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Research Paper

Inheritance of Morpho-Biological and Economic Traits in Breed of Reciprocal Cotton Hybrids

Botany

KEYWORDS : Allotetraploid, Reciprocal cotton hybrid, parental cotton varieties (KS-1, AN-14 and IL-296), Korotkostebelniy 1 (KS-1) cotton variety

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ABSTRACT

: Cottons are not only a world's leading textile fiber and oilseed crop, but also a crop that is of significance for bioengergy production. Cotton is frequently treated by highly toxic agrochemicals to prevent it from harmful insects. High-toxic agrochemicals exert very strong negative influence on ecological environment. A priority guideline of the cotton growing is the designing of new gene and selective breeding methods for inventing varieties of cotton having high resistance to diseases. In order to obtain stable high-quality yield the present study was conducted and inheritance pattern of morpho-biological and economic traits in breed of reciprocal cotton hybrids were being obtained. Crossbreeding was based on allotetraploid mid-staple varieties Korotkostebelniy 1 and Of Academy of Science RUz 14 with synthetic amphidiploid introgressive line IL-296 which was created with using of wild diploid species G.trilobum Skovsted. Resistance to verticillium wilt in the first and second filial hybrids was also studied.

Introduction:

Cotton growing is a leading sector of agriculture of the Republic of Uzbekistan since its products having great demand are used in various areas of national economy. Uzbekistan is the 6th largest producer of cotton worldwide (preceded by China, India, USA, Pakistan and Brazil) and the 3rd largest exporter. Uzbekistan participates extensively in world cotton industry. In 2010/11, Uzbekistan produced 1 million tons of cotton. Uzbekistan is a major exporter of cotton. Exports were close to 1 million tons during the past decade and a half. Traditionally, cotton was (and is still is) Uzbekistan's important cash crop. In 2010, cotton accounted for 11% of total Uzbek exports[1.]

According to the Food and Agriculture Organization (FAO) of the United Nations 2(http://www.fao.org), the cotton planting area reached about 35 million hectares and the total world's cotton production had a record of about 23 million metric tons in 2004/2005. Cotton products include fibers and seeds that have a variety of uses. Cotton fibers sustain one of the world's largest industries, the textile industry, for wearing apparel, home furnishings, and medical supplies, whereas cottonseeds are widely used for food oil, animal feeds, and industrial materials (such as soap). Cottonseed oil is ranked fifth in production and consumption volume among all vegetable oils in the past decades, accounting for 8% of the world's vegetable oil consumption3. In addition to their economic importance, cottons are an excellent model system for several important biological studies, including plant genome size evolution, plant polyploidization and single-celled biological processes. The genomes of angiosperm plants vary over 1000 folds in size, ranging from 100 to >100,000 Mb/1C (haploid)32.

Currently, the Uzbek government is pursuing development strategies to reform and modernize cotton supply chain1. Earlier Mavlyanova4 reviewed about the plant genetic resources and scientific activities of the Uzbek research institute of plant based industry. Authors mentioned in details about the cotton programme in country, but still we are far lacking behind as per the demand. Therefore implementation of complex activities in development of domestic cotton to fast-ripening, high-yielding commercial varieties is the need of hour. However, cotton is frequently treated by highly toxic agrichemicals in controlling of harmful insects in order to obtain stable high-quality yield5. Meanwhile highly toxic agrichemicals exert very strong negative influence on ecological environment which is the most complicated problem of the agriculture of the country because of increase in environmental pollution hazard by residues of various pesticides. Furthermore residuals of used chemical pesticides have not only high toxicity but also embryo toxicity, carcinogenicity and mutagenicity6. Hence the priority guideline of the modern cotton growing is the designing of new gene and selective breeding methods in inventing of cotton varieties having high resistance to diseases, cat facing insects and extreme factors of ecological environment together with other important economic traits.

It should be emphasized that conventional methods still being applied in cotton gene and selective breeding researches based on intraspecific hybridization are almost exhaust its potentialities in producing valuable initial material with positive genetic potential. In this context the remote interspecific hybridization of cotton is of great importance in solution number of theoretical and applied matters of selective plant breeding 7,8,9,10,11,12,13,14,15,16. Method potentiality of remote interspecific cotton hybridization is that the wild species especially diploids have unique and economic traits and features. Transfer of these useful features to allotetraploid varieties and perspective lines of cotton allows producing new initial parental donors for practical selective breeding. It should be also noted that use of wild cotton species with the purpose of transfer of their economic traits and features to cultivated cottons attracts for a long time many national and foreign researchers 9,16,17,18,19,20,21.

Material and Methods:

It is known that the world diversity of genus Gossypium - is inexhaustible source of genetic material. Only two polyploid (G. hirsutum L., G. barbadense L.) and two diploid (G. herbaceum L., G. arboretum L.) varieties had been spreading in crop. It is evidence of vast reserves of remote intraspecific cotton hybridization in enrichment and improvement of gene pool of cultivated varieties with missing traits by using of genes of wild species 22.

Deployment of this method in researches made it possible for number of scientists 26,27,28,29 to derive valuable synthetic amphidiploid species of cotton which combine features of wild and cultivated varieties that may serve as valuable donors for obtaining combination of compound hybrids between different varieties. They are not yielding directly fast practical results since their plants mightily developed, sprawling, late-ripening, monopodial type having small boll, short staple and etc. At the same time they have such valuable features as resistance to harmful fungus diseases, insect pests, excessive soil salinization, water deficiency, low temperatures and also they are distinguished by good strength and silkiness of the staple, early ripeness, high yielding capacity, inclination to defoliation ability which indicates to their unlimited potentialities for widespread use in gene and selective breeding researches of cotton.

There are quite enough papers so far 23,24,25,26,30,31 which had been invented valuable collections of introgressive backcrossed amphidiploid families and perspective lines of cotton on the basis of widespread use of synthetic amphidiploid varieties in basic genetic and applied selective breeding researches.

On the basis of the foregoing the main objective of our studies was to research of inheritance pattern of the main morpho-biological and economic traits in reciprocal hybrid generations, mid staple varieties and introgressive lines of cotton. The synthetic amphidiploid introgressive line IL-296 was served as a

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target of researches being obtained with using of wild diploid G. trilobum Skovsted species and allotetraploid cotton species Korotkostebelniy 1 (KS-1), Of Academy of Science RUz 14 (AN-14) in hybridization.

Reciprocal crossing of parental varieties had been carried out by the following scheme: IL-296 x KS-1; KS-1 x IL-296; IL-296 x AN-14; AN-14 x IL-296. Initial parental varieties (KS-1, AN-14 and IL-296) are characterized by the following morpho-biological and economic traits:

Korotkostebelniy 1 (KS-1) cotton variety: The plants are of medium height (75-80 cm) with 1-2 monopodial branches of mid length; 1.0-1.5 type of branching with short internodes of the main stem and very closely located bolls on fruit spurs. The stem does not lodge; the leaves are small, light green colored, five-lobed weakly divided with soft fluffs, the flower with white petals without anthocyan fleck; the boll is egg-shaped with blunt beak. The fiber is white, silky and strong. It is relatively resistant to verticillium wilt, cotton aphid and spider mite. It was obtained from crossbreeding of radio-mutant cotton line ML-281 with Tashkent 1 variety.

Of Academy of Science RUz 14 (AN-14) cotton variety: The plants are of medium height with short monopodial branches (0-1 pes.), 1.0-1.5 type of branching with short internodes of the main stem; the leaves are of medium size, five-lobed with weak dissected leaves, dark green colored, bare, the flower with white petals without anthocyan fleck; the boll is egg-shaped with slight blunt beak. The fiber is white, fine-fibered, silky and strong. It is affecting by verticillium wilt, cotton aphid and spider mite. It is not tolerable to water deficiency and salinization of soils. It was obtained from crossbreeding of radio-mutant cotton line ML-281 with Tashkent 2 variety.

Synthetic amphidiploid introgressive line - IL-296: The plants are of medium height, sprawling (2-3 type of branching) with 2-3 shorter monopodial branches, the stem is without indumentum and inclined to lodging, weakly leafed; the leaves are five-lobed, light green colored, of medium size with weak dissected leaves, the flower with petals of light lemon color without anthocyan fleck, bracts are long, the boll is egg-shaped with small blunt beak. The fiber is white, short stapled, silky and strong. It is highly resistant to verticillium wilt, cotton aphid, spider mite and water deficiency. Interstage periods (sowing -flowering - ripening of bolls) are distinctly extended.

Synthetic amphidiploid introgressive line IL-296: has high resistance to verticillium wilt, cotton aphid, spider mite and good technological properties of the fiber. However this line has also negative morpho-economic traits such as late ripeness, small bolls, branchy shrub and short staples.

Experimental researches on studying of reciprocal hybrids of the first and second filial generations as well as abovementioned varieties and their inheritance of morpho-biological and economic traits from parental cotton varieties had been carried out on naturally highly infected test plot of the institute by verticillium wilt.

Result and Discussion:
The analysis of obtained results shows that initial parental cotton varieties KS-1, AN-14 and synthetic amphidiploid introgressive line IL-296 do not differ in amount of bolls and fiber length but in morpho-economic traits such as main stem height, number of sympodial branches, length of vegetation period, raw cotton weight of one boll, fiber yield, susceptibility to verticillium wilt have differences. The main stem height of KS-1, AN-14 and IL-296 was 82 ± 1.69 cm, 97 ± 1.83 cm and 113 ± 1.96 cm respectively; number of sympodial branches was 15 ± 1.27; 16 ± 1.36 and 19 ± 1.31; number of bolls per one plant was 19 ± 1.23, 21 ± 1.37 and 19 ± 1.46 respectively; the length of vegetation period was 118 ± 1.43 days; 121 ± 1.71 days and 128 ± 1.33 days respectively; raw cotton weight of one boll was 5.4 ± 0.13 g, 5.8 ± 0.09 g and 4.8 ± 0.06 g; fiber yield was 37,2 ± 1.36%, 35.3 ± 1.86% and 32.3 + 1.17%; staple length was 34.1 ± 1.29 mm, 34.1 ± 1.82 mm and 33.6 ± 1.58 mm; overall susceptibility to verticillium wilt was 39.6%, 50.5% and 2.7%.

The main stem height, number of sympodial branches (except IL-296 x AN-14), the length of vegetation period, fiber yield and overall susceptibility to verticillium wilt had been observed incomplete dominance in reciprocal first filial hybrids being obtained from crossbreeding of initial parental cotton species. Definite mechanism of inheritance had not been observed in other traits (number of bolls, raw cotton weight of one boll, fiber length).

For example, number of bolls per one plant of 3 hybrid combinations F^ (IL-296 x KS-1, KS-1 x IL-296 and AN-14 x IL-296) amounted to 20 ± 1.28 bolls, 20 ± 1.34 bolls and 23 ± 1.41 bolls respectively; and in parental varieties KS-1, AN-14 and IL-296 amounted to 19 ± 1.23 bolls, 21 ± 1.37 bolls and 19 ± 1.46 bolls respectively. At the same hybrid combination Ft of IL-296 x AN-14 by value of this trait was at the level of AN-14 (21 ± 1.45 bolls on a plant).

Parent materials and cotton hybrids	Main stem height, cm	Quantity (in pieces)		Vegetation period, days	Raw cotton weight of one boll, g	Fiber yield, %	Staple length, mm	Susceptibility to verticillium wilt, %
		Sympodial branches	Bolls					
	x±Sx	x±Sx	x±Sx	x±Sx	x + Sx	x±Sx	x±Sx	
Initial parental varieties								
KS-1	82±1.69	15+1.27	19±1.23	118±1.43	5.4+0.13	37.2+1.36	34.1+1.29	39.6
AN-14	97±1.83	16±1.36	21±1.37	121+1.71	5.8±0.09	35.3+1.86	34.1+1.82	50.5
IL-296	11311.96	19±1.31	1911.46	128+1.33	4.8+0.06	32.3+1.17	33.6+1.58	2.7
First filial hybrids								
IL-296 x	92±1.66	17±1.38	20±1.28	120±1.38	6.0+0.16	35.8+1.27	35.3+1.28	10.2
KS-1								
KS-1 x IL-296	90±1.74	17±1.46	20±1.34	118±1.35	5.8±0.08	35.7±1.73	34.1 ±1.55	9.6

IL-296 x AN-14	98±1.63	19±1.41	21 ±1.45	123±1.87	5.3±0.11	33.5±1.64	34.8±1.77	13.9
AN-14 x IL-296	107±1.85	18±1.33	23±1.41	123±1.49	5.4±0.06	34.7±1.67	34.6±1.70	9.8
Second filial hybrids								
IL-296 x KS-1	91 ±1.63	17+1.39	18±1.37	116±1.39	5.1±0.16	36.1 ±1.63	34.6±1.70	16.8
KS-1 x IL-296	93±1.75	17±1.30	18±1.30	118+1.33	5.2±0.12	36.4±1.35	34.3±1.83	18.9
IL-296 x AN-14	105+1.78	18±1.40	24±1.31	120±1.90	5.2±0.08	36.2±1.65	34.0±1.31	19.4
AN-14 x IL-296	109±1.93	18±1.35	23±1.42	121 ±1.74	5.5±0.09	35.8±1.73	34.2±1.58	21.4

Table 1:Inheritances of morpho-biological and economic traits in reciprocal cotton hybrids

Hence based on obtained research results it may be noted that incomplete dominance in reciprocal first filial hybrids had been observed in morpho-physiological traits such as main stem height, number of sympodial branches, length of vegetation period, fiber yield and overall susceptibility to verticillium wilt but definite mechanism had not been observed in number of bolls per one plant, raw cotton weight of one boll and staple length (Table 1).

Traits in reciprocal second filial hybrids such as main stem height, number of sympodial branches, raw cotton weight of one boll and susceptibility to verticillium wilt had been inherited by type of incomplete dominance but definite mechanism had not been observed in other traits (number of bolls on a shrub, vegetation period, fiber yield and length). For example, according to fiber yield four reciprocal hybrids F, were in intermediate position while in two second filial hybrid combinations F, (IL-296 x KS-1 and KS-1 x IL-296) fiber yield was 36.1 ± 1.63% and 36.4 ± 1.35% respectively which indicates to incomplete dominance and in two remaining hybrids (IL-296 x AN-14 and AN-14 x IL-296) the value of this trait was 36.2 ± 1.65% and 35.8 ± 1.73% respectively, namely the dominance over values of parental varieties is observed. The similar pattern is observed in reciprocal second filial hybrids according to traits such as number of bolls on a plant, length of vegetation period and staple length (Table 1).

Conclusions:

Traits in reciprocal first and second filial hybrids being obtained from crossbreeding of synthetic amphidiploid introgressive line IL-296 with cultivated allotetrapoid cotton varieties KS-1 and AN-14 such as main stem height, number of sympodial branches and susceptibility to verticillium wilt are inheriting by type of incomplete dominance with explicit deviation to the side of the best initial variety. Reciprocal first and second filial hybrids according to resistance to verticillium wilt had been more deviated to the side of wilt-resistant initial line IL-296 which indicates to considerable potentiality of using of this line in gene and selective breeding researches for obtaining wilt-resistant cotton varieties.

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