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INHERITANCE, HETEROSIS AND COMBINING ABILITY IN F_1 INTRASPECIFIC *G. hirsutum* L. COTTON CROSSES

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Abstract

Line × tester analysis of 5 Bulgarian cotton varieties used for mothers and 3 foreign ones as fathers was applied to study the inheritance of the most important economic traits and the breeding value of parental forms (G. hirsutum L.) and F_1 hybrids. The trial was conducted in 2013-2014 by block method in three replicates. Different types of inheritance were observed by the productivity, boll weight and length and lint percentage of the fibre. Exhibition of heterosis was most pronounced by productivity reaching 39.1%. For all studied traits the genetic variance was mainly of non-additive type and the prognosis for selection in early segregate generations could not be good. The varieties of Bulgarian selection, Boyana and IPK Nelina had high GCA for productivity and fibre lint percentage. Their high GCA was combined with low SCA variances making them suitable for the synthetic selection. Of the foreign varieties, the Turkish Nazilli 954 had high GCA for the fibre lint percentage, the Greek Corina - for the fibre length. Because of the high SCA variances they appeared to be more suitable for the heterosis selection.

Key words*: G. hirsutum L., genetic control, productivity, fibre properties.*

INTRODUCTION

The method of intraspecific hybridization in the selection of cotton in Bulgaria is basic and continues to be so. Local varieties, which are early and with reduced heat-loving, are crossed mainly with foreign ones which are later mature, but have high fiber quality and high fiber lint percentage, and some of them are resistant to the most dangerous and economically important disease in cotton - Verticillian wilt (*Verticillium dahliae* Kleb.).

The main varieties for cotton production in Bulgaria, characterized by high earliness and high yield potential, were obtained by intraspecific hybridization within *G. hirsutum* L. species (Bojinov and Dimitrova, 1981a; 1981b; 1989; Bojinov et al., 1996). The newer and latest varieties - Beli Iskar, Beli Lom, IPTP Veno, Boyana and Denitsa, obtained by this method, are a step forward in the selection for increasing the productivity and lint percentage of cotton fiber (Bozhinov and Bojinov, 2004; Bozhinov and Bojinov, 2008; Valkova and Bojinov, 2010; Valkova, 2014).

The success of each breeding program depends to a large extent on the right selection of the parental forms for crossing and their combining ability.

The aim of this research was to study the inheritance and breeding value of parental forms by economically most important traits in F_1 intraspecific (*G. hirsutum* L.) crosses of Bulgarian and foreign varieties, with a view to their effective usage in breeding programs with cotton.

MATERIALS AND METHODS

15 F_1 intraspecific crosses (*G. hirsutum* L.) of 5 Bulgarian varieties - Chirpan-539, Helius, Rumi, Boyana and IPK Nelina, used for mothers, with 3 foreign ones - Nazilli 954 (Turkish), Mytra and Corina (Greek), used as fathers, were studed. The trial was carried out in the experimental field of the Field Crops Institute in town of Chirpan, in 2013-2014, on leached soil type, set by block method design, in three replicates. Each F_1 hybrid combination and the parental varieties were sown in 2 rows, 3 m long, randomized, with a 60 × 20 × 1 sowing scheme. 10 plants of each replicate were observed. There were studed the following traits: productivity/plant; boll weight; fiber length determined by the "butterfly" method and fiber lint percentage. Productivity per plant and boll weight data are given for one year (2014), for fiber length and fiber lint

percentage - for two years (2013-2014) and are presented by years.

Crossing (mothers × fathers) and combining ability analysis (general combining ability - GCA and specific combining ability - SCA) are given by the method of Savchenko (1984). The sum of the squares of the crosses was divided into variation due to mothers, variation due to fathers and variation due to mothers × fathers interaction. The main effects of mothers and fathers are equivalent to the GCA, and of the mothers × fathers interaction represents SCA.

The years of the study were characterized as follows: in terms of temperature security 2013 was warm, 2014 was average; in terms of rainfall 2013 was moderately dry and 2014 was moderately wet.

RESULTS AND DISCUSSION

The inheritance of productivity/plant determined by the "d/a" indicator in 6 of the 15 crosses studied was positively over-dominance, which caused heterosis up to 39.1% and productivity/plant reached 40.3-50.2 g (Table 1). Only one cross showed negative over-dominance. At other six crosses the inheritance was completely and incompletely dominant to the parent with the higher or lower productivity and additively at one cross. The genotype of the parent varieties (mothers and fathers) and their combining ability were important for the inheritance of productivity/plant.

The crosses with the Turkish variety Nazilli 954 inherited the boll weight with positive

Table 1. Inheritance and heterosis by productivity/plant and boll weight in the F_1 hybrids obtained from the crosses of 5 Bulgarian cotton varietis with 1 Turkish and 2 Greek varieties in 2014

Hybrid combination	P_1	P_2	F_1	d/a	HP %
Productivity/plany, g					
Chirpan-539×Nazilli 954	30.5	35.1	34.3	0.65	97.7
Chirpan-539 × Mytra	30.5	36.9	31.5	-0.69	85.4
Chirpan-539 × Corina	30.5	36.1	32.5	-0.29	90.0
Helius × Nazilli 954	29.9	35.1	35.6	1.19	101.4
Helius × Mytra	29.9	36.9	35.2	0.51	95.4
Helius × Corina	29.9	36.1	40.3	2.35	111.6
Rumi × Nazilli 954	31.5	35.1	22.9	-5.78	65.2
Rumi × Mytra	31.5	36.9	33.0	-0.44	89.4
Rumi × Corina	31.5	36.1	41.2	3.22	114.1
Boyana × Nazilli 954	33.0	35.1	34.0	-0.05	96.9
Boyana × Mytra	33.0	36.9	44.4	4.85	120.3
Boyana × Corina	33.0	36.1	39.7	3.32	110.0
IPK Nelina × Nazilli 954	30.2	35.1	31.4	-0.51	89.5
IPK Nelina × Mytra	30.2	36.9	45.1	3.45	122.2
IPK Nelina × Corina	30.2	36.1	50.2	5.78	139.1
GD 5.0%; 1.0%; 0.1%	*3.6; 4.8; 6.3*				
Boll weight, g					
Chirpan-539×Nazilli 954	5.3	5.7	5.9	2.00	103.5
Chirpan-539 × Mytra	5.3	5.8	5.7	0.60	98.3
Chirpan-539 × Corina	5.3	6.0	5.8	0.43	96.7
Helius × Nazilli 954	5.4	5.7	5.9	2.33	103.5
Helius × Mytra	5.4	5.8	5.7	0.50	98.3
Helius × Corina	5.4	6.0	5.6	0.33	93.3
Rumi × Nazilli 954	5.5	5.7	5.8	2.00	101.8
Rumi × Mytra	5.5	5.8	5.6	-0.33	96.6
Rumi × Corina	5.5	6.0	5.6	-0.60	93.3
Boyana × Nazilli 954	5.4	5.7	5.8	1.67	101.8
Boyana × Mytra	5.4	5.8	5.7	0.50	98.3
Boyana × Corina	5.4	6.0	5.9	0.67	98.3
IPK Nelina × Nazilli 954	5.2	5.7	5.9	1.80	103.5
IPK Nelina × Mytra	5.2	5.8	5.7	0.67	98.3
IPK Nelina × Corina	5.2	6.0	5.8	0.50	96.7
GD 5.0%; 1.0%; 0.1%	*0.6; 0.7; 0.9*				

over-dominance and slightly manifested heterosis effect of 1.8-3.5%. Eight crosses showed incomplete dominance of the parent with the higher value.

The crosses of Rumi variety with the Greek varieties Mytra and Corina showed incomplete dominance towards the parent with the lower value.

The inheritance of the fiber lint percentage at the crosses with the Turkish variety Nazilli 954 during the first year of the study was partially dominant towards the parent with the lower value to negative over-dominance (Table 2). An exception was the cross IPK Nelina × Nazilli 954 in which the inheritance of the trait was incompletely dominant to the parent with the higher value. At the crosses with the Greek varieties Mytra and Corina, the inheritance of this trait was positively over-dominance, except the crosses of Rumi, in which the inheritance was negatively over-dominance. In the second year of the study, positive over-dominance was found only at the Chirpan-539 × Corina cross, negative over-dominance was observed in four crosses, and in the others the inheritance was incompletely dominant to the parent with the lower or higher value.

Averaged data for two years showed that three crosses (with Corina variety) inherited the fiber lint percentage with positive over-dominance, while other three crosses showed negative over-dominance. The inheritance of this trait was complete and incomplete dominant to the parent with the higher value in 4 crosses, to the parent with the lower value - in 2 crosses and additively - in 3 crosses. The genotype of paternal forms had great influence on the inheritance of the trait also relevant was the genotype of the maternal components and their combining ability.

Table 2. Inheritance and heterosis by fiber lint percentage in F_1 hybrids obtained from the crosses of 5 Bulgarian cotton varieties with 1 Turkish and 2 Greek varieties in 2013-2014

Hybrid combination	2013					2014					Average	
	P_1	P_2	F_1	d/a	HP%	P_1	P_2	F_1	d/a	HP%	F_1	HP%
Chirpan-539×Nazilli954	40.1	42.2	39.8	-1.29	94.3	41.1	43.6	41.8	-0.46	95.7	41.3	96.3
Chirpan-539 × Mytra	40.1	39.3	41.1	3.50	102.5	41.1	43.7	42.7	0.28	97.9	41.5	100.0
Chirpan-539 × Corina	40.1	39.3	41.1	3.50	102.5	41.1	38.4	43.0	2.41	104.6	42.1	103.7
Helius × Nazilli 954	37.7	42.2	39.5	-0.20	93.6	39.9	43.6	37.6	-2.24	86.2	38.6	90.0
Helius × Mytra	40.1	39.3	41.1	3.50	102.5	39.9	43.7	40.9	-0.47	93.6	41.0	98.8
Helius × Corina	40.1	39.3	41.1	3.50	102.5	39.9	38.4	39.5	0.47	99.0	40.3	103.6
Rumi × Nazilli 954	37.7	42.2	39.5	-0.20	93.6	43.0	43.6	41.4	-6.33	95.0	40.5	94.4
Rumi × Mytra	38.3	39.3	37.2	-3.20	94.7	43.0	43.7	40.7	-7.57	93.1	39.0	94.0
Rumi × Corina	38.3	39.3	38.2	-1.20	97.2	43.0	38.4	40.1	-0.26	93.3	39.2	97.0
Boyana × Nazilli 954	39.6	42.2	40.8	-0.08	96.7	42.5	43.6	42.8	-0.45	99.1	42.0	97.9
Boyana × Mytra	39.6	39.3	39.3	-1.00	99.2	42.5	43.7	42.1	-1.73	94.1	40.2	96.9
Boyana × Corina	39.6	39.3	40.1	4.33	101.3	42.5	38.4	39.6	-0.41	93.2	39.9	97.1
IPK Nelina×Nazilli 954	38.6	42.2	41.2	0.44	97.6	41.9	43.6	43.5	0.88	99.8	42.4	98.8
IPK Nelina × Mytra	38.6	39.3	39.6	1.86	100.8	41.9	43.7	43.0	0.22	97.4	41.3	99.5
IPK Nelina × Corina	38.6	39.3	39.5	1.57	100.5	41.9	38.4	41.7	0.89	99.5	40.6	100.7
GD 5.0%; 1.0%; 0.1%	*0.9; 1.2; 1.6*					*1.1; 1.4; 1.9*						

There was also diversity in the type of inheritance of the fiber length (Table 3). At the crosses with the Turkish variety Nazilli 954 as father, the inheritance of this trait was from partial dominance of the longer fiber of this variety to positive over-dominance. An exception was the cross IPK Nelina × Nazilli 954, in which the inheritance of the fiber length was positively over-dominance in the first year and negatively over-dominance in the second year of the study. At the crosses with fathers the Greek varieties Mytra and Corina, inheritance was from partial dominance of the longer fibers of these varieties to positive over-dominance, but negative over-dominance was also observed. The genotypes of mothers and fathers were important for inheritance of this trait. Environmental conditions (years of testing) also affected its inheritance.

Table 3. Inheritance and heterosis by fiber length in F_1 hybrids obtained from the crosses of 5 Bulgarian cotton varieties with 1 Turkish and 2 Greek cotton varieties in 2013-2014

Hybrid combination	2013					2014					Average	
	P_1	P_2	F_1	d/a	*HP	P_1	P_2	F_1	d/a	*HP	F_1	*HP
Chirpan539×Nazilli954	27.0	27.4	27.5	1.50	100.4	26.1	27.0	26.6	0.11	98.5	27.1	99.6
Chirpan-539 × Mytra	27.0	27.5	27.3	0.20	99.3	26.1	27.8	27.1	0.18	97.5	27.2	98.2
Chirpan-539 × Corina	27.0	28.4	28.2	0.71	99.3	26.1	26.6	27.7	5.40	104.1	28.0	101.8
Helius × Nazilli 954	27.5	27.4	27.5	1.00	100.0	25.3	27.0	27.1	1.12	100.4	27.3	100.4
Helius × Mytra	27.5	27.5	28.1	-	102.2	25.3	27.8	26.3	-0.20	94.6	27.2	98.2
Helius × Corina	27.5	28.4	27.3	-1.44	96.1	25.3	26.6	26.0	0.08	97.7	26.7	97.1
Rumi × Nazilli 954	27.4	27.4	27.3	-	99.6	26.6	27.0	27.9	5.50	103.3	27.6	101.5
Rumi × Mytra	27.4	27.5	27.6	3.00	100.4	26.6	27.8	27.0	-0.33	97.1	27.3	98.6
Rumi × Corina	27.4	28.4	26.8	-2.20	94.4	26.6	26.6	26.8	-	100.8	26.7	97.1
Boyana × Nazilli 954	26.7	27.4	28.2	3.29	102.9	26.1	27.0	26.9	0.78	99.6	27.6	101.5
Boyana × Mytra	26.7	27.5	27.5	1.00	100.0	26.1	27.8	27.2	0.29	97.8	27.4	98.9
Boyana × Corina	26.7	28.4	28.5	1.12	100.4	26.1	26.6	27.0	2.60	101.5	27.8	101.1
IPK Nelina×Nazilli 954	27.5	27.4	28.2	15.00	102.5	27.1	27.0	25.8	-25.0	95.2	27.0	98.9
IPK Nelina × Mytra	27.5	27.5	28.3	-	102.9	27.1	27.8	26.2	-3.57	94.2	27.3	98.6
IPK Nelina × Corina	27.5	28.4	28.0	0.11	98.6	27.1	26.6	27.7	3.40	102.2	27.9	101.5
GD 5.0%; 1.0%; 0.1%	*1.1; 1.5; 1.9*					*0.8; 1.1; 1.4*						

There were significant GCA and SCA effects for productivity/plant (Table 4). The involvement of σ^2_{GCA} and σ^2_{SCA} in the genetic variance revealed that non-additive gene effects were more important for the inheritance of productivity/plant. The results obtained were similar to those reported by Senthilkumar et al. (2010), Karademir et al. (2016), Sajjad et al. (2016), Memon et al. (2017), Sivia et al. (2017), who also found predominance of non-additive gene effects for raw cotton yield using the line × tester method.

The GCA and SCA for the fiber lint percentage were signifivant in both years of the study and as for the fiber length the GCA effects only of mothers and SCA were significant only in 2014.

The sum of the squares of the SCA effects for the fiber lint percentage was 49.7% in 2013 and 44.7% in 2014 of the total variation indicating that additive and non-additive gene effects were equally important for the inheritance of this trait. The $\sigma^2_{GCA}/\sigma^2_{SCA}$ ratio revealed that non-additive gene effects were more important for the inheritance of the fiber lint percentage.

The sum of squares of the SCA effects for the fiber length was 71.1% in 2014, revealing that the main component of the genetic variance was of the non-additive type. The calculated components of the genetic variances and their ratio $\sigma^2_{GCA}/\sigma^2_{SCA}$ confirmed the greater importance of the non-additive gene effects in the inheritance of this trait.

Significant positive GCA for the productivity/plant was found, of the mothers for Boyana variety, with the highest productivity under the conditions of 2014, and IPK Nelina variety, and of the fathers for Mytra and Korina varieties, which had higher productivity than the Turkish variety Nazilli 954. Chirpan-539 and Rumi varieties of the mothers and Nazilli 954 variety of the fathers had negative GCA (Table 5). Helius variety had a positive but non-significant GCA for productivity/plant. Significant positive SCA effects were found for 6 of 15 crosses (Table 5), F_1 hybrids exceeded or equalized with the mean of the two parents. Some crosses (Rumi × Corina, Boyana × Mytra, IPK Nelina × Mytra and IPK Nelina × Corina) surpassed the parent with the higher value and showed heterosis from 14.1% to 32.1% (see Table 1).

Table 4. Analysis of the variance of combining ability by productivity/plant, lint percentage and length of the fiber in F1 hybrids of 5 Bulgarian cotton varieties with 1 Turkish and 2 Greek cotton varieties in 2013-2014

Source of variation	Degree of freedom	2013 g.			2014 g.		
		Sum of squares	Mean square	F-exsp.	Sum of squares	Mean squares	F-exp.
		Productivity/plant, g					
GCA - mothers	4	-	-	-	244.879	61.220	36.868^{+++}
GCA - fathers	2	-	-	-	211.311	105.655	63.627^{+++}
SCA	8	-	-	-	232.451	29.056	17.498^{+++}
Errors	15	-	-	-	-	1.661	-
Components of the variance		-	-	-	σ^2_{GCA}=0.712; σ^2_{SCA}=9.132;		
		-	-	-	*F=0,* σ^2_A*=2.848;* σ^2_D *=36.527*		
		-	-		*F=1,* σ^2_A*=1.424;* σ^2_D *=9.132*		
		Lint percentage, %					
GCA - mothers	4	5.219	1.305	11.046^{++}	12.193	3.048	41.383^{++}
GCA - fathers	2	5.422	2.711	22.951^{++}	6.201	3.101	42.092^{++}
SCA	8	10.498	1.312	11.101^{++}	14.855	1.857	25.209^{++}
Errors	15	-	0.118	-	-	0.074	-
Components of the variance		σ^2_{GCA}=0.007; σ^2_{SCA}=0.398			σ^2_{GCA}=0.201; σ^2_{SCA}=0.594		
		F=0, σ^2_A*=0.028;* σ^2_D *=1.592*			*F=0,* σ^2_A*=0.804;* σ^2_D*=2.376*		
		F=1, σ^2_A*=0.014;* σ^2_D *=0.398*			*F=1,* σ^2_A*=0.402;* σ^2_D *=0.594*		
		Fiber length, mm					
GCA - mothers	4	-	-	-	1.376	0.344	5.272^{++}
GCA - fathers	2	-	-	-	0.207	0.04	1.587
SCA	8	-	-	-	3.898	0.487	7.469^{++}
Errors	15	-	-	-	-	0.065	-
Components of the variance		-	-	-	σ^2_{GCA}=-0.223; σ^2_{SCA}=0.141		
		-	-	-	*F=0,* σ^2_A*=-0.892;* σ^2_D *=0.564*		
		-	-	-	*F=1,* σ^2_A*=-0.446;* σ^2_D *=0.141*		

Table 5. Evaluation of the GCA and SCA effects by productivity/plant in F_1 hybrids of 5 Bulgarian varieties with 1 Turkish and 2 Greek cotton varieties in 2013-2014

Mothers	GCA	Fathers	SCA	Fathers/SCA effects			
				Nazilli	Mytra	Corina	σ^2_{Si}
Chirpan-539	-4.844	Nazilli 954	-4.895	7.451	-4.049	-3.402	40.858
Helius	0.500	Mytra	0.671	3.473	-2.493	-0.971	8.735
Rumi	-4.178	Corina	4.224	-4.549	-1.555	4.564	19.878
Boyana	2.822			-0.449	4.351	-3.902	16.295
IPK Nelina	5.700			-5.927	2.207	3.720	26.031
Stand. error	1.052		0.815				
σ^2_{Sj} –fathers				30.015	10.717	14.723	

The values obtained for the heterosis effect were much lower than those reported in the literature, Wankhade et al. (2009) reported a maximum heterosis effect for raw cotton yields of 231.99% and 115.14% in diallel crosses, but they were commensurable or close to those reported by Karademir and Gencer (2010) - 39.39-56.11%

All parental forms with high GCA, of mothers Boyana and IPK Nelina varieties, of fathers

Mytra and Corina varieties, had low variances of SCA (Table 5). The low variances of SCA indicated that their high GCA effects were mainly determined by additive gene effects.

In four of the crosses with positive SCA, the parental forms had significant positive GCA, in the other two, only one of the two parents had a positive GCA.

Significant positive and constant by years GCA for the fiber lint persentage was found for Boyana and IPK Nelina varieties of the mothers and for Nazilli 954 variety of the fathers (Table 6). The other varieties, mothers and fathers, had constant, significant negative GCA for this trait. An exception was Chirpan-539 variety, which showed inconstant, negative in the first year of the study and positive in the second year, but non-significant in the two years GCA by this trait. Average for the two years, of the mothers IPK Nelina variety with high fiber lint percentige had the highest GCA, and of the fathers Nazili-954 variety with the highest fiber lint percentage was with positive and high GCA.

Positive SCA effects for the fiber lint percentage were found for 5 crosses in the first year and for 8 crosses in the second year of the study (Table 7). Two crosses Rumi × Corina and IPK Nelina × Nazilli 954 showed constant positive SCA in the two years. At the first cross, both parental forms had negative GCA for this trait, while at the second one they had positive and high GCA. Maternal forms with high GCA (Boyana and IPK Nelina varieties) had low variances of SCA indicating that their high GCA effects were mainly due to additive gene effects. Nazilli 954 variety (of fathers) with high GCA had high variance of SCA.

The high variance of the SCA indicates that its high GCA was due to the presence of both additive and non-additive gene actions and interactions.

Table 6. Evaluation of GCA and SCA effects by fibre lint percentage in F_1 hybrids of 5 Bulgarian cotton varieties with 1 Turkish and 2 Greek varieties during 2013-2014

2013				2014			
Mothers	GCA	Fathers	GCA	Mothers	GCA	Fathers	GCA
Chirpan-539	-0.091	Nazilli 954	0.842	Chirpan-539	0.100	Nazilli 954	0.807
Helius	-0.258	Mytra	-0.318	Helius	-1.589	Mytra	-0.031
Rumi	-0.924	Corina	-0.524	Rumi	-0.111	Corina	-0.077
Boyana	0.631			Boyana	0.455		
IPK Nelina	0.642			IPK Nelina	1.145		
Stand. error	0.281		0.217	Stand. error	0.222		0.172

Table 7. Evaluation of GCA and SCA effects by fibre lint percentage in F_1 hybrids of 5 Bulgarian cotton varieties with 1 Turkish and 2 Greek varieties in 2013-2014

	2013				2014			
Fathers Mothres	Nazilli 954	Mytra	Corina	σ^2_{Si}	Nazilli 954	Mytra	Corina	σ^2_{Si}
Chirpan-539	-0.409	2.018	-1.609	3.351	0.893	-0.193	-0.700	0.623
Helius	-0.575	-0.382	0.958	0.634	-2.484	1.495	0.989	4.654
Rumi	0.824	-0.982	0.158	0.772	-0.162	0.018	0.144	-0.015
Boyana	-0.098	-0.438	0.535	0.181	1.071	-0.149	-0.922	0.971
IPK Nelina	0.258	-0.215	-0.042	-0.006	0.682	-1.171	0.489	0.999
σ^2_{Sj}					2.113	0.878	0.605	

In terms of fiber length, of the mothers Chirpan-539 and Rumi varieties were with positive GCA, of the fathers Corina variety was with positive but non-significant GCA (Table 8). IPK Nelina variety, which had the longest fiber of the mothers, had a negative GCA for this property and Helius variety, with the shortest fiber, also had a negative GCA. Boyana variety had positive but insignificnt GCA. Nazilli 954 and Mytra varieties of the fathers had negative but insignificnt GCA. The insignificant values of the fathers showed that they did not differ in GCA for the fiber length, which confirmed the results obtained from the analysis of the variance of the combining

ability of the parental forms by this trait (see Table 4).

Specific combining ability for the fiber length was found for 6 crosses (Table 8), which average values were equal to the average parental value or exeeded it. Some crosses IPK Nelina × Corina, Rumi × Nazilli 954 and Chirpan-539 × Corina surpassed the better parent and exhibited heterosis of 2.2 to 4.1%. At crosses with manifested SCA effects, both parental forms had positive GCA effects (Chirpan-539 × Corina), or negative GCA efffects (Helius × Nazilli 954), or one of parental forms showed positive GCA and the other one - negative GCA. Chirpan-539 variety with positive GCA was with low variances of SCA, its high SCA was due mainly to additive gene effects. Rumi variety showed higher GCA than Chirpan-539 had medium high variancess of SCA, which means that its high GCA, exept by additive genes, to a considerable extent it was due to non-additive gene actions and interactions. Corina variety, with positive but insignificant GCA, had high variances of SCA, indicating that it positive GCA was conditioned by additive and non-additive gene actions and interactions.

GCA effects for productivity/plant and fiber length were inconsistent by years as a result of the specific response of F_1 hybrids to environmental conditions. The SCA effects were also unstable for most of the crosses which was due to their interaction with the environmental conditions (year conditions).

Table 8. Evaluation of GCA and SCA effects by fibre length in F_1 hybrids of 5 Bulgarian varieties with 1 Turkish and 2 Greek cotton varieties in 2013-2014

Mothers	GCA	Fathers	GCA	Fathers SCA effects			
				Nazilli 954	Mytra	Corina	σ^2_{Si}
Chirpan-539	0.242	Nazilli 954	-0.011	-0.489	0.071	0.418	0.175
Helius	-0.424	Mytra	-0.138	0.678	-0.062	-0.615	0.386
Rumi	0.342	+Corina	0.149	0.711	-0.129	-0.582	0.396
Boyana	0.131			-0.144	0.349	-0.204	0.057
IPK Nelina	-0.291			-0.755	-0.229	0.984	0.761
St. error/	0.209		0.161				
σ^2_{Sj}				0.414	0.015	0.441	

CONCLUSIONS

At the studied 15 intraspecific crosses of 5 Bulgarian cotton varieties with three foreign ones, different types of inheritance were found for the productivity/plant, boll weight, fiber length and lint percentage.

Positive over-dominance, dominance of parent with the higher value and additive inheritance were observed by all traits studied.

The heterosis effect was most pronounced for the productivity/plant and reached 39.1%, which was a prerequisite for transgressive segregation in F_2 generation.

Additive and non-additive gene effects were of importance for the inheritance of the traits studied.

The genetic variance was mainly of non-additive type and the prognosis for the selection in the early segregating generations could not be good.

Of the cotton varieties Bulgarian selection, included in the crosses, Boyana and IPK Nelina emerged as good common combiners for the productivity and fiber lint percentage, differed with high performance for both traits and high GCA. Chirpan-539 and Rumi varieties appered to be good common combiners for the fiber length.

Their high GCA was combined with low variances of the SCA, making them very suitable for the synthetic selection.

Of the foreign varieties, the Turkish Nazilli 954, possessing high fiber lint percentage, emerged as a good common combiner by this trait, the Greek variety Corina had high GCA for the fiber lenght.

Their high GCA was combined with high variances of the SCA and they appear to be more suitable for the heterosis selection.

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