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Verticillium Wilt Tolerance in Some Cotton Genotypes

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Abstract: For evaluation yield and *Verticillium* resistance in cotton, 21 genotypes were screened as Randomized Complete Block Design (RCBD) with 4 replications. Disease percent, index and severity were determinated after harvesting stage. Results showed that Sahel and smooth leaf had the most disease percent (89.56 and 92.56%, respectively) and these genotypes had the greatest infected plant. On the other hand, Sahel had the highest severity and Q29 cultivar had the lowest disease severity among test genotypes. Sahel, Smooth leaf and Gokroba had the most disease index and Q29 and Termez14 had the least disease index.

Key words: Cotton, *Verticillium*, genotype, tolerance

INTRODUCTION

Verticillium wilt is a serious disease of cotton in Iran. Control measures include cultural practices and the cultivation of regionally adapted tolerant cultivar (Moshirabadi, 1998). High tannin content is reported to be associated with *Verticillium* wilt resistance (Singh, 1998) The original selection for *Verticillium* resistance was made before 1917 (Hillocks, 1992). Cultivars that have moderate to high levels of resistance to Fusarium wilt and low to moderate levels of resistance to *Verticillium* wilt include Deltapine 20, Deltapine 50, DES199, Germain's GC-510, Stoneville 112 and Stoneville 506. In the former soviet Union, about 200 cultivars have wilt resistance derived from a single wild strain of *Gossypium hirsutum* sp. *mexicanum* var. *nerveosum*. The first and most popular of these were the Tashkent cultivars, such as Tashkent 1, Tashkent 2, etc. (Kravtsova, 1990).

Shaanxi 1155 and Liaomiao T were developed for resistance to both Fusarium and *Verticillium* wilts in China (Li and Shen, 1987).

No completely resistant forms were discovered in wild cotton species, but the species studied differed in tolerance. It was found that *G. arboreum* and *G. herbaceum* could serve as differentiators of the two races of *V. dahliae* (Alikhodzhaeva *et al*., 1980).

Forms highly resistant to physiological race 1 included *G. hirsutum* subsp. m *exicanum* var. *nervosum* and *G. hirsutum* subsp. *punctatum*. *G. tricuspidatum* subsp. *purpurascens* 02800 showed good tolerance to races 1 and 2. Forms of *G. barbadense* tolerant to several physiological races included 6465V, 9078I and 9041I. Several forms of *G. arboreum* and *G. herbaceum* were found to carry genes for resistance to race 2, which infects varieties of the Tashkent type. New physiological races have been found in the USSR, particulary the virulent races 3 and 4 (Kas Yanenko *et al*., 1978).

Resistance to *Verticillium dahliae* was studied in 135 forms of *G. arboreum* and *G. herbaceum* in field and pot experiments. Both species proved resistant to race 2, which affects *G. hirsutum* Tashkent 1 (Alyamov and Kas Yanenko, 1980).

In has been reported that, disease damage are high in north of Iran, therefore has a resistance cultivars as a practical disease management strategy. In view of this, present studies were designed to determine resistance cultivars and climate (year) effects on *Verticillum* wilt.

MATERIALS AND METHODS

Experiment was carried out in Karkandeh cotton research station (North of Iran) in 2004 and 2005. Station soil was naturally infested with *Verticillium* wilt. 21 genotypes of tetraploid cotton genotypes (*G. hirsutum* and *G. barbadense*) were evaluated for resistance to *Verticillium* wilt. The experimental traits were Randomized Complete Block Design (RCBD) With 4 replications. Every plot was fours rows, 6 m long with 80 cm between rows. Genotypes included to: Sahel, Siokra, Varamin, Q26, Q27, Q29, Bakhtegan, Red leaf okra, B-557, Sindos, 818-312, Delta pine 25, Termez14, Pak, Glandlees Stonevill, Smooth leaf, Deformeh leaf, Giza, Barbadence 5539, Gokroba and 43259.

Disease percent, index and severity determined in harvesting stage. Disease Severity (DS) and index (DI) calculated with formula (Dervis and Bicici, 2005).

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$$DS = \frac{(A\times 0)+(B\times 1)+(C\times 2)+(D\times 3)=(E\times 4)}{M}$$

Where A, B, C, D, E and M refer, respectively

A = plant No. with degree 0,
B = plant No. with degree 1,
C = plant No. with degree 2,
D = plant No. with degree 3,
E = plant No. with degree 4,
M = total plant No.

Every plant was vertically divided to 4 sections and Verticillum wilt degrees of every plant were assessed from 0 to 4 using the following degree:

0 = no vascular discolored
1 = 1-25 % of vascular tissue discolored (First section of stem plant top)
2 = 26-50% of vascular tissue discolored (First and second section of stem plant top)
3 = 51-75% of vascular tissue discolored (First, second and third section of stem plant top)
4 = 76-100% of vascular tissue discolored (Total of plant died)
DI = Disease percent × Disease severity

Data were analyzed by using of the statistical method adapted by Gomez and Gomez (Gomez and Gomes, 1984). Means were separated by Duncan's Multiple range test (DMRT) ($\alpha = 0.05$) with MSTATC computer program's.

RESULTS AND DISCUSSION

Analysis of variance was showed that disease percent was significantly different in 2004 and 2005. Results were demonstrate climate changed *Verticillium* percent and infected plant numbers were increased by favorable weather conditions. Disease severity was non significant in 2 years of experiment. Climate did not change *Verticillium* wilt severity (Table 1). Year × genotypes interaction was not significant for *Verticillium* wilt percent. All genotypes were showed reaction to year (climate) and tolerant genotypes were infected in favorite year. Year × genotypes effect was significant for *Verticillium* severity at $\alpha = 0.01$. Genotypes were infested with *Verticillium* but wilt disease severity of susceptible cultivars were increased (Table 1).

Results showed that Sahel and smooth leaf had the most disease percent (89.56 and 92.56%, respectively) and these genotypes had the greatest infected plant. The otherwise, Q29 (48.02%) had the least disease percent and was the least infected plants and 51.98% of plants were not infected in Q29 cultivar (Table 2). Sahel had the highest disease severity. The most of plants were infected to degree 3 and 4. Vascular penetration of *Verticillium* was increased in Sahel genotype. Probably, *Verticillium* fungi decreased seed cotton production (yield) (Table 2). Cultivars with moderate to high levels of resistance to *Verticillium* wilt have also been developed in several other countries: Laoyang 5, 8004, 8010 and Zhong Mien 12 in China (Shen, 1985); Sahel in Iran (Moshiabadi, 1981); and Albar G501 in Zimbawe (Hillocks, 1991).

Q29 had the lowest disease severity (0.83). Penetration *Verticillium* fungi to vascular was least and the most of plants had disease degree 1 and 2. Seedling of *Verticillium* tolerant cotton cultivar Acala 4852 were subjected to chilling at 10°C. Radicle exudates were taken after 2-5 days. Disease severity increased significantly with increase of amino acids and sugars exudation, while top dry weight deceased also significantly (Shao and Christiansen, 1982).

Sahel, Smooth leaf and Gokroba had the most disease index (201.4, 196.8 and 187.6, respectively) and were the most susceptible to wilt disease. Q29 and Termez 14 had the least disease index (50.5 and 57.2, respectively). Q29 and Termez 14 were *G. barbadence*. These genotypes were tolerance to *Verticillium* disease (Table 2). Several cultivars released in the USA have high levels of resistance to *Verticillium* wilt. These include Acala Prema, Acala Royal, Acala Maxxa, Acala 1517-91, Paymaster 147, Paymaster 303, Paymaster 404 and Delcot 344. Moderate to high levels of resistance to both *Fusarium* and *Verticillium* wilt occur in Acala Sj5, Deltapine, Acala 90 and Delcot 344 (4). The New Mexico

Table 1: Analysis of variance on *Verticillium* percent, severity, index and seed cotton (yield) in 2004 and 2005

		Mean square			
Source	df	*Verticillium* percent	*Verticillium* severity	*Verticillium* index	Seed cotton (yield)
Year	1	6604.066**	0.390Ns	2.514*	0.791**
Error	6	233.928	7.641	0.366	0.046
Genotypes	20	1370.292**	42.06**	1.289**	0.151**
Year × Genotypes	20	389.286Ns	12.473**	0.423**	0.030Ns
Error	120	235.103	5.587	0.169	0.022
CV (%)		19.93	20.87	24.30	4.30

*, ** and Ns were significant in $\alpha = 0.05$ and significant in $\alpha = 0.01$ and non significant, respectively

Table 2: Data means of *Verticillium* wilt and seed cotton separated by DMRT

Genotypes	*Verticillium* percent	*Verticillium* severity	*Verticillium* index	Seed cotton yield (kg ha^{-1})
Sahel	89.56a	1.23e-g	110.16c-e	4535a-d
Siokra	83.47ab	1.89a-c	158.3a-c	4635ab
Varamin	86.86ab	1.89a-c	164.6ab	4552a-c
Q26	64.40cd	1.59c-e	110.3c-e	1977e
Q27	85.89ab	1.97a-c	171.5ab	2162e
Q29	48.02d	0.83g	50.5f	1761e
Baktegan	74.23a-c	1.51c-e	116.4b-e	3686a-d
Red leaf okra	85.70ab	2.09ab	183.3ab	3141cd
B-557	62.36cd	1.26e-g	85.5ef	4991a
Sindos	81.65ab	1.75b-d	146.4a-d	5437a
818-312	74.10a-c	1.56c-e	119.6b-e	3851a-c
Deltapine 25	87.51ab	1.90a-c	168.7ab	3542a-d
Termez 14	47.86d	0.91fg	57.2f	4345a-c
Barbadence 5539	62.99cd	1.17e-g	83.9ef	2637de
Pak	83.49ab	1.87a-c	155.2a-c	5117a
Glanless stonevill	86.17ab	1.95a-c	168.4ab	3443a-d
Smooth leaf	92.52a	2.12ab	196.8a	4130a-c
Deformeh leaf	77.89a-c	1.73b-d	140.1a-d	3291b-d
Giza	69.55bc	1.29d-f	97.3de	3052b-d
Gokroba	86.08ab	2.16a	187.6a	4381a-c
43259	84.94ab	1.83a-c	155.4a-c	4326ab

Within columns, numbers followed by the same letter(s) are non significantly different

cotton breeding program was established in 1926 and has been led by five generations of breeders and geneticists. The program has released mor than 30 Acala 1517 cotton (*Gossypium hirsutum* L.) cultivars and numerous germplasm lines known for high fiber quality and *Verticillium* wilt (caused by *Verticillium dahliae* Kleb.) (Zhang *et al*., 2005).

The tolerant cultivar Acala SJC-1 was crossed to more susceptible parents, breeding line S5971 and cultivars Acala 4-42 and Deltapine 70. Seven generations were evaluated for each crosses: the two parents (P1 and P2), F1, F2, F3 and reciprocal backcrosses (B1 and B2). The genetic control of tolerance in these crosses appears to involve more than on gene, based on an unsatisfactory fit to expected phenotypic distributions for the generations under a single-locus model. An analysis of generation means indicated that pooled additive and pooled dominance effects over loci were adequate to explain the variation among generations for crosses of SJC-1×S5971 and SJC-1×DPL70. Tolerance in these crosses appeared to be controlled by recessive factors. For the SJC-1×4-42 cross, an adequate fit to a digenetic epistatic model was not possible and none of the genetic parameters except the F2 mean were significant (Devey and Roose, 1987).

B-557, Sindos and Pak (4991, 5437 and 5117 kg ha^{-1} respectively) were recorded the highest yield. Q26, Q27 and Q29 had the least yield too. A brief account is given of the genetics of resistance in various *Gossypium* species. The selection MCUWT, with tolerance to 10% wilt, has been selected from the highly productive but susceptible variety MCU (Srinivasan *et al*., 1981).

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