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СОДРЖИНА
CONTENT

ПРЕДГОВОР

Универзитетот „Гоце Делчев" – Штип, со донесување на Законот за основање на државен Универзитет „Гоце Делчев" – Штип, започна со работа на 27 март 2007 година како високообразовна институција со четири факултетски единици и со дисперзија на наставата во Штип, Струмица и Кочани. Денес, за само четири години од своето постоење, оваа институција прерасна во еден од водечките високообразовни центри во Република Македонија, втор по големина, со 13 факултети и 1 висока школа и со дисперзија на наставата во 12 општини: Штип, Струмица, Кавадарци, Гевгелија, Кочани, Свети Николе, Виница, Берово, Радовиш, Прилеп и Скопје. На прагот од четвртата академска година, во нашите современо опремени амфитеатри, предавални, лаборатории и кабинети, својата иднина ќе ја градат околу 12.800 студенти (со новата студиска 2010/2011 година), кои заедно со околу 550 вработени ќе ги доградуваат темелите на овој млад, но модерен и перспективен универзитет.

Земјоделскиот факултет, како интегриран дел од Универзитетот „Гоце Делчев" - Штип, ги следи модерните и современи трендови на високото образование, а според потребите на пазарот на трудот во државата, наставата ја организира во 4 општини и тоа: Штип, Струмица, Кавадарци и Свети Николе - Општа насока, тригодишни студии, и четиригодишни студии организирани по модули во градовите: Штип - модул Агроменаџмент; Струмица - модул Интегрално земјоделско производство; Кавадарци - модул Енологија и Свети Николе - модул Преработка на земјоделски производи.

Покрај наставно-образовна дејност, голем дел од своите активности Земјоделскиот факултет ги посветува на науката и истражувањето. Како плод од стручно-апликативната и научноистражувачката дејност на Земјоделскиот факултет произлегува и оваа издание на Годишниот зборник, што во континуитет годинава се објавува по деветти пат.

Македонското земјоделско производство има долгогодишно искуство и богата традиција за што нашите земјоделски производи се познати по квалитет во регионов и пошироко. Инволвирањето на науката во аграрот е еден од нашите водечки приоритети, со што го унапредуваме производството на здрава храна по квалитет и по квантитет, придонесуваме за развојот на индустријата за преработка на земјоделските производи, влијаеме во управувањето на македонските природни ресурси, а со тоа непосредно и во развојот на руралната и урбаната средина.

Оваа издание на Годишниот зборник на Земјоделскиот факултет при Универзитетот „Гоце Делчев" – Штип е уште една потврда за нашата севкупна активност и стремеж за негување, подобрување и осовременување на македонското земјоделско производство.

Издавачки одбор
Штип, септември 2010 год.

Одговорен уредник
Проф. д-р Саша Митрев

INTRODUCTION

The "Goce Delcev" University – Stip, resumed operation following the enactment of the Law that founded it. The university opened on March 27 th , 2007, and established itself as an institution of higher learning made up of four colleges and three affi liates located in Stip, Strumica and Kochani.

Today, a mere tree years after its establishment, this university has developed into one of the leading centers of higher education in the Republic of Macedonia. It is now the second largest in the country, and consists of 14 colleges and affiliates in different municipalities, including Stip, Strumica, Kavadarci, Gevgelija, Kochani, Sveti Nikole, Vinica, Berovo, Radovish, Prilep and Skopje.

The university has entered its fourth academic year and already acquired state-of-the-art equipment for its amphitheaters, lecture rooms, laboratories and offi ces. In that short time 12.800 students (including study year 2010/2011) and 550 employees came together to build their future and upgrade the foundation of this young, modern, but remarkably prosperous university.

As an integral part of the "Goce Delcev" University – Stip, the College of Agriculture pursued contemporary trends in higher education that complement the requirements of the national labor market. The college has organized its teaching and scientifi c work in four different municipalities: Stip, Strumica, Kavadarci and Sveti Nikole. The College of Agriculture, within its department of general studies that offers a three and a four year degree, is organized according to various modules: agricultural management in Stip, integrated agricultural production in Strumica, enology in Kavadarci and production and manufacturing of agricultural produce in Sveti Nikole.

The College of Agriculture dedicates a large portion of its activities to science and research, in addition to its educational/teaching function. This annual edition, the nine in a series, is the result of applied expertise and scientifi c research performed at the "Goce Delcev" University College of Agriculture.

Macedonian agricultural production has long experience and a rich tradition that has led to its excellent reputation in the broader region. Introducing science into the agrarian sector has been a priority in advancing the qualitative and quantitative production of healthy foods. This process contributes to the development of food manufacturing, and to the university's scientifi c impact on the proper management of Macedonia's natural resources.

This has had a positive effect on the development of rural and urban environment. This issue further confi rms that our overall activity facilitates the goal of fostering, improving and modernizing Macedonian agricultural production.

Editorial board **Editor in chief**
Stip, September 2009 **Prof. Sasa Mitrev, Ph.D**

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Оригинален научен труд
Original research paper

APPLICATION OF CLUSTER ANALYSIS FOR EVALUATION OF NEW BULGARIAN AND MACEDONIAN COTTON VARIETIES AND LINES

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Abstract

The aim of this study was to assess the genetic distance between eleven Bulgarian and four Macedonian cotton varieties by applying the method of cluster analysis. The trial was carried out in 2008 and 2009. The cluster analysis based on the varieties of agronomic and fiber technological properties confirmed the genetic differences between them. The varieties grouped into two basic groups depending on the breeding directions and breeding methods.

Some varieties were genetically very similar and they could be included in one breeding program for rapid breeding effect. The Macedonian varieties and lines were genetically distant from some Bulgarian varieties and their including in one breeding program can has a good effect. The year conditions had influence on genetic similarity and genetic remoteness as a result of predetermination of genetic formulas controlling the traits. In Strumica the varieties differentiated stronger in yield and lint percentage and weaker in fiber length.

Key words: *G. hirsutum L., breeding, productivity, fiber length, lint percentage*

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ПРИМЕНА НА ЗБИРНИ АНАЛИЗИ ЗА ЕВАЛУАЦИЈА НА НОВИ БУГАРСКИ И МАКЕДОНСКИ СОРТИ И ЛИНИИ ПАМУК

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Краток извадок

Целта на оваа испитување беше да се одреди генетската разлика меѓу единаесет бугарски и четири македонски сорти памук, преку методот на збирна анализа. Испитувањата беа изведени во текот на 2008 и 2009 година. Збирната анализа, базирана на различните земјоделски и технолошки својства на влакното, ја потврди разликата меѓу сортите памук. Сортите памук беа групирани во две основни групи во зависност од начинот и методите на одгледување.

Некои сорти беа генетски многу слични и можат да бидат вклучени во една програма за одгледување за побрз ефект во размножувањето. Македонските сорти и линии беа генетски многу поразлични од некои бугарски сорти и нивното вклучување во една програма за размножување на памукот ќе биде корисна. Надворешните услови во годината на испитувањето имаа влијание на генетската сличност и оддалеченост како резултат на генетски предодредените формули кои ги контролираат опитите. Во Струмица сортите повеќе се разликуваа во приносот и процентот на влакно, а беа послаби и во однос на должината на влакното.

Клучни зборови: *G. hirsutum*, *размножување, продуктивност, должина на влакно, процент на влакно*.

1. Introduction

Cluster analysis is applied widely for assessment of genetic distance, respectively genetic remoteness of definite set of genotypes. In the recombinatory breeding the most remoteness genotypes are included in crosses for strengthening of the heterosis manifestation, segregation processes and variability in the next generations. Cluster analysis gives a very visual picture for grouping of varieties by single trait or complex of traits, which could be facilitated to a great degree their effective usage in the cotton breeding programs.

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In cotton this analysis is used very limited (Brown, 1991; Kalsy et al., 1995; Tatineni et al., 1996; Patil et al., 1999; Valkova, and Dechev, 2003; Stoilova and Dechev, 2003; Dimitrova et al., 2004 a, b, c, Stoilova et al., 2005).

The aim of this study was by applying of cluster analysis to assess the genetic remoteness of modern Bulgarian and Macedonian cotton cultivars and lines through the phenotype of the most important agronomic traits.

2. Materials and methods

In the experiment were included new Bulgarian and Macedonian cotton varieties and lines: Chirpan-539 (standard for productivity), Beli Iskar, Veno, Trakia, Helius, Avangard-264 (standard for fiber quality), Perla, Vega, Colorit, Natalia and Darmi (Bulgarian); Strumica-105, 5136, 5138, 5140 and 5141 (Macedonian). In the experimental field of Agrarian faculty in Strumica to Goce Delchev University in Stip a trial set up by the block design method in two replications and harvest plot of 10 m^2 and 15 m^2 in 2007 and 2008, respectively was carried out. The trial was set on alluvial type soil, which distinguishes with low content of humus, nitrogen and phosphorus and good security of active potassium. Wheat was predecessor in the two years of study.

The seed cotton yield, boll weight, length and lint percentage of fiber were evaluated.

Hierarchical cluster analysis was applied for the genotypes grouping (Ward, 1963). As a measure for divergence the Euclidean distance between them was used. The data were standardized preliminary.

The Strumica valley is situated on 200-300 *m* altitude and it is under the influence of the Sub-Mediterranean and Eastern-continental climate. Rainfall distinguished with Mediterranean regime with maximum in November and minimum in summer months (July or August).

The years of the investigation were characterized the following way: 2008 was very dry by 70 *mm* less rainfall in May and September and by 87.8 *mm* less in simmer months; in 2009 during the vegetation period rainfall were by 11.5 % more than the norm and promoted for developing of high yields.

The temperature sum in both years was in limits of average value or little above for a long term period.

3. Results and discussions

In 2008 the varieties Helius and Natalia showed the highest yield - 5714 *kg/ha* (equal for both varieties) and exceeded the standard Chirpan-539 by 24.6 % (Table 1).

High yield was obtained from Vega - 5429 *kg/ha*, 18.4 % over Chirpan-539. The Macedonian variety Strumica-105 was equal to the standard

variety the others were strongly inferior to it. The biggest bolls were found for the Macedonian varieties 5140 (8.4 *g*), Strumica-105 (7.8 *g*), 5138 (7.1 *g*) and Bulgarian varieties Trakia (7.7 *g*), and Perla (7.6 *g*). The longest fiber was found for the Bulgarian varieties Natalia (29.2 *mm*) and Colorit (28.3 *mm*) whilst the shortest fiber was found for Trakia (25.0 *mm*), 5138 (25.5 *mm*) and Perla (25.7 *mm*). As for the fiber lint percentage the varieties Chirpan-539, Veno and Strumica-105 had the highest values – 41.0-41.3 %.

The varieties and standards were clustered by four traits on the base of data in table 2. The dendrogram presented on Fig. 1 showed that the genotypes divided into two basic clusters. The first cluster included Bulgarian varieties which subdivided into two smaller clusters indicating some genetic differences. The second cluster included all Macedonian varieties and three Bulgarian ones – Trakia, Perla and Vega. The Macedonian varieties formed separate subgroup that means they were genetically similar with the exception of line 5138. Of the Bulgarian varieties genetically very similar were Colorit and Natalia, Darmi and Veno, and of the Macedonian ones – Strumica-105 and 5140. Genetic similarity was observed for some Bulgarian and Macedonian varieties as Perla and line 5138, Vega and line 5136.

Clustering by three traits – seed cotton yield, fiber length and lint percentage, showed that the Macedonian line 5138 was in one cluster together with the Bulgarian varieties whilst the Bulgarian variety Vega was in one cluster together with the Macedonian varieties (Fig. 2). The Macedonian varieties together with Avangard-264, Vega, Trakia and Perla (Bulgarian) formed one basic cluster when they were clustered by fiber length and lint percentage (Fig. 3).

On the base of results from the cluster analyses we can conclude that the line 5138 was genetically more distant from the other Macedonian varieties. This line was at a short distance to the Bulgarian varieties. Of the last the variety Vega was the most distant and genetically nearest to the Macedonian varieties.

In 2009 the variety Helius showed the highest yield of 5520 *kg/ha* and exceeded the standard Chirpan-539 by 31.1% (Table 2).

Very high yields of 5010-5090 *kg/ha* or by 18.8-20.9 % over the standard were obtained from Macedonian line 5136 and Bulgarian varieties Natalia, Vega and Trakia. The varieties Perla, Darmi, Colorit and line 5140 surpassed Chirpan-539 by 10.5 to 17.1 %, whilst Avangard-264 was equal to it. The varieties Trakia, Vega and line 5136 had the biggest bolls – 7.0 *g* at 6.1-6.7 *g* for the others. The varieties Veno and Vega showed by 0.5 *mm* longer fiber than that of the standard, whilst for the variety Trakia it was shorter. This year was unfavorable for the fiber length formation and the varieties differentiated weakly by this trait. As for the fiber lint percentage the varieties Chirpan-539,

Veno and Helius showed the highest indices - 40-40.2 %. The varieties Perla, Natalia and Colorit had the lowest lint percentage - 37.0-37.5 %.

Clustering of the varieties based on data in table 2 (by four traits) is presented on Fig. 4. The varieties were divided into two basic clusters. The first cluster included Chirpan-539, Avangard-264, 5140 (Macedonian), Helius, Darmi and Veno. The standard variety Chirpan-539 and Avangard-264 showed high similarity. The variety Veno formed separate group because of its low yield. The other cluster included Trakia, 5136 (Macedonian), Perla, Natalia, Colorit and Vega. The last four varieties formed one subgroup. The varieties Perla and Natalia were very similar. In Strumica in this year the varieties differentiated better in yield and lint percentage and weaker in fiber length. As a result some varieties changed their basic cluster. The Macedonian varieties 5136 and 5140 which were in one basic cluster in 2008 referred to different clusters in 2009.

The highest yield of 5619 *kg/ha* average for two years was found for the variety Helius which exceeded the standard Chirpan-539 by 22.7 % and the Macedonian lines 5140 and 5136 by 27.0 % and 24.6 %**,** respectively (Table 3). High yields of 5390 *kg/ha* and 5222 *kg/ha* by 22.5 % and 18.6 % over Chirpan-539 were obtained from Natalia and Vega. The variety Natalia surpassed the Macedonian lines by 19.5-21.8 %, Vega - by 15.8-18.0 %. The biggest bolls were found for Trakia, Perla and 5140 – 7.1-7.4 *g*, the smallest – for Darmi – 5.7 *g*, the other varieties had boll weight of 6.0-6.9 *g*. The longest fiber of 28.3 *mm*, by 1.6 *mm* over Chirpan-539 and by 1.2-1.4 *mm* over the Macedonian lines, was found for the variety Natalia. The varieties Colorit and Vega had by 0.8 *mm* longer fiber than that of Chirpan and by 0.4-0.6 *mm* longer than that of the Macedonian lines. The shortest fiber was found for the variety Trakia. The varieties Chirpan-539, Veno and Helius had the highest lint percentage of 40.2-40.5 %. Macedonian lines had lower lint percentage about 39.5-39.7 %. The lowest lint percentage of 37.7 % was found for Perla.

Clustering of varieties based on the data in table 3 (by 4 traits) is presented on Fig. 5. The varieties divided into two basic clusters. The first cluster included Chirpan-539, Helius, Darmi and Veno. The varieties Chirpan-539 and Helius showed high similarity. They differed in yield but had the same boll weight, fiber length and lint percentage. Large genetic diversity is observed in the second cluster.

The varieties Natalia and Vega were very similar and separated into single group. The variety Trakia and Perla formed other single group. The variety Perla is characterized by longer fiber than realized in Strumica. The Macedonian varieties were in one subclusters together with Avangard-264 and Colorit.

The Bulgarian cotton varieties have been created from two differently purposeful breeding programs. The varieties Chirpan-539, Beli Iskar and Veno have been obtained trough intraspecific hybridization, Trakia and Helius by applying of experimental mutagenesis. These varieties possess earliness, high genetic potential for yield and high lint percentage. The varieties Avangard-264, Perla, Vega, Colorit, Darmi and Natalia possess germplasm from the *G. barbadense L.* species and distinguish by longer fiber, which realized in suitable conditions. The cluster analyses showed that the Macedonian lines were closer to the varieties from the second group. Lines 5136 and 5140 were at a short distance with Avangard-264 and Colorit. Because of that it is better the Macedonian lines to be included in crosses with the varieties of the first group.

The varieties Helius, Natalia and Vega proved to be the best for the Strumica region. The variety Helius was genetically distant from the other two. These three varieties are high achievement in the Bulgarian cotton breedeng – Helius in breeding for productivity, Natalia and Vega – in breeding for fiber quality.

Clustering based on average data included the phenotype stability of traits and gave more reliable information for genetic remoteness of genotypes.

4. Conclusions

By the Bulgarian cotton breeding large variety diversity has been created which is a good precondition for the cotton breeding development in our country.

The cluster analysis confirmed the genetic differences between the varieties and showed visually their genetic remoteness. The varieties grouped into two basic groups depending on the breeding directions, breeding methods and preliminary selection by the traits.

Some varieties were genetically very similar by the studied traits and they could be included in one breeding program for rapid breeding effect.

The Macedonian varieties and lines were genetically distant from some Bulgarian varieties and their including in one breeding program can has a good effect.

The year conditions had influence on genetic similarity and genetic remoteness as a result of predetermination of genetic formulas controlling the traits.

In Strumica the varieties differentiated stronger in yield and lint percentage and weaker in fiber length.

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Table 1. Agronomic properties of varieties tested in Strumica in 2008
Табела 1. Земјоделски карактеристики на сортите тестирани во Струмица во 2008 г.

Variety Line № Сорта линија бр.	Seed cotton yield Принос на суров памук *(kg/ha)*	In % to Chirpan-539 Во % за чирпан 539	Boll weight Тежина на чушка *(g)*	Fiber length Должина на влакно *(mm)*	Lint percentage Процент на линтер *(%)*
Chirpan-539	4586	100.0	6.0	26.5	41.0
Veno	5143	112.1^{+}	5.7	26.5	41.6
Trakia	4000	87.2^{0}	7.7^{+++}	25.0^{00}	40.0
Helius	5714	124.6^{+++}	5.8	26.4	40.2
Avangard-264	2871	62.6^{000}	6.7^{+}	27.3^{+}	38.5^{0}
Perla	3857	84.4^{00}	7.6^{+++}	25.7^{0}	38.3^{00}
Natalia	5714	124.6^{+++}	7.0^{++}	29.2^{+++}	39.5
Darmi	4000	87.2^{0}	5.4^{0}	27.0	38.6^{0}
Colorit	3943	86.0^{0}	6.9^{++}	28.3^{+++}	40.3
Vega	5429	118.4^{++}	6.4	27.5^{+}	39.0^{0}
Strumica-105	4613	100.6	7.8^{+++}	27.9^{++}	41.3
5140	4000	87.2^{0}	8.4^{+++}	27.0	40.7
5141	3643	79.4^{00}	5.5^{0}	26.5	39.0^{0}
5136	3928	85.6^{0}	6.3	27.5^{+}	40.4
5138	3500	76.3^{000}	7.1^{++}	25.5^{0}	40.7
GD 5 %	495.2	10.8	0.5	0.8	1.9
GD 1%	698.7	15.2	0.8	1.1	2.6
GD 0.1 %	998.2	21.8	1.1	1.6	3.7

Table 2. Agronomic properties of varieties tested in Strumica in 2009
Табела 2. Земјоделски карактеристики на сортите тестирани во Струмица во 2009 г.

Variety Line № Сорта линија бр.	Seed cotton yield Принос на суров памук *(kg/ha)*	In % to Chirpan-539 Во % за чирпан 539	Boll weight Тежина на чушка *(g)*	Fiber length Должина на влакно *(mm)*	Lint percentage Процент на линтер *(%)*
Chirpan-539	4210	100.0	6.5	27.0	40.0
Veno	1150	27.3^{000}	6.2	27.5	40.0
Trakia	5000	118.8^{+++}	7.0	26.5	39.4
Helius	5520	131.1^{+++}	6.7	26.9	40.2
Avangard-264	4200	99.8	6.4	26.8	39.4
Perla	4930	117.1^{+++}	6.6	27.0	37.0^{00}
Natalia	5060	120.2^{+++}	6.7	27.3	37.2^{00}
Darmi	4650	110.5^{+++}	6.1	27.3	39.7
Colorit	4800	114.0^{+++}	6.6	26.7	37.5^{00}
Vega	5010	119.0^{+++}	7.0	27.5	38.5
5140	4850	115.2^{+++}	6.2	26.7	38.8
5136	5090	120.9^{+++}	7.0	26.6	38.2
GD 5 %	117	2.8	0.6	1.1	1.6
GD 1%	165	3.9	0.8	1.5	2.2
GD 0.1 %	236	5.6	1.2	2.2	3.2

Table 3. Agronomic properties of varieties tested in Agrarian faculty, Strumica in 2008-2009 (average for two years)

Табела 3. Земјоделски карактеристики на сортите тестирани на Земјоделски факултет во Струмица 2008-2009 г. (просек за две години)

Variety Line № Сорта линија бр.	Seed cotton yield Принос на семе памук *(kg/ha)*	In % to Chirpan-539 Во % за чирпан 539	Boll weight Тежина на чушка *(g)*	Fiber length Должина на влакно *(mm)*	Lint percentage Процент на линтер *(%)*
Chirpan-539	4401	100.0	6.3	26.7	40.5
Veno	3146	71.5^{000}	6.0	27.0	40.8
Trakia	4500	102.2	7.4^{+++}	25.7^{00}	39.7
Helius	5619	127.7^{+++}	6.3	26.7	40.2
Avangard-264	3536	80.3^{000}	6.6	27.1	39.0^{0}
Perla	4396	99.9	7.1^{+++}	26.4	37.7^{000}
Natalia	5390	122.5^{+++}	6.9^{++}	28.3^{+++}	38.3^{000}
Darmi	4327	98.3	5.7^{00}	27.2	39.1^{0}
Colorit	4374	99.4	6.8^{+}	27.5^{++}	38.9^{00}
Vega	5222	118.6^{+++}	6.7^{+}	27.5^{++}	38.7^{00}
5140	4425	100.5	7.3^{+++}	26.9	39.7
5136	4510	102.5	6.7^{+}	27.1	39.5
GD 5 %	281	6.4	0.4	0.6	1.2
GD 1%	381	8.6	0.6	0.8	1.6
GD 0.1 %	511	11.6	0.8	1.1	2.1