new cotton varieties with high economical and ecological effects in spite of their shorter fiber and lower lint percentage than those of standard cultivars. Some others (created later) had fiber length equal to that of check variety which reveals a possibility for enhancing the fiber quality of brown cotton through breeding. Lines No 196 and 197 have commercial potential. Very valuable were lines No 105 and 106 with naked seeds, No 201 with naked seeds and natural early fall of the leaf. The variety Izabell is a new achievement in the breeding of a new generation varieties with an exclusive characteristic – naturally coloured brown lint. This variety had high productivity, earliness, suitability for machine picking, medium fine and short fiber with high uniformity, good elongation and strength. In fiber length and some fiber length characteristics it was inferior to the standard cultivars – Chirpan-539 and Avangard-264. By the other technological fiber properties it was equal to the standards.

Keywords: *G. hirsutum* L., lines, varieties, economical traits, fiber properties

Introduction

Cotton yarns and tissues are dyed with synthetic products that cause allergies and pollute the environment. Lately, there is a reviving of the interest to naturally coloured cotton in order to avoid any dyes and their impact on human health. Coloured cotton attracts the attention of many researchers in the USA, China, Brazil, India, Pakistan, Turkey and other countries. In China brown cotton varieties Brown Fiber 1, New Caimian 2 and Xincaimian 5 were created and introduced in cotton production (Du KiongMing et al., 2000; Li JinFeng et al., 2005; Peng GuangTian and Mo Jun, 2002). In India hybrids based on coloured cotton (brown and green) with high heterosis for yield were developed and introduced (Punitha and Raveendran, 1999). In China among 5 hybrids, Huaizongza 1 was superior in terms of growth, agronomic characters, leaf area, dry matter accumulation and boll set (Zhou TaoHua, Zhang HaiPeng, 2006). In Brazil commercial lines with high economic and technological fiber properties were obtained (Freire et al., 1999). Excellent technological properties of coloured cotton have been reported by Wanderley et al. (1999). Usage of naturally coloured cotton is a new challenge for the cotton producers, textile industry and the European market.

The aim of this paper was to study the productivity and fiber quality of brown cotton lines in comparison with the early and high yielding standard variety of white cotton for developing of new generation cotton varieties with high ecological and economic effects.

Material and methods

In 2007-2008 a competition cultivar trial was conducted with eight brown cotton lines. In 2008-2009 six new lines were included in

second trial. The trials were set up by the standard method, in four replications, with a harvest plot of 20 m², and a sowing space of 60×10×1. The early and high yielding variety Chirpan-539 of white cotton was used as a standard. Ten plants from each replication were analyzed. The fiber length was determined by the “butterfly” method. The data for the September yield, seed cotton yield, boll weight, fiber length and lint percentage were statistically treated by applying ANOVA.

Complete fiber technological analysis of variety Izabell was made by the automated systems HVI (High Volume Instrument) in 2007 and 2008 in B-TEX, Burgas, HVI and AFIS (Automated Fiber Information System) in 2008 in Textile Research Institute in Lodz, Poland. From the AFIS the indices of importance for the varieties were presented: L(w), mm – mean length by weight; L(w)CV; L(n) – mean length by number; L(n)CV; 5.0 % SL staple length; 2.5 % SL staple length; UQL(w) – mean value of upper quartile; FDI – fiber distribution index; Fine – fineness; Mat – maturity; SFC(w), % - short fiber content by weight; SFC(n) - short fiber content by number; IFC – index of fiber content; Nep size; Nep Cnt – nep content; Nep Cnt/g.

In terms of meteorological conditions, the investigated years were characterized the following way: 2007 - very hot and moderately wet; 2008 - hot and moderately dry; 2009 – hot and dry.

Results and discussion

Average results from the competitive cultivar testing of brown cotton lines in 2007-2008 are given in Table 1. In terms of total yield, line No 126 was significantly inferior (by 12.0 %) to the standard. It was also inferior in September yield. Other lines did not differ significantly in seed cotton yield between them and from the standard variety. They were inferior by 3.4 - 6.7 % to the standard. In terms of September yield (criterion of earliness), line No 125 was equal to the standard, the rest stood behind it by 3.8-7.8 %, but the

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Table 1. Results obtained from the competitive variety trials in 2007-2008 (average data)

Line No	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 %
Chirpan-539	1854	100.0	1609	100.0	5.0	25.6	38.0
115	1736	93.6	1488	92.5	4.7 ⁰⁰	22.0 ⁰⁰⁰	35.4 ⁰⁰⁰
116	1791	96.6	1533	95.3	4.4 ⁰⁰⁰	23.4 ⁰⁰⁰	34.2 ⁰⁰⁰
121	1739	93.8	1484	92.2	4.8 ⁰	23.1 ⁰⁰⁰	34.4 ⁰⁰⁰
122	1740	93.8	1506	93.6	4.8 ⁰	22.9 ⁰⁰⁰	35.6 ⁰⁰⁰
123	1791	96.6	1548	96.2	4.8 ⁰	22.0 ⁰⁰⁰	35.4 ⁰⁰⁰
124	1730	93.3	1514	94.1	4.6 ⁰⁰⁰	22.0 ⁰⁰⁰	35.8 ⁰⁰⁰
125	1824	93.4	1599	99.4	4.6 ⁰⁰⁰	21.9 ⁰⁰⁰	35.5 ⁰⁰⁰
126	1635	88.0 ⁰⁰	1443	89.7 ⁰	4.8 ⁰	22.5 ⁰⁰⁰	36.1 ⁰⁰⁰
GD 5 %	143	7.7	134	8.3	0.2	0.8	0.8
GD 1%	191	10.3	179	11.1	0.3	1.0	1.0
GD 0.1 %	249	13.4	233	14.5	0.4	1.3	1.3

differences being statistically insignificant. As for the boll weight, all lines had lower values than the standard. The fiber length (21.9-23.4 mm) was by 2.2-3.7 mm shorter than that of standard. In terms of fiber lint percentage all lines were inferior to the standard by 1.9-3.8 %.

Lower fiber indices of coloured cotton have been reported by other authors (Leonhard et al., 1999; Wang XueDe and Li YueYou,

2002). Geng et al. (1998) found that coloured fiber gene had negative effect on yield and fiber quality. According to Leonhard et al. (1999) fiber technological properties could be improved by effective selection. In this aspect obtained lines were of great importance for the Bulgarian cotton breeding in spite of their short fiber. From these lines two candidate-cultivars – No 115 and No 121 were isolated (Figure 1 and 2).



Figure 1. Lines No. 115 and 121 (121 - the new brown cotton variety Izabell)



Figure 2. Line 115 in comparison with the standard variety Chirpan-539

Table 2. Economical traits of brown cotton lines tested in 2008-2009 (average data)

Line No	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 %
Chirpan-539	1972	100.0	1808	100.0	5.1	24.9	39.5
193	1964	99.6	1723	95.3	4.9	24.3 ⁰	35.4 ⁰⁰⁰
194	1831	92.8 ⁰	1598	88.4 ⁰⁰⁰	4.8 ⁰	24.5	36.5 ⁰⁰⁰
196	1890	95.8	1724	95.3	4.8 ⁰	25.8 ⁺⁺⁺	36.3 ⁰⁰⁰
197	2033	103.1	1861	102.9	5.0	24.5	36.9 ⁰⁰⁰
198	2205	111.8 ⁺⁺⁺	1991	110.1 ⁺⁺	4.9	24.6	34.0 ⁰⁰⁰
199	1756	89.0 ⁰⁰⁰	1543	85.3 ⁰⁰⁰	4.9	24.9	36.5 ⁰⁰⁰
GD 5.0 %	122	6.2	12.1	6.7	0.3	0.5	0.8
GD 1.0 %	163	8.3	16.2	9.0	0.4	0.7	1.0
GD 0.1 %	215	10.9	21.3	11.8	0.5	0.9	1.3

Table 3. Economical traits of brown cotton lines tested in 2009

Line No	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 %
Chirpan-539	1978	100.0	1612	100.0	5.0	24.4	41.7
201	1917	96.9	1575	97.7	5.0	23.0 ⁰⁰	38.6 ⁰⁰⁰
221	1885	95.3	1290	80.0 ⁰⁰⁰	5.1	22.6 ⁰⁰⁰	37.3 ⁰⁰⁰
222	1800	91.0	1276	79.2 ⁰⁰⁰	5.0	24.0	39.4 ⁰⁰⁰
GD 5.0 %	187	9.5	132	8.2	0.3	0.7	0.8
GD 1.0 %	255	12.9	180	11.1	0.4	0.9	1.1
GD 0.1 %	343	17.4	242	15.0	0.6	1.2	1.4

Table 4. Economical traits of lines with naked seeds – 2007-2009 (average for three years)

Line No	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 %
Chirpan-539	1879	100.0	1601	100.0	5.0	25.2	39.3
105	1586	84.4 ⁰⁰⁰	1360	84.9 ⁰⁰⁰	4.7 ⁰⁰	25.4	35.8 ⁰⁰⁰
106	1735	92.3 ⁰⁰	1522	95.1	4.8 ⁰	24.8	34.9 ⁰⁰⁰
GD 5.0 %	103	5.5	113	7.1	0.2	0.5	0.7
GD 1.0 %	138	7.3	151	9.4	0.3	0.7	0.9
GD 0.1 %	18.1	9.6	198	12.4	0.4	0.9	1.2

The results obtained from the competition variety test of other six lines in 2008-2009 are presented in Table 2. Line No 198 significantly exceeded the standard in seed cotton yield and September yield by 11.8 % and 10.1 %, respectively. Lines No 194 and 199 were inferior to the standard in seed cotton yield by 7.2-11.0 % and in September yield by 11.6-14.7 %, the rest ones were equal to it. All lines had smaller boll weight than the standard, significant for two lines only. Longer fiber than that of standard was found for the line No 196, shorter – for No 193. The fiber length of all these lines was improved compared to the lines tested in 2007-2008. Although, in rainfall security 2008 and 2009 were extremely unfavorable for the fiber length, it was above 24 mm, approximately equal to that of brown cotton in other countries – Greece, Turkey, Brazil and the USA, where cotton is grown under irrigation. As for the fiber lint percentage (34.0-36.9 %) lines were inferior to the standard by 2.6-5.5 %. In a complex evaluation, lines No 197 and 198 for their higher yields by 3.1 %-11.8 % than the standard, and No 196 for its longer fiber, appeared to be the best.

Lines No 201, 221 and 222 tested in 2009 were also of interest for coloured cotton breeding (Table 3). These lines realized seed cotton yields of 91.0-96.9 % to the standard. Line No 201 was with

naked seeds and natural early fall of the leaf. No 221 and 222 - with dark brown lint. Line No 222 in fiber length (24.0 mm) was equal to the standard, while the other two lines were inferior to it.

Results from the competitive variety test of two brown cotton lines with naked seeds are presented in Table 4. Line No 106 realized a total yield of 92.3 % to the standard, in fiber length (24.8 mm) it was inferior by 0.4 mm. Line No 105 showed comparatively lower productivity (84.4 %), but in fiber length (25.4 mm) it was equal to the standard. In fiber lint percentage both lines stood behind the standard. These lines are of great importance for the breeding, because seeds for sowing are treated with sulfuric acid that pollute environment, in addition large quantity of water is used for washing which raises the cost of cotton production.

In 2009 the Executive Agency for Variety Test and Seed Approbation approved the first brown cotton variety Izabell (line No 121). In 2007-2009 from Chirpan-539 and Izabell average seed cotton yields of 1870 kg/ha and 1787 kg/ha (95.6 %), respectively were obtained (Table 5). In fibre length (23.0 mm) Izabell was inferior to Chirpan by 2.2 mm. The fibre lint percentage was 35.4 %, by 3.9 % lower.

Average data from the fiber technological analysis made by HVI

Table 5. Economical traits of variety Izabell tested in 2007-2009 (average for three years)

Line No	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 %
Chirpan-539	1870	100.0	1651	100.0	5.0	25.2	39.3
Izabell	1787	95.6	1458	88.3 ⁰⁰⁰	4.8 ⁰	23.0 ⁰⁰⁰	35.4 ⁰⁰⁰
GD 5.0 %	119	6.3	101	6.1	0.2	0.5	0.7
GD 1.0 %	161	8.5	136	8.2	0.3	0.7	0.9
GD 0.1 %	216	11.5	183	11.1	0.4	0.9	1.2

Table 6. Technological fiber properties of Izabell measured by HVI in B-TEX Burgas in 2007-2008 (average data)

Variety	Micronaire		Strenght		Lenght, mm		Uniformity %	Elongation %
	mic	dtex	cN	dtex	Modal, mm	dtex		
Chirpan-539	4.95	0.195	5.56	29.54	27.19	30.30	82.58	9.28
Avangard-264	4.90	0.191	5.62	30.12	28.05	31.00	83.36	9.04
Izabell	4.95	0.195	4.98	26.30	23.85	27.00	80.49	9.38

Table 7. Technological fiber properties, measured by HVI in Textile Research Institute – Lodz, Poland in 2008

HVI					
Variety	Micronaire Mic	Strenght cN/tex	Lenght mm	Uniformity %	Elongation %
Chirpan-539	3.9	29.3	26.5	83.6	5.3
Avangard-264	4.0	29.4	27.6	84.2	5.3
Izabell	4.4	25.4	22.2	82.0	5.9

Table 8. Technological fiber properties, measured by AFIS in Textile Research Institute – Lodz, Poland in 2008

AFIS														
Variety	Fine mtex	IFC %	L(w) mm	L(w) CV %	UQL (w) mm	SFC (w) %	L(n) mm	L(n) CV %	SFC (n) %	5 mm	2.5 mm	Mat	Nep Cnt Cnt/g	Nep Size µm
Chirpan-539	161	6.4	24.5	29.6	28.2	5.3	21.5	37.5	15.0	31.9	34.8	0.90	226	818
Avangard-264	162	5.9	25.2	29.7	29.6	5.2	22.0	38.3	15.0	33.6	36.2	0.91	113	724
Izabell	177	5.7	21.1	27.8	24.0	6.7	18.9	34.0	15.8	27.3	29.5	0.90	116	663

(High Volume Instrument) in B-TEX Burgas are given in Table 6. In micronaire value (4.95 mic) the variety Izabell was equal to Chirpan-539. Micronaire value, expressed in dtex, was the same for both varieties. In fibre fineness Izabell was inferior to the variety Avangard-264, standard for the fibre quality. In fiber strength this variety was inferior to Chirpan-539 and Avangard-264 by 0.58 cN and 0.64 cN, respectively. In dtex (26.30) it stood behind the standards, too. According to classification of cotton in strength, the variety Avangard-264 had very strong fiber ((30.12 dtex), the variety Izabell – strong (26-29). In modal (23.85 mm) and staple (27.00 mm) length Izabell was inferior to the standards. As for the uniformity of fiber length (80.49 %) the variety Izabell was slightly inferior to the standards. New variety and both standards had the same very good elongation (9-10).

The analysis of results shows that the variety Izabell had shorter

fiber than the standards. As for the other technological properties it was slightly inferior or equal to the standards. Data from the technological analysis made by HVI in Textile Research Institute in Lodz, Poland in 2008 confirmed our results concerning the fiber quality of variety Izabell (Table 7).

Data for the technological fiber properties, measured by AFIS (Table 8) showed lower indices of fiber fineness, length and uniformity of the variety Izabell than those of the standards. Fiber maturity was the same for the new cotton variety and standards. The variety Izabell had higher content of short fibers, measured by the index SFC (w) %, but by the index SFC (n) % it was equal to the standards. The variety Izabell had lower content and smaller size of nep than both standards.

Within the state cultivar testing of the variety Izabell in 2006, 2007 and 2008, a total yield of 98.5 % to the cultivar Chirpan-539

Table 9. Results obtained from the competitive variety test of promising brown cotton lines in 2009-2010 (average data)

Line No	Seed cotton yield kg/ha	In % to Chirpan-539	First picking kg/ha	In % to Chirpan-539	Boll weight g	Fiber length mm	Lint percentage %
			1369				
Izabell	2580	100.0	1706	100.0	5.0	23.1	35.5
196	2592	100.4	1544	124.6	4.9	25.7	35.1
197	2799	108.5	1208	112.8	5.0	25.3	35.7
198	2471	95.8	504	88.2	4.9	24.2	33.0
GD 5.0 %	388	15.0	724	36.8	-	-	-
GD 1.0 %	557	21.6	1065	52.9	-	-	-
GD 0.1 %	820	31.8		77.8	-	-	-

(standard for earliness and productivity) was realized as an average for the three years and for all stations included. Detailed description of morphological, biological, economical and fiber technological properties of variety Izabell have been reported by Stoilova et al. (2010) in previous publication.

Studies on the lines No. 196, 197 and 198 in 2009-2010 (Table 9) showed that in seed cotton yield No 197 exceeded by 8.5 % the variety Izabell, No 196 was equal to it, while No 198 was inferior by 4.2 % (differences being not significant). In fiber length they surpassed the variety Izabell by 1.1-2.6 mm. In fiber lint percentage lines No 196 and 197 were equal to Izabell, No 198 stood behind it.

Matusiak (2009) analyzed fiber quality of coloured cotton of different origin (including Bulgarian lines 115 and 121), obtained yarns and tissues, and found that in spite of lower fiber indices it could be processed in tissues. Bulgarian lines 115 and 121 (Izabell) were with the same fiber quality as brown cotton from USA, Greek, Turkish, Pakistan, Brazil and other countries.

Conclusion

Some brown cotton lines in earliness and productivity were equal to the early and high yielding standard cultivar Chirpan-539. These lines are of great importance for developing of new cotton varieties with high ecological and economic effects in spite of their shorter fiber and lower lint percentage than those of the standard cultivars. Six other brown cotton lines, created later, had fiber length equal to that of the standard cultivar which reveals a possibility for enhancing the fiber quality through breeding. Lines No 196 and 197 have commercial potential. Very valuable for cotton breeding were lines No 105 and 106 with naked seeds, No 201 with naked seeds and natural early fall of the leaf, No 221 and 222 with dark brown lint. These lines enrich the gene pool of Bulgarian cotton and are of interest for ecological cotton breeding programs. The new cotton variety Izabell is a new achievement in the breeding of a new generation varieties with an exclusive characteristic – naturally coloured brown lint. In fiber length and some fiber length characteristics it was inferior to the standard cultivars – Chirpan-539 and Avangard-264. By the other technological fiber properties it was equal to the standards. In seed cotton yield and earliness the variety Izabell was equal to the cv. Chirpan-539 (the standard for earliness and productivity).

Acknowledgements

The authors express their gratitude to Dr. Malgorzata Matusiak

– Head of “Textile Technology” Research Department in Textile Research Institute in Lodz, Poland for the fiber technological analysis of new variety Izabell (line 121), line 115 and both standard cultivars Chirpan-539 and Avangard -264 with automated systems HVI and AFIS.

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Todorov N and Mitev J, 1995. Effect of level of feeding during dry period, and body condition score on reproductive performance in dairy cows, IXth International Conference on Production Diseases in Farm Animals, Sept.11 – 14, Berlin, Germany, p. 302 (Abstr.).

Thesis:

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AGRICULTURAL SCIENCE AND TECHNOLOGY

Volume 3, Number 2
June 2011



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