INHERITANCE, HERITABILITY AND VARIABILITY OF TOLERANCE TO *VERTICILLIUM DAHLIAE* KLEB AMONG GEOGRAPHICALLY REMOTE F_1-F_2 PROGENY OF *GOSSYPIUM HIRSUTUM* L.

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Abstract

An important problem of cotton breeding in Uzbekistan is developing varieties tolerant to the plant pathogen *Verticillium dahliae*. To this end, we are utilizing ecologically remote intraspecific and interspecific hybridization. We now report breeding and selection research directed at determining heredity and variability of wilt tolerance of these geographically remote hybrids.

Our research shows intermedium inheritance and overdominance of resistance to *V. dahliae* in F_1 hybrids. The observed coefficients of dominancy (hp) F_1 and heritability (h^2) of *V. dahliae* tolerance among F_2 populations allows us to determine perspective hybrids in F_1 and plants in F_2 populations. The *V. dahliae* tolerance ranged between 0.92 and 0.97. This demonstrates high heritability of the resistant trait and allows selection of tolerant plants in F_2 generations. Based on our results, the varieties Carmen and Flora of Turkish origin were recommended to breeders to develop plants tolerance to *V. dahliae* Klebhan in Uzbekistan.

Introduction

In Uzbekistan, we are developing cotton varieties with early maturity, superior resistant to major pathogens, and high yield and fiber quality that are suited to the unique ecological conditions in Central Asia. To successfully select suitable genetic materials for these conditions and with the required complex genotypical parameters, we began with cultivars that are being successfully grown in Uzbekistan and crossed these with genetically remote lines. A goal of vital importance is development of ultra-early maturing varieties combined with high fiber quality and good yield (Avtonomov, A.A. 1973; Avtonomov, V.A. 2006, 2007). Of equal importance is selection of plants with high resistance to *V. dahliae*.

Others have demonstrated that some resistant varieties become susceptible as a result of appearance of new more aggressive races of *V. dahliae* Kleban (Voytenok, 1966; Mirakhmedov, 1971, 1974; Popov, 1974; Avtonomov, A.A. 1993). For example, with superior local varieties S-6524 and Namangan-77 that in the past exhibited 10-15% crop damage due to *V. dahliae*, these may now exhibit damage of 70-80% with yield losses up to 30-50% and with reduced fiber quality. To overcome this problem, extensive research has been directed at developing cotton varieties with resistance to both *V. dahliae* and *Fusarium oxysporum* f. sp. *vasinfectum* (Avtonomov, A.A. 1973; Avtonomov, V.A., 2006, 2007; Egamberdiev, 2009) utilizing geographically remote F_1-F_2 hybrids. These efforts continue to be important to accelerate and optimize the breeding process at an early stage by selecting suitable initial germplasm. To this end, we are determining the variability, direction and dominance data on the "*V. dahliae* resistance" in F_1 and heritability in F_2 of crosses between Uzbek and Turkish varieties. Specific research goals are to:

- Characterize *V. dahliae* resistance within initial Turkish and Uzbek germplasm.
- Determine variability of "*V. dahliae* resistance" within the hybrids developed from crosses between these geographically remote lines.

Materials And Methods

The initial germplasm used in this study were the Uzbek cotton varieties Namangan-77, Namangan-34 and L-136, and the Turkish varieties Carmen and Flora (*G. hirsutum* L.) and their progeny. Research was conducted in fields heavily infected by natural populations of *V. dahliae*. To calculation the wilt-index it is necessary to estimate all susceptible plants of the given variety and rate them with corresponding scores. For an objective and

exact estimation of wilt tolerance we used the method of Popov et al. (1974) where susceptibility is defined as the expression of wilt on leaves and a decrease of quantity of generative organs according to following scale:

0 – the plant shows no susceptibility;
1 – only individual leaves have necrotic discoloration;
2 – >50 % of leaves on a plant have a small necrotic discoloration;
3 – strong necrotic discoloration on almost all leaves or the plant is defoliated by up to 50%;
4 – complete defoliation of leaves, however a visible loss of the quantity of generative organs isn't appreciable;
5– complete defoliation of leaves, and plant has 2-4 deformed (underdeveloped) bolls.

The scores of individual plants from a group of several plants were recorded for a particular cross and these scores were averaged; this provides a susceptibility index rating. This score can vary between 0 up to 5. A zero index means that all plants are tolerant, and an index of 5 indicates an extreme degree of a susceptibility which may lead to 75-80 % loss of raw cotton.

Results and Discussion

The data in Table 1 show that Turkish varieties Carmen and Flora were highly resistant to *V. dahliae* with susceptibility scores of 0.23 and 0.24 (respectively). Among Uzbek varieties, Namangan-34 had a comparatively low susceptibility score of 0.92 score. Among the F_1 progeny, the Carmen x Namangan-34, and Flora x Namangan-77 had susceptibility scores of 0.87 and 0.90, respectively. In the F_2 generation, F_2L-136 x Namangan-34 and F_2Flora x Namangan-34 had relatively low susceptibility scores of 0.76 and 0.78, respectively.

Table 1. Variability, inheritance and heritability of "*Verticillium dahliae Klebhan resistance*" at geographically remote hybrids F_1-F_2 of *G. hirsutum* L.

No.	Varieties and progeny	n	k=1 score						M±m	σ	V%	hp	h^2
			0	1	2	3	4	5					
1.	Flora	102	84	11	7				0.24±0.06	0.57	237.5		
2.	L-136	133		14	114	5			1.93±0.03	0.37	19.17		
3.	Carmen	120	97	18	5				0.23±0.05	0.51	221.73		
4.	Namangan-77	142			121	18	3		2.16±0.04	0.43	19.90		
5.	Namangan-34	149	17	127	5				0.92±0.03	0.37	40.21		
6.	S-6524	132			24	97	11		2.90±0.03	1.51	52.06		
7.	Tashkent-1	158				27	112	19	3.95±0.04	0.53	13.41		
8.	108-F	233				34	136	63	4.12±0.04	0.63	15.29		
9.	F_1L-136 x Nam-77	366		35	314	17			1.95±0.02	0.37	18.97	-0.82	
10.	F_2L-136 x Nam-77	338	175	6	9	21	26	101	2.06±0.12	2.27	110.24		0.97
11.	F_1Carmen x Nam-77	286	11	223	52				1.14±0.03	0.44	38.59	-0.05	
12.	F_2Carmen x Nam-77	1136	657	50	21	55	75	278	1.71±0.06	2.19	127.79		0.95
13.	F_1Flora x Nam-77	253	28	221	4				0.90±0.02	0.34	37.77	-0.31	
14.	F_2Flora x Nam-77	1123	689	39	19	59	81	236	1.56±0.06	2.13	136.53		0.95
15.	F_1L-136 x Nam-34	154	13	116	25				1.08±0.04	0.49	45.49	-0.66	
16.	F_2 L-136 x Nam-34	1445	1163	17	17	59	62	127	0.76±0.04	1.65	217.1		0.94
17.	F_1Carmen x Nam-34	379	51	327	1				0.87±0.02	0.34	39.08	0.85	
18.	F_2Carmen x Nam-34	1533	1084	77	45	102	98	127	0.97±0.04	1.70	175.25		0.94
19.	F_1Flora x Nam-34	467	42	412	13				0.93±0.02	0.33	35.48	1.02	
20.	F_2Flora x Nam-34	1888	1435	84	68	80	84	137	0.78±0.04	1.57	201.28		0.92

M-average scores, σ- standard deviation, V%-variability, hp- coefficient of dominancy, h^2- heritability, Nam-77- Namangan-77, Nam-34- Namangan-34

The comparative analysis of standard deviation (σ) and variation (V) of parental lines and progeny showed that the parental varieties and F_1 were 1.5 to 2 times more susceptible than in the F_2 generation. The data in Table 1 indicates that the parents and F_1 progeny distributed into three classes, while F_2 progeny distributed in 6 classes. The incomplete dominance was observed among the most susceptible parent among the four crosses. In the case of one progeny (F_1Carmen x Namangan-34), the effect of incomplete dominance was observed in the most resistant parent. Among the investigated hybrids only the F_1Flora x Namangan-34 showed a positive heterosis (hp=1.02). The analysis of the heritability factor (h^2) for "*V. Dahliae* resistance" (between 0.92 and 0.97) indicates this trait is inherited at a high level.

Based on the observed averages for the trait (M), it may be concluded that hybrids of crosses F_1Carmen x Namangan-34 and F_1Flora x Namangan-77 showed the best average resistance. The effect of incomplete dominance on transmission of this trait from the most resistant parent with dominance of hp=-0.82 was observed with the progeny F_1L-136 x Namangan-77. The heritability factor (h^2) of the second generation of the resistant trait was inherited at a high level (i.e., 0.92 to 0.97).

Conclusions

Our research on tolerance of Uzbek and Turkish cotton varieties and lines to *V. dahliae* Klebhan indicates that the Turkish varieties Carmen and Flora offer the best germplasm to breed for tolerant varieties. We found that the F_1 hybrids of "*Verticillium dahliae* resistance" are inherited mainly as negative incomplete domination. Exception were F_1Carmen x Namangan-34 and F_1Flora x Namangan-34 with a respective positive coefficients of hp=0.85 and hp=1.02. The high heritability of trait "*Verticillium dahliae* resistance" had heritability factors that ranged between 0.92 and 0.97; this allowed selection of separate tolerant plants among the F_2 progenies.

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