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DETERIORATION IN COTTON FIBERS CAUSED BY SOME CELLULOSE-DEGRADING FUNGI

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ABSTRACT

Deterioration in fibers of the cotton cultivars Giza 80, Giza 85, Giza 86, Giza 89 and Giza 90 (long staple), and Giza 88 (extra long staple) caused by *Alternaria* sp., *Fusarium semitectum, Trichothecium* sp. *Penicillium* sp., *Trichoderma* sp. *Rhizopus*, *Aspergillus flavus*, *Cladosporium herbarum*, *F. monoliforme*, and *Nigrospora* sp. Was evaluated under pure culture conditions. The tested properties were upper half mean, uniformity index, short fiber index, Brightness, Yellowness, trash no., maturity, micronaire value, fiber strength, elongation, cellulose, reducing sugar content, and fiber damage index. Cultivars, fungi, and cultivars × fungi interaction were all very highly significant sources of variation in all the tested properties. Cultivars were the most important source of variation in most of the tested properties. Due to the significance of the cultivars × fungi interaction, a least significant difference (LSD) was used to compare the individual fungal means within cultivars for each of the tested properties. These comparisons showed that most of the tested properties tended to decline as a result of fungal infection; however, the magnitude of decline varied from one cultivar to another. The present study clearly demonstrated that cotton cultivars were much more important than fungal isolates in determining the level of deterioration in most of the tested properties. This result implies that the deleterious effects of the cellulose-degrading fungi on quality of fibers could be considerably reduced if resistant of cotton cultivars to these fungi is effectively enhanced.

INTRODUCTION

Many of the fungi associated with lint contamination are capable of producing cellulolytic enzymes in sufficient quantity to degrade cotton fibers if they are able to grow on the seedcotton for long enough. The most efficient cellulose degradets are *Alternaria* spp., *Curvularia*, *Fusarium moniliforme* and *Glomerella* species isolated from cotton bolls. Most species of *Aspergillus*, including *A. niger*, are poor cellulose degraders. It should be noted however, that there is considerable variation with respect to production of cellulolytic enzymes between species of the same genus and, indeed, among isolates of the same species (Hillocks, 1992).

Fungal microflora associated with deterioration of cotton fibers are classified into two groups: field and storage fungi. Field fungi usually invade the maturing seed cotton on the developing plants in the field before harvest of bolls. These fungi require a moisture content in equilibrium with a relative humidity of more than 90 % to grow. The storage fungi are those that grow on stored lint. Most of them are able to grow without free water, and on media with high osmotic pressure (Amer, 1986).

Under proper invironmental conditions, cellulose degrading fungi may lower substantially the quality of cotton fibers. For example, Badr (1980) studied the effect of infection with rhizopus nigricans, Aspergillus niger and Fusarium oxysporum f.sp. vasinfectum on fiber properties of some Egyptian cotton varieties. She found that all the tested fungi affected fiber tensile strength and elongation at 1/8 inch gauge length, stiffness, and toughness causing substantial losses, which varied from one fungus to another. She also reported that all fiber damage index values of the infected fibers significantly increased than those of the control. in most cases, pH aqueous extracts of infected fibers tended to increase. A highly significant increase in reducing sugars content was also observed. Rao *et al*. (1989) reported that properties of cotton fibers such as length, strength, fineness, and maturity were adversely affected by high investations of whitefly and sooty mold. Abd El-Rehim *et al.* (1993) evaluated deterioration in cotton fibers of Giza 75 cv. Caused by *Nigrospors, Aspergillus, Fusarium, Alternaria, Rhizopus, Trichothecium, Cladosporium,* and *Penicillium*. Floating fiber index and number of neps tended to increase as a result of fungal infection, micronair reading showed no change, the other properties tended to decrease. Within each of the tested properties, except the micronair reading, the observed magnitude of change varied from one fungus to another;however, none of the tested fungi was able to affect all properties. Abd El-Rahim *et al*. (2001) evaluated deterioration in quality of Giza 86 cv. Caused by the sooty mold (SM) fungus *Cladosporium herbacium* (CH) under field conditions in 14 samples, obtained from 7 different locations in 4 governorates. They found that all fiber length parameters were highly affected by SM incidence. Micronaire reading was significantly decreased as a result of SM incidence in all locations. CH caused significant decrease in maturity ratio in all the tested locations. Hair weight was adversely affected by CH in all the tested locations. CH significantly reduced fiber strength in all the tested locations. All chemical properties significantly increased as a consequence of CH infection. However, the greatest magnitude of increase was observed in the case of fiber damage index.

In the present study, we reported on the deterioration effects of 10 cellulose-degrading fungi on physical, mechanical, and chemical properties of 6 cotton cultivars under pure cultural conditions.

MATERIALS AND METHODS

Fungal isolates

Isolates of fungi used in this study (Table 1) were isolated, purified, and identified at Cotton Pathology Lab., Plant Path. Res. Inst., Agric. Res. Cent., Giza, Egypt.

Inoculation of cotton fibers

Substrate for growth of fungal isolates was prepared in 500-ml glass bottles, each bottle contained 10 g of cotton fibers to which 20ml of tap water was added. The bottles were autoclaved for 30 minutes, and the fungal inocula, taken from one-week old cultures grown on potato dextrose agar, were aseptically introduced into the bottles and allowed to colonize fibers for 3 weeks at 26±3°C. the uninoculated controls were autoclaved for 30 minutes.

Congo red test

The Congo red test was achieved according to the method of Celegg(1940). Sample of cotton fibers (which contained about 100 fibers) . was drawn on a glass side and immersed in a solution of 11 % caustic soda for 3 min., then washed for several times with distilled water. A drop of Congo red solution (0.19% in 95% ethyl alcohol) was placed on the fibers and left for 10 min. at room temperature, followed by washing with water for several times. A drop of 18 % caustic soda solution was again placed on the fiber and left for few sec. for swelling fibers , then microscopically examined (G208 projection microscope was used according to ASTM: D 2130-1986)

and sorted into four classes according to the degree of damage as follows :

0= Non deteriorated fibers , were indicated by appearance pink color.

1= Slightly deteriorated fibers, were appeared with several celluloid spiral lines.

2=moderately deteriorated fibers, which regularly appeared with red color.

3= severally deteriorated fibers which appeared with several red colored sloughing off parts.

The fibers damage index was calculated as follows :

$$\frac{\text{Total numbers of damage fibers (classes 1+2+3)}}{\text{Total number of tested fibers}} \times 100$$

Fiber physical properties

Micronaire value, and fiber maturity ratio were determined using Micromate instrument according to (ASTM: D3818-) While, Spain Lab 900B HVI instrument system was used to determine fiber length, fiber uniformity Index,short fiber index, fiber reflectance percentage (Rd%), fiber yellowness degree (+b), fiber strength and fiber elongation according to ASTM : D4605-1986 .

Fiber chemical properties

1- Fiber cellulosic materials content:

Cellulosic materials % in cotton fiber was determined according to the methods described by Jenkis (1930).

2- Fiber reducing Sugar content:

Reducing Sugar content in cotton fiber was determined by using Soxhlet extraction according to the methods of Smith (1956).

3- Total wax content of fiber:

Total wax content was determined according to the methode described by Conrad (1944).

All tests were performed at the laboratories of Cotton Research institute, Agricultural Research Center, under constant conditions of temperature. (20 $\pm$ 2 ^{0}c) and (65% $\pm$ 5%) of relative humidity.

Statistical analysis of the data

A completely randomized block design with three replicates was used in the present study. The least significant difference (LSD) was applied for comparing treatment means. Analysis of variance (ANOVA) of the data was performed with the MSTAT-C statistical package.

Table 1. Fungi used in the study.

No.	Fungus	Geographic origin
1	*Altrernarid sp*	**Giza**
2	*Fusarium semitectum*	**Daqahlia**
3	*Trichothecium sp.*	**Sharqiya**
4	*Penicillium sp*	**Sohag**
5	*Trichoderma sp*	**Assiute**
6	*Rhizopus sp*	**Giza**
7	*Aspergillus flavus*	**Gharbiya**
8	*Cladosporium herbarum*	**Beheira**
9	*Fusarium moniliforme*	**Daqahliya**
10	*Nigrospora sp*	**Sharqiya**

RESULTS AND DISCUSSION

In the present study, 10 cellulose-degrading fungi (Table1) were used to inoculate fibers of 6 Egyptian commercial cotton cultivars. These cultivars were chosen because they are differing in fiber quality. Giza 88 belongs to the extra long staple category, while the remaining cultivars belong to the long staple category.

ANOVA of Table 2 showed very highly significant effects of cultivars, fungi, and cultivars × fungi interaction on fiber length parameters. Cultivars were the first in importance as a source of variation in upper half mean and short fiber index. Fungi were the most important source of variation in uniformity index. Cultivars and cultivars × fungi interaction were almost equally important as sources of variation in uniformity index (Table 3). The very highly significant interaction of cultivars × fungi for all the tested properties (Table 2) indicated that cultivars responded differently to fungi regardless of the tested property. Due to the significance of this interaction, a least significant difference (LSD) was used to compare the individual fungal means within cultivars for each of the tested properties.

Table 2. Analysis of variance of the effect of some cellulose-degrading fungi on fiber length parameters of six Egyptian cotton cultivars.

Parameters and source of variation	D.F	M.S	F. values	P> F
Upper half mean (mm)				
Replications	2	0.021	0.0989	
Cultivars (C)	5	164.649	772.9187	0.0000
Fungi (F)	10	34.924	163.9437	0.0000
C x F	50	4.685	21.9922	0.0000
Error	130	0.213		
Uniformity Index (%)				
Replications	2	5.329	7.1987	
Cultivars (C)	5	174.399	235.6027	0.0000
Fungi (F)	10	161.841	218.6371	0.0000
C x F	50	17.937	24.2313	0.0000
Error	130	0.740		
Short Fiber Index				
Replications	2	54.874	12.4895	
Cultivars (C)	5	2138.739	486.7829	0.0000
Fungi (F)	10	866.824	1972916	0.0000
C x F	50	117.409	26.7226	0.0000
Error	130	4.394		

Table 3. Relative contribution of fungi, cotton cultivar, and their interaction to variation in fiber length parameters.

Source of variation	Relative contribution to variation in [a]		
	Upper half mean (mm)	Uniformity Index (%)	Short Fiber Index
Cultivars (C)	58.52	25.66	42.20
Fungi (F)	24.83	47.63	34.21
C x F	16.65	26.39	23.15

[a] Calculated as percentage of sum of squares of the explained (model) Variation.

These comparisons showed that the upper half mean of all cultivars significantly decreased as a result of fungal infection (Table 4); however, the upper half mean of Giza 86 and Giza 88 were notable exceptions because they were resistant to infection with *A. flavus*. Uniformity index of all cultivars significantly increased by all fungi. Short fiber indexes of Giza 80 and Giza 88 were not affected by *A. flavus* and *F. semitectum* respectively. Also, Giza 89 was not affected by *Penicillium* sp., *Trichoderma* sp., and *A. flavus* short fiber index of all the remaining cultivars significantly increased due to fungal infection. The observed decline in the fiber length parameters could be attributed to the deleterious effects of cellulolytic enzymes produced by the fungi. These enzymes weaken the fibers, which become more susceptible to breakage during testing the fiber length. Consequently, the short fiber content increases. These results are in harmony with those of Abd El-Rehim *et al.* (1993) and Mahmoud (1996).

Cultivars, fungi, and cultivars × fungi were all very highly significant sources of variation in brightness, yellowness, and trash no. (Table 5). Cultivars were the most important source of variation in brightness and trash no., while isolates were the most important source of variation in yellowness (Table 6). Brightness of Giza 80, Giza 85, Giza 86, Giza 88 and Giza 90 was significantly reduced by all the fungi (Table 7). However, brightness of Giza 89 showed variable responses to fungal infection. Thus, *F. semitectum, Penicillium* sp., *Trichoderma* sp., *Nigrospors* sp., significantly increased it, while *Alternaria* sp., *Trichothecium* sp., *Rhizopus* sp., *Cladosporium herbarium* and *F. moniliforme* had no effect. On the other hand, *A. flavus* was the only fungus, which reduced it. *Trichoderma* sp., did not effect yellowness of Giza 80, while the remaining fungi sifnificantly increased it. yellowness of Giza 85, Giza 86, Giza 88 and Giza 90 increased by all the tested fungi. *Trichothecium* sp., *Cladosporium herbarium* and *F. moniliforme* did not affect yellowness of Giza 89, while other fungi decreased it. The decrease in brightness as well as the increase in yellowness could be accounted for by the production of pigments by fungi; however, it is difficult to account for the increase in brightness and the decrease in yellowness in Giza 89 under the effects of some of the tested fungi. As to trash no., the responses of the cultivars to fungal infection were too variable to draw meaningful conclusions.

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Table 5. Analysis of variance of the effect of some cellulose-degrading fungi on fiber brightness (Rd %), yellowness (+b)and trash no. of six Egyptian cotton cultivars.

Parameters and source of variation	D.F	M.S	F. values	P> F
Brightness (Rd %)				
Replications	2	1.203	1.2438	0.2917
Cultivars (C)	5	638.481	659.9382	0.0000
Fungi (F)	10	204.152	211.0128	0.0000
C x F	50	32.519	33.6118	0.0000
Error	130	0.967		
Yellowness (+b)				
Replications	2	0.079	1.2910	0.2785
Cultivars (C)	5	18.698	306.1839	0.0000
Fungi (F)	10	29.025	475.2842	0.0000
C x F	50	2.769	45.3361	0.0000
Error	130	0.061		
Trash no.				
Replications	2	2.399	0.3013	
Cultivars (C)	5	3384.784	425.0590	0.0000
Fungi (F)	10	139.444	17.5113	0.0000
C x F	50	195.864	24.5965	0.0000
Error	130	7.963		

Table 6. Relative contribution of fungi, cotton cultivar, and their interaction to variation in fiber brightness (Rd %), yellowness (+b)and trash no.

Source of variation	Relative contribution to variation in [a]		
	Brightness (Rd)%	Yellowness (+b)	Trash no.
Cultivars (C)	46.52	17.90	60.19
Fungi (F)	29.45	55.57	4.96
C x F	23.69	26.50	34.83

[a] **Calculated as percentage of sum of squares of the explained (model) Variation.**

Cultivars, fungi, and cultivars × fungi interaction were all very highly significant source of variation in maturity, micronaire value, strength, and elongation (Table 8). Cultivars were the most important source of variation in maturity and micronaire value, isolates were the most important source of variation in strength, and the interaction was the most important source of variation in elongation (Table 9). Maturity of Giza 80 and Giza 85 showed variable responses to fungal infection, while maturity of all remaining cultivars was reduced by all the fungi except that of Giza 89, which was not affected by *A. flavus* (Table 10). All the tested fungi significantly reduced the micronaire value of all the cultivars except *Trichothecium* sp., which did not affect micronaire value of Giza 86 and *A. flavus* which did not affect micronaire value of Giza 80, Giza 85, and Giza 89. Fiber strength of all the cultivars was significantly reduced by all the fungi (Table 11).

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Elongation of Giza 88 was not affected by any fungus, while that of Giza 90 was significantly reduced by all the fungi. Elongation of the other cultivars showed variable responses. The decrease in fiber strength could be ascribed to the deleterious effects of cellulolytic enzymes secreted by the fungi, these enzymes attack the amorphous regions of cellulose, which are located between the crystalline regions. Thus, weak point occur in fiber structure. The deterioration in fiber strength by the fungi is coincided with that previously reported by Abd El-Rehim *et al.* (1993) and Mahmoud (1996).

Table 8. Analysis of variance of the effect of some cellulose-degrading fungi on fiber maturity % , micronaire value and fiber mechanical properties of six Egyptian cotton cultivars.

Parameters and source of variation	D.F	M.S	F. values	P> F
Maturity %				
Replications	2	0.000	5.5418	0.0826
Cultivars (C)	5	0.009	91.9685	0.0000
Fungi (F)	10	0.007	77.7982	0.0000
C x F	50	0.002	20.456	0.0000
Error	130	0.000		
Micronaire value				
Replications	2	0.013	2.2166	
Cultivars (C)	5	1.609	272.6799	0.0000
Fungi (F)	10	0.046	7.8608	0.0000
C x F	50	0.087	14.7170	0.0000
Error	130	0.006		
Fiber Strength				
Replications	2	0.737		
Cultivars (C)	5	297.950	0.9764	0.0000
Fungi (F)	10	334.811	394.6204	0.0000
C x F	50	25.864	443.4412	0.0000
Error	130	0.755	34.2551	
Elongation %				
Replications	2	0.001	0.0199	
Cultivars (C)	5	3.336	50.7882	0.0000
Fungi (F)	10	0.940	14.7931	0.0000
C x F	50	0.387	6.0926	0.0000
Error	130	0.064		

Table 9. Relative contribution of fungi ,cotton cultivar , and their interaction to variation in fiber maturity % , micronaire value and fiber mechanical properties.

Source of variation	Relative contribution to variation in [a]			
	Maturity %	Micronaire value	Fiber Strength	Elongation %
Cultivars (C)	62.47	62.46	24.28	35.94
Fungi (F)	3.60	3.57	54.60	20.94
C x F	33.71	33.77	21.09	43.12

[a] Calculated as percentage of sum of squares of the explained (model) Variation.

Table 10. Effects of some cellulose-degrading fungi on Maturity % and micronaire value

Fungus [a]	Cultivars											
	Maturity %						Micronaire value					
	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90
1	0.85	0.81	0.85	0.86	0.85	0.82	4.00	3.47	4.10	3.55	4.00	3.70
2	0.87	0.83	0.88	0.86	0.83	0.82	4.20	3.60	4.11	3.65	4.00	3.73
3	0.85	0.81	0.85	0.84	0.91	0.82	3.90	3.63	4.30	3.40	3.87	3.77
4	0.89	0.83	0.87	0.87	0.90	0.81	4.05	3.50	4.05	3.65	4.17	3.63
5	0.85	0.83	0.85	0.82	0.81	0.81	4.05	3.53	3.85	3.70	4.30	3.77
6	0.83	0.84	0.86	0.82	0.87	0.83	4.00	3.77	3.95	3.65	4.15	3.73
7	0.89	0.85	0.88	0.93	0.96	0.85	4.35	3.79	4.16	3.78	4.50	3.78
8	0.82	0.81	0.86	0.84	0.84	0.80	3.85	3.57	4.03	3.60	4.03	3.60
9	0.82	0.80	0.84	0.80	0.83	0.80	3.80	3.57	3.82	3.55	3.83	3.63
10	0.84	0.82	0.85	0.93	0.85	0.81	3.85	3.50	3.90	3.75	4.17	3.63
Cont	0.87	0.92	0.93	0.88	0.96	0.89	4.45	3.90	4.30	4.05	4.53	3.97
LSD for fungus(F) x Cultivar (C) (p<0.05)=0.015 LSD for fungus(F) x Cultivar (C) (p<0.01)= 0.021							LSD for fungus(F) x Cultivar (C) (p<0.05)= 0.13 LSD for fungus(F) x Cultivar (C) (p<0.01)= 0.17					

[a] **Identification of fungi is shown in Table 1**

Table 11.Effects of some cellulose-degrading fungi on mechanical properties

Fungus [a]	Cultivars											
	Fiber Strength						Elongation %					
	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90
1	22.70	21.93	24.30	30.25	25.20	22.2	6.60	7.17	6.55	6.15	6.80	7.13
2	25.25	22.37	30.02	33.85	26.80	20.2	6.90	7.77	6.17	6.40	6.50	6.70
3	20.27	20.53	25.85	27.10	22.37	20.38	6.50	6.40	6.40	6.35	7.10	6.50
4	29.60	21.60	26.95	27.73	29.22	20.00	7.55	6.93	6.00	6.25	7.90	6.73
5	24.73	22.70	26.82	33.03	32.47	20.00	7.55	6.50	6.55	6.15	6.97	6.60
6	20.60	23.30	26.70	22.95	21.70	18.60	6.45	6.53	6.50	6.30	6.17	6.77
7	26.90	27.17	33.20	29.35	33.40	19.73	7.15	7.70	6.50	6.65	7.80	6.97
8	20.15	23.93	29.35	25.25	23.23	25.50	6.65	6.37	6.15	6.00	6.73	6.47
9	19.95	20.10	25.82	18.55	19.07	18.80	6.85	6.17	6.48	6.00	6.00	6.83
10	26.67	21.17	25.40	29.95	24.43	18.33	6.75	6.97	6.40	6.00	6.43	6.57
Cont	38.40	39.88	39.57	46.75	37.47	39.30	7.07	7.30	6.45	6.25	7.73	7.63
LSD for fungus(F) x Cultivar (C) (p<0.05)= 1.40 LSD for fungus(F) x Cultivar (C) (p<0.01)= 1.86							LSD for fungus(F) x Cultivar (C) (p<0.05)= 0.41 LSD for fungus(F) x Cultivar (C) (p<0.01)= 0.54					

[a] **Identification of fungi is shown in Table 1**

ANOVA of Table 12 showed very highly significant effects of cultivars, fungi, and cultivars × fungi interaction on cellulose, reducing sugar, and damage index. Cultivars were the most important source of variation in reducing sugar. Fungi and the interaction were almost equally important as sources of variation in damage index (Table 13).

Table 12. Analysis of variance of the effect of some cellulose-degrading fungi on fiber chemical properties and fiber damage index of six Egyptian cotton cultivars.

Parameters and source of variation	D.F	M.S	F. values	P> F
Cellulose %				
Replications	2	0.087	0.2344	
Cultivars (C)	5	268.169	725.1134	0.0000
Fungi (F)	10	16.179	43.7468	0.0000
C x F	50	7.252	19.6087	0.0000
Error	130	0.370		
Reducing sugar content %				
Replications	2	0.000	1.1635	0.3156
Cultivars (C)	5	0.001	27.5695	0.0000
Fungi (F)	10	0.009	197.8962	0.0000
C x F	50	0.003	67.1382	0.0000
Error	130	0.000		
Fiber damage Index				
Replications	2	6.173	0.6006	
Cultivars (C)	5	501.201	48.7693	0.0000
Fungi (F)	10	5414.013	526.8101	0.0000
C x F	50	1039.424	101.1411	0.0000
Error	130	10.277		

Table 13. Relative contribution of fungi ,cotton cultivar , and their interaction to variation in fiber chemical properties and damage index.

Source of variation	Relative contribution to variation in [a]		
	Cellulose %	Reducing sugar content %	Fiber damage Index
Cultivars (C)	71.88	2.54	2.31
Fungi (F)	8.67	36.02	49.84
C x F	19.44	61.44	47.84

[a] Calculated as percentage of sum of squares of the explained (model) Variation.

The fungi significantly decreased cellulose and increased each of reducing sugar and damage index. However, *F. moniliforme* was a notable exception because it significantly decresed reducing sugar of Giza 85 (Table 14).

It is believed that fungi decompose cellulose by a three-enzyme system. The first endo- 1,4-B-D glucanase (EC 3.2.1.4) randomly cleaves internal glucosidic bonds within unbroken glucan chain. The exposed non reducing chain ends become substrate for 1, 4-B-D- glucan cellobiohydrolase (EC 3.2.1.91), which cleaves the cellobiose dimmers from the chain releasing them into the environment. The hydrolysis of cellobiose to glucose is accomplished by B-glucosidase (EC 3.2.1.21) (Goodman *et al.* 1986). Therefore, the increase in reducing sugar content could be ascribed to the decomposition of fiber cellulose to glucose. The increase in damage index suggests that the fungi caused breaks in the primary wall of the fiber.

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Thus, only the interior of the fiber became more accessible for staining with congo red stain. Therefore, the amount of this stain in the fiber is an indication for the degree of deterioration (Abd El-Rehim and Aly, 1999).

The present study clearly demonstrated that cotton cultivars were much more important than fungal isolates in determining the level of deterioration in most of the tested properties. This result implies that the deleterious effects of the cellulose-degrading fungi on quality of fibers could be considerably reduced if resistance of cotton cultivars to these fungi is effectively enhanced.

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التدهور في ألياف القطن الناجم عن الإصابة ببعض الفطريات المحللة للسليولوز

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لقحت ألياف القطن لأصناف جيزة ٨٠ و جيزة ٨٥ و جيزة ٨٦ و جيزة ٨٩ و جيزة ٩٠ (تيلة طويلة) و جيزة ٨٨ (تيلة فائقة الطول) بعشرة فطريات محللة للسليولوز، وذلك تحت ظروف المعمل. قيم التدهور في صفات الألياف –الناجم عن نشاط هذه الفطريات- من خلال دراسة التغيرات التي طرأت على الصفات التالية: طول التيلة و معدل انتظام الطول ونسبة الشعيرات القصيرة ودرجة انعكاس الضوء ودرجة الاصفرار ونسبة العادم ونسبة النضج وقراءة الميكرونيتر ومتانة التيلة والنسبة المئوية للاستطالة ونسبة السليولوز والمحتوى من السكريات المختزلة و معدل تدهور الألياف. كانت الأصناف والفطريات وتفاعل الأصناف × الفطريات مصادر عالية المعنوية للتباين في جميع الصفات موضع الدراسة . نظراً لمعنوية تفاعل الأصناف × الفطريات فإن أقل فرق معنوي استعمل لمقارنة تأثير الفطريات على كل صنف ، وذلك لكل صفة . أظهرت هذه المقارنات أن أغلب الصفات كانت تميل إلى التدهور بتأثير الإصابة الفطرية ، إلا أن حجم هذا التدهور اختلف من صنف لآخر. تدل نتائج الدراسة الحالية على أن أصناف القطن أهم بكثير من عزلات الفطر –كمصدر للتباين في أغلب الصفات موضع الدراسة- وعلى ذلك فإن التدهور في صفات الجودة بالتيلة – الناجم عن الإصابة بهذه الفطريات – يمكن الحد منه بدرجة ملحوظة عن طريق زيادة مستوى مقاومة الأصناف لهذه الفطريات.

Table 4. Effects of some cellulose-degrading fungi on fiber length parameters of six Egyptian cotton cultivars.

Fungus [a]	Cultivars																	
	Upper half mean (mm)						Uniformity Index (%)						Short Fiber Index					
	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90
1	24.45	24.30	28.35	30.20	26.63	22.20	70.45	74.90	77.35	76.20	77.40	69.60	38.83	40.57	29.20	26.30	27.50	50.43
2	26.60	24.70	29.05	31.50	27.43	23.33	75.50	74.63	78.93	81.20	77.50	69.07	32.20	36.80	23.53	14.43	27.13	51.93
3	26.25	23.90	27.03	25.50	24.33	22.50	76.65	72.67	75.42	73.42	70.73	69.80	32.27	45.90	33.10	36.40	42.77	50.60
4	28.20	23.80	28.65	28.73	28.27	21.67	79.93	73.10	75.80	77.20	82.07	72.27	25.30	44.07	26.20	20.57	19.23	47.70
5	24.45	24.57	29.40	26.88	29.13	22.67	70.23	73.13	77.50	76.97	80.20	69.93	44.37	41.53	25.20	22.63	18.77	50.43
6	24.45	25.53	29.80	28.50	25.33	23.10	70.67	74.77	77.70	74.75	72.90	70.13	41.85	36.50	25.10	28.17	23.40	51.50
7	28.50	26.03	31.10	31.90	28.50	26.07	79.97	76.10	80.27	80.40	80.30	78.50	20.70	31.87	18.93	18.70	21.30	29.00
8	24.10	23.60	30.60	26.50	26.00	23.30	68.35	71.60	78.67	76.60	75.70	70.17	49.50	45.87	22.70	37.60	31.63	50.00
9	23.55	26.03	27.00	29.30	24.93	23.87	70.02	74.57	77.70	74.65	74.27	71.73	51.10	33.63	32.73	28.93	23.83	43.67
10	25.90	24.07	27.65	29.90	27.40	23.60	76.52	72.50	75.78	76.60	77.87	73.03	35.70	44.80	33.00	24.87	28.77	42.70
Cont.	29.05	30.60	30.60	32.60	34.17	27.30	86.68	85.93	85.20	86.80	84.00	84.70	17.93	10.83	12.33	14.93	19.33	19.93
LSD for fungus(F) x Cultivar (C) (p<0.05)= 0.75 LSD for fungus(F) x Cultivar (C) (p<0.01) = 0.99							LSD for fungus(F) x Cultivar (C) (p<0.05)= 1.39 LSD for fungus(F) x Cultivar (C) (p<0.01)= 1.84						LSD for fungus(F) x Cultivar (C) (p<0.05)= 3.39 LSD for fungus(F) x Cultivar (C) (p<0.01)= 4.47					

[a] **Identification of fungi is shown in Table 1**

Table 7. Effects of some cellulose-degrading fungi on fiber color and trash no. of six Egyptian cotton cultivars.

Fungus [a]	Cultivars																	
	Brightness (Rd %)						Yellowness (+b)						Trash no.					
	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90
1	52.75	64.00	64.00	55.30	62.47	57.13	17.80	16.30	15.45	16.80	14.80	17.43	89.33	9.00	14.00	6.67	3.67	16.67
2	53.25	62.73	66.60	57.90	66.27	55.97	17.50	17.03	15.60	15.90	13.13	17.83	39.33	11.33	15.67	10.67	5.67	6.00
3	53.25	62.32	65.40	55.50	62.40	58.47	17.20	15.77	15.65	15.70	15.07	16.23	49.00	10.00	5.00	7.67	4.67	16.00
4	57.70	63.07	64.10	55.50	63.33	56.50	14.75	16.43	15.10	15.75	14.77	16.47	39.00	8.33	14.00	11.67	7.33	9.00
5	52.80	63.93	59.70	58.15	66.73	54.67	14.40	14.93	16.45	15.40	14.37	16.63	28.00	11.67	9.00	7.00	6.00	14.00
6	54.20	64.87	60.85	53.75	61.00	57.27	17.55	15.83	16.55	17.20	14.10	16.90	21.67	13.67	13.33	9.67	9.33	16.0
7	52.25	62.43	59.95	47.80	59.20	55.13	15.50	14.30	13.85	14.45	13.77	14.53	12.00	16.33	15.33	21.67	12.67	13.67
8	52.65	61.13	56.35	54.45	62.13	55.67	17.25	15.93	16.65	17.60	15.73	16.93	48.00	6.00	12.90	20.00	12.67	15.00
9	50.55	64.90	61.45	55.05	62.47	53.63	17.10	15.07	16.35	16.40	15.60	17.60	22.00	9.67	12.33	15.00	6.67	21.00
10	51.10	61.33	60.15	53.52	62.83	56.27	17.50	15.83	15.40	15.95	13.90	15.67	60.33	7.33	15.67	20.00	6.33	10.00
Cont	67.57	81.00	77.30	62.90	60.93	68.60	14.30	9.77	10.50	10.75	15.43	13.03	22.33	15.33	6.33	7.00	21.00	5.00
LSD for fungus(F) x Cultivar (C) (p<0.05)= 1.59							LSD for fungus(F) x Cultivar (C) (p<0.05)= 0.40						LSD for fungus(F) x Cultivar (C) (p<0.05)= 4.56					
LSD for fungus(F) x Cultivar (C) (p<0.01)= 2.10							LSD for fungus(F) x Cultivar (C) (p<0.01)= 0.53						LSD for fungus(F) x Cultivar (C) (p<0.01)= 6.02					

[a] **Identification of fungi is shown in Table 1**

Table 14. Effects of some cellulose-degrading fungi on fiber and of six Egyptian cotton cultivars.

Fungus [a]	Cultivars																	
	Cellulose %						Reducing sugar content %						Fiber damage Index					
	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90	G80	G85	G86	G88	G89	G90
1	80.40	81.41	86.42	85.55	81.50	80.13	0.30	0.27	0.24	0.27	0.26	0.26	47.27	87.30	70.40	79.37	50.23	70.50
2	81.60	85.70	88.12	85.83	83.75	80.71	0.25	0.24	0.27	0.27	0.25	0.27	59.37	48.77	54.60	55.63	59.07	58.60
3	81.53	82.22	89.00	86.30	82.00	80.20	0.25	0.26	0.23	0.23	0.25	0.26	59.00	52.57	83.33	85.17	70.80	49.93
4	81.15	81.17	85.70	86.00	81.00	81.40	0.25	0.23	0.24	0.24	0.27	0.27	79.27	38.13	33.63	70.50	39.33	68.10
5	81.44	81.40	86.61	87.96	81.86	80.50	0.24	0.26	0.27	0.26	0.24	0.21	71.26	83.50	33.30	86.87	70.20	72.90
6	80.89	81.21	89.00	85.40	88.54	80.70	0.21	0.22	0.29	0.27	0.25	0.20	76.83	59.03	46.37	88.77	74.77	72.27
7	83.10	86.37	89.45	88.26	89.00	81.81	0.20	0.19	0.22	0.23	0.25	0.22	34.63	17.00	30.00	29.91	36.37	36.47
8	81.06	81.73	87.80	85.40	84.15	76.90	0.26	0.25	0.26	0.23	0.24	0.24	83.03	54.23	76.87	53.93	43.30	69.93
9	80.63	82.51	85.64	87.23	79.00	80.00	0.26	0.11	0.26	0.25	0.25	0.21	70.53	94.47	90.40	88.88	70.74	76.60
10	80.03	79.38	83.00	85.00	82.00	78.00	0.27	0.27	0.29	0.28	0.28	0.28	89.03	65.53	70.30	35.23	37.70	58.83
Cont	95.00	96.00	89.33	98.00	95.00	93.00	0.11	0.12	0.11	0.10	0.11	0.12	13.00	6.50	7.60	8.43	9.53	11.73
LSD for fungus(F) x Cultivar (C) (p<0.05)= 0.98 LSD for fungus(F) x Cultivar (C) (p<0.01)= 1.30							LSD for fungus(F) x Cultivar (C) (p<0.05)= 0.010 LSD for fungus(F) x Cultivar (C) (p<0.01)= 0.014						LSD for fungus(F) x Cultivar (C) (p<0.05)= 5.18 LSD for fungus(F) x Cultivar (C) (p<0.01)= 6.84					

[a] **Identification of fungi is shown in Table 1**