CHARACTERISTICS OF QUALITY TRAITS OF COTTON GENETIC COLLECTION AND THEIR INTERRELATION

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Abstract. *We discuss the problems of genetic qualitative traits of the cotton G. hirsutum L. The regularities of inheritance and splitting in F_2 in 23 variants of joint inheritance of 9 qualitative traits are determined and it is found that within the species G. hirsutum L., the presence of an anthocyanin spot at the base of flower petals is controlled by two non-allelic genes with complete dominance of the presence of an anthocyanin spot and joint inheritance and cleavage in F_2 of five variants of the sign "presence - absence" of an anthocyanin spot at the base of the petals of a flower with such signs as the shape of the leaf and bracts. Plant coloration, color of flower petals, "presence - absence" of leafy nectaries are observed both trigenous and tetragenic control. In the functioning of their genes, inter-allelic and non-allelic gene interactions (polymerization) are observed.*

Keywords: *cotton, qualitative traits, genotype, phenotype, inheritance, genetic collection, polymeria, epistasis, genetic analysis, self-pollination, inter-allelic and non-allelic gene interactions, monohybrid and dihybrid crosses.*

1. INTRODUCTION

Investigations on genetic control of number qualitative characters by means of genetic analysis of the hybrids from crossing of isogenic for these characters cotton G. hirsutum L. stocks are of fundamental and practical importance in cotton science.

Considerable effort has been spent earlier for such studies [1-4]. In particular, the phenotypic and genotypic characteristics of our multiple marked with the genes qualitative signal characters are given in the paper [1,5-8].

In this paper we present results of multi-years research on the study of the genetics of qualitative traits in hybrid generations, obtained using also new lines of the genetic collection in various combinations with not only monohybrid, but also their dihybrid crosses.

Unlike the earlier studies on the ordinary varieties and samples of cotton, which, due to the optional self-pollination cotton, are characterized to a certain extent by pronounced heterogeneity and heterozygosity, the results present here some novel issues.

2. MATERIALS AND METHODS

As the initial materials for the investigations, we choose the isogenic stocks with homozygous genotype and alternative phenotype for the follows qualitative characters: sympodia type, leaf shape, plant coloration, fiber coloration, bract shape, petal coloration, presence-absence of an anthocyanin pigment spot in the base of a petal, pollen coloration, presence-absence of leaf nectary’s and gossypol glandules on the cotton plants. Genetic analysis was carried out on the hybrids got from monohybrid, dihybrid and polyhybrid crosses of the stocks.

As it is known, cotton on its flowering biology is not obligate but facultative self-pollinator. Therefore, the flower self-pollination both on parental stocks and their hybrids has been carrying out on the all stages of the research.

Genetic analysis of the self-pollinated progeny has been proceeding to actual revealing theoretically expected stocks with different homozygous genotype of gene alleles of abovementioned characters. We used the gene markers for these characters proposed by our predecessors and us.

3. RESULTS AND DISCUSSION

According to our investigations for genetic analysis of the hybrids got from monohybrid crosses of the isogenic stocks for qualitative characters and literature data the isogenic stocks for studied qualitative characters are obtained using the self-pollination. The selection have the following genotypes and phenotypes:

Sympodia type: non-ultimate (SS) – ultimate (ss). It inherits as incomplete dominance.

Leaf shape: okra (O_1O_1) – broad 5-lobed (o_1o_1). It inherits as incomplete dominance.

Plant coloration: anthocyan (RpRp) – green (rprp). It inherits as incomplete dominance.

Fiber coloration: brown ($Br^{Fr}Br^{Fr}$) – white ($br^{Fr}br^{Fr}$). It inherits as incomplete dominance.

Petal coloration: yellow (Y_1Y_1) – cream (y_1y_1). It inherits as complete dominance.

Anthocyanin pigment spot in the base of a petal: presence of an anthocyanin pigment spot ($R_2R_2R_2^1$ R_2^1) – absence of the spot ($r_2r_2r_2^1$ r_2^1). It inherits as complete dominance.

Pollen coloration: yellow (P_1P_1) – cream (p_1p_1). It inherits as complete dominance.

Bract shape: cordate (FgFg) – narrow (fgfg). It inherits as complete dominance.

Leaf nectaries: presence of leaf nectaries ($Ne_1Ne_1Ne_2Ne_2$) – absence of leaf nectaries ($ne_1ne_1ne_2ne_2$). It inherits as complete dominance.

Gossypol glandules: presence of gossypol glandules on stem and boll (Gl_1Gl_1) – absence of gossypol glandules (gl_1gl_1).

According to the research results the Genetic Collection of multiple marked with the qualitative signal genes isogenic stocks was developed.

The first stage of the research provided the creation of 16 isogenic stocks for first four alternative qualitative characters (see, Fig. 1).

On the next stage the genetic analysis with the involvement of subsequent group of stocks (5-10) with alternative phenotype and homozygous genotype of 6 alternative qualitative stocks was carried out in the broad scale. The phenotypic and genotypic characteristics of a number of isogenic multiply marked stocks are presented in Table 1 (inheritance and relationship of qualitative traits of cotton G.hirsutum L.).

Isogenic stocks marked with genes of qualitative characters are used:

as model objects for molecular genetics, biochemical and ecological investigations;

as model objects for cytogenetic marking of chromosomes and construction of gene maps;

as valuable initial material for study of genetic correlations between marker and economic characters;

for breeding of new cotton varieties with semidominant marker characters that is favourable for seed-growing work for support of variety homogeneity.

Genotype	Phenotype			Genotype	Phenotype		
	Plant coloration and leaf shape	Sympodia type	Fiber coloration		Plant coloration and leaf shape	Sympodia type	Fiber coloration

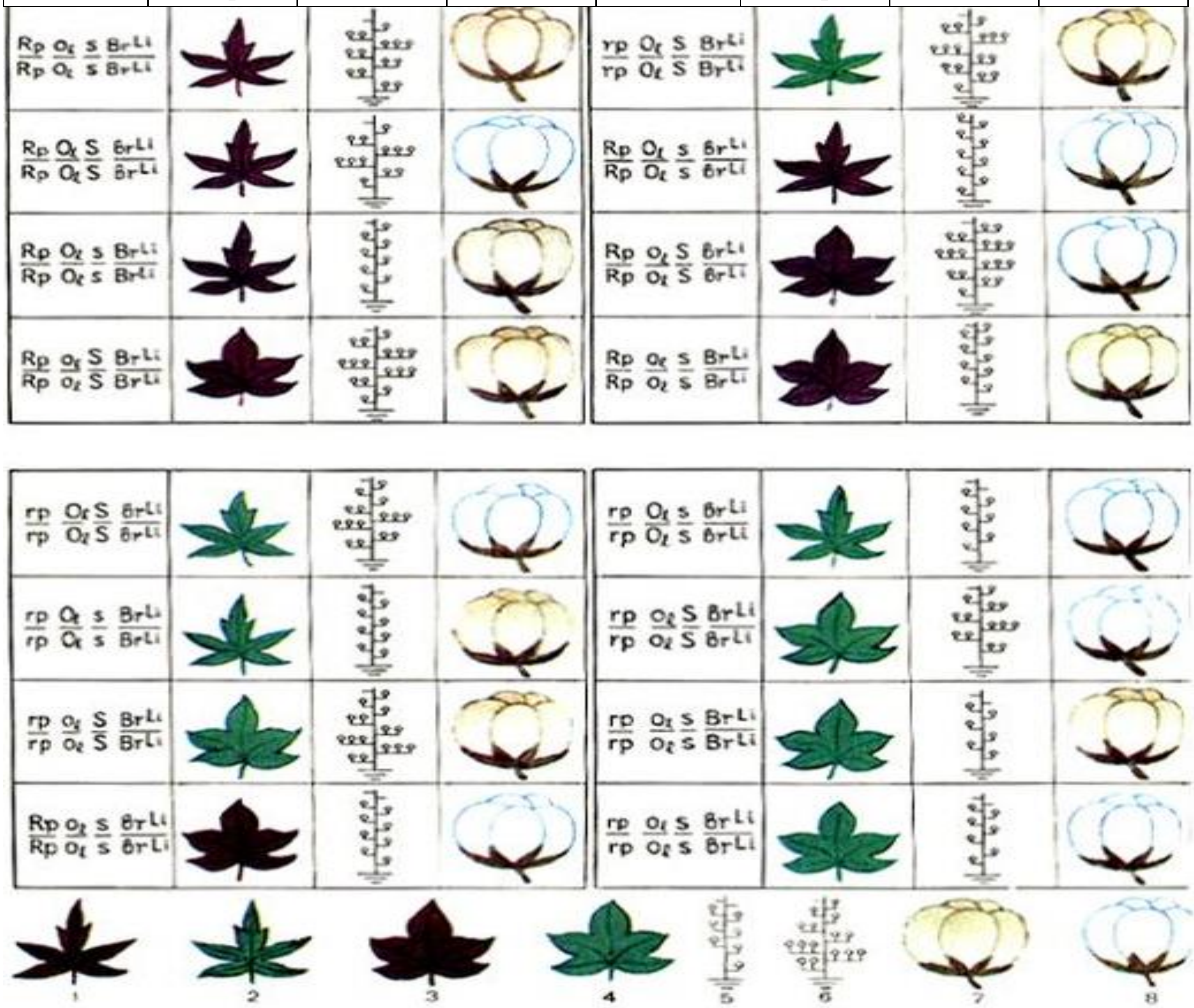

FIG. 1. Cotton Genetic Collection for qualitative characters: 1 – okra leaf and anthocyan plant coloration; 2 - okra leaf and green plant coloration; 3 – broad 5-lobed leaf and anthocyan plant coloration; 4 - broad 5-lobed leaf and green plant coloration; 5 – brown fiber; 6 – white fiber.

The main results of the investigations on genetic control of number qualitative characters by means of genetic analysis of the hybrids from crossing of isogenic for these characters cotton G. hirsutum L. stocks are presented in the paper. We supported the research results of our predecessors during our investigations [2-4]. The phenotypic and genotypic characteristics of our multiple marked with the genes qualitative signal characters are given in the paper [1,5-8].

Our work is essentially a continuation and further expansion of the results of studying the genetics of qualitative traits in hybrid generations, obtained using also new lines of the genetic collection in various combinations with not only monohybrid, but also their dihybrid crosses.

TABLE 1. Phenotypic and genotypic characteristics of a number isogenic stocks from Cotton Genetic Collection

Genotype	Phenotype
$RpRpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}O_{1}O_{1}SSBr^{Fr}Br^{Fr}$	Anthocyan plant coloration; okra leaf; nonultimate sympodia type; brown fiber
$RpRpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}O_{1}O_{1}SSbr^{Fr}br^{Fr}$	Anthocyan plant coloration; okra leaf; nonultimate sympodia type; white fiber
$RpRpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}OiOiSsBr^{Fr}Br^{Fr}$	Anthocyan plant coloration; okra leaf; ultimate sympodia type; brown fiber
$RpRpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}o_{1}o_{1}SSBr^{Fr}Br^{Fr}$	Anthocyan plant coloration; broad 5-lobed leaf; nonultimate sympodia type; brown fiber
$RpRpr^{V}_{st}r^{V}_{st}in^{1}\ in^{1}O_{1}O_{1}ssbr^{Fr}br^{Fr}$	Anthocyan plant coloration; okra leaf; ultimate sympodia type; white fiber
$RpRpr^{V}_{st}r^{V}_{st}in^{1}\ in^{1}o_{1}o_{1}SSbr^{Fr}br^{Fr}$	Anthocyan plant coloration; broad 5-lobed leaf; nonultimate sympodia type; white fiber
$RpRpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}o_{1}o_{1}ssBr^{Fr}Br^{Fr}$	Anthocyan plant coloration; broad 5-lobed leaf; ultimate sympodia type; brown fiber
$RpRpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}o_{1}o_{1}ssbr^{Fr}br^{Fr}$	Anthocyan plant coloration; broad 5-lobed leaf; ultimate sympodia type; white fiber
$rprpr^{v}_{st}r^{V}_{st}in^{1}\ in^{1}O_{1}O_{1}SSBr^{Fr}Br^{Fr}$	Green plant coloration; okra leaf; nonultimate sympodia type; brown fiber
$rprpr^{V}_{st}r^{V}_{st}in^{1}\ in^{1}O_{1}O_{1}SSBr^{Fr}Br^{Fr}$	Green plant coloration; okra leaf; nonultimate sympodia type; white fiber
$rprpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}O_{1}O_{1}ssBr^{Fr}Br^{Fr}$	Green plant coloration; okra leaf; ultimate sympodia type; brown fiber
$rprpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}o_{1}o_{1}SSBr^{Fr}Br^{Fr}$	Green plant coloration; broad 5-lobed leaf; nonultimate sympodia type; brown fiber
$rprpr^{v}_{st}r^{V}_{st}in^{1}\ in^{1}O_{1}O_{1}ssbr^{Fr}Br^{Fr}$	Green plant coloration; okra leaf; ultimate sympodia type; white fiber
$rprpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}O_{1}O_{1}SSbr^{Fr}br^{Fr}$	Green plant coloration; broad 5-lobed leaf; nonultimate sympodia type; white fiber
$rprpr^{V}_{st}r^{V}_{st}in^{1}\ in^{1}o_{1}o_{1}ssBr^{Fr}Br^{Fr}$	Green plant coloration; broad 5-lobed leaf; ultimate sympodia type; brown fiber
$rprpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}O_{1}O_{1}ssbr^{Fr}br^{Fr}$	Green plant coloration; broad 5-lobed leaf; ultimate sympodia type; white fiber
$rprpr^{v}_{st}r^{v}_{st}In^{1}\ In^{1}o_{1}o_{1}SSbr^{Fr}br^{Fr}$	Green plant coloration; integrin leaf; nonultimate sympodia type; white fiber
$rprpr^{v}_{st}r^{V}_{st}in^{1}\ in^{1}O_{1}O_{1}SSbr^{Fr}br^{Fr}$	Anthocyan stem and vein coloration; okra leaf; nonultimate sympodia type; white fiber
$RpRpR^{v}_{st}R^{v}_{st}in^{1}\ in^{1}O_{1}O_{1}ssbr^{Fr}br^{Fr}$	Anthocyan plant coloration; okra leaf; ultimate sympodia type; white fiber

$rprpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}O_1O_1SSbr^{Fr}br^{Fr}Y_1Y_1p_1p_1R_2R_2$	Green plant coloration; 5-lobed leaf; nonultimate sympodia type; white fiber; yellow petal coloration; cream pollen coloration; anthocyanin pigment spot in the base of a petal
$rprpr^{v}_{st}r^{v}_{st}in^{1}\ in^{1}o_1o_1SSbr^{Fr}br^{Fr}y_1y_1P_1P_1r_2r_2$	Green plant coloration; 5-lobed leaf; nonultimate sympodia type; white fiber; cream petal coloration; yellow pollen coloration; anthocyanin pigment spot in the base of a petal absents

4. CONCLUSION

Thus in this study we found that within the species G.hirsutum L. the presence of an anthocyanin spot at the base of flower petals is controlled by two non-allelic genes with complete dominance of the presence of an anthocyanin spot. The second gene of the anthocyanin spot was designated by us - R_2^{ps}. ($R_2R_2R_2^{ps}R_2^{ps}$).

Also, is found that in the joint inheritance and splitting in F_2 of five variants of the trait "presence - absence" of an anthocyanin spot at the base of flower petals with such traits as the shape of the leaf and bracts, plant color, color of flower petals, "presence - absence" of leaf nectaries is observed both trigenic and tetragenic control. In the functioning of their genes, inter-allelic and non-allelic gene interactions (polymerization) are observed.

As a result of the study of the patterns of inheritance and splitting in F_2 in 23 variants of joint inheritance of 9 qualitative traits, we established that in the allotetraploid species Gossypium hirsutum L. genetic control of a qualitative trait can have not only monogenic, but also digenic character. In their F_2 hybrids, obtained from crossing lines with different qualitative traits controlled by digeno, a complicated type of gene interaction is observed (allelic and non-allelic gene interactions - polymerization + epistasis). Moreover, depending on the genotype, according to marker characters, the parental lines in their F_2 have trigenous and tetragenic cleavage.

The results of genetic analysis of F_2 and F_b hybrids with 23 variants of different paired combinations of the 9 qualitative traits studied by us show that they are inherited and recombined independently. Consequently, their genes are located in different linkage groups.

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