



Degree of *Verticillium* Wilt Infection and the Relative Damage in Fiber Quality Parameters

U.E. Kechagia and F.P. Xanthopoulos

National Agricultural Research Foundation

Cotton and Industrial Plants Institute, 57400 Sindos, Thessaloniki.

ABSTRACT

Verticillium wilt is a major problem in many cotton producing countries. In addition to causing big losses in yield, deterioration in fiber quality affects the commercial value of cotton. This study was undertaken to determine the damage caused in fiber quality characters by various degrees of Verticillium wilt infection. Four commercial cotton cultivars (G. hirsutum), varying in earliness and vulnerability to the pathogen, were used. Based on visual symptoms the degree (level) of infection ranged from 0 to 4. Eleven representative plants from each infection level and from each cultivar under study, were labelled and their product was bulked, ginned and evaluated for most fiber properties. Fiber length parameters were the least affected, except for the short fiber content (SFC) which was nearly doubled in the highest level. Micronaire deterioration was highly depended on the cultivar, while maturity was significantly decreased from 0 to 4 degree in all cultivars. Immature fiber content (IFC) increased and fineness decreased mainly in the highest two degrees. Fiber neps were dramatically increased in the highest degree but nevertheless cultivar plays an important role too. The same applies for trash and seed coat neps. The general conclusion is that fiber damage in the wilted plants was analogous to the severity of infection. Thus fibers from the higher degree are unsuitable as spinning raw material because they are below spinnable limits in all cultivars. In the lower degrees, fiber damage depends on the cultivar.

Introduction

Verticillium wilt is the most serious disease and a major problem in most cotton producing countries. In addition to its detrimental effect on yield, severe wilt infection causes significant deterioration in fiber quality that, in turn, decreases its commercial value and spinning efficiency. Severe wilt infection increases the percentage of immature fibers and decreases fiber length and length uniformity, as well as strength and grade. Furthermore the spinability of wilted fibers is very poor and the yarns produced are inferior in grade and appearance while the number of neps and the amount of manufacturing waste are considerably higher (Bell, 1994).

No single method is effective in controlling the disease but an integrated management system is necessary to minimize losses (El-Zik, 1985). The selection of resistant or tolerant cultivars (Shen, 1985) and the application appropriate cultural practices are recommended to control the disease.

Resistance to the pathogen in the field is expressed by a delay in the onset of visual symptoms, a lower rate in disease progress and a decrease in the severity of damage caused (Bell, 1994). Resistant cultivars have a restricted number of plants with foliar symptoms as well as a lower percentage of total loss (Verhalen *et al.*, 1971; Wilhelm *et al.*, 1974).

Based on visual symptoms, *Verticillium wilt* infection in respective degrees or levels can readily be

distinguish. Four degrees are usually adequate to describe the severity of the disease (Cotton Research Institute, Greece).

The aim of this study is to determine the impact of progressive *Verticillium* infection on fiber quality and the relationship between the damage caused and the severity of foliar symptoms in relation to cultivars at various resistance levels.

Materials and methods

Four commercial cultivars of upland cotton, varying in earliness and vulnerability to the pathogen were used as experimental material. The early and more sensitive cultivars Eva and 4S were studied along with the relatively late and less sensitive Korina and Christidis. All of them are local cultivars released by the Cotton and Industrial Plants Institute. Earlier releases Eva, 4S and Korina, are widely cultivated in Greece, while Christidis is a relatively new cultivar, released in 1997. Based on foliar symptoms, the range of severity of infection was from 0 to 4. Degree 0 applies to plants completely lacking symptoms of the disease while degree 4 is totally wilted plants.

From each cultivar and degree of infection, eleven plants were labelled, making a total of 220 plants. The open bolls of the labelled plants were picked separately and ginned in an experimental roller gin unit. The resulting fibers were evaluated for nearly all fiber properties.

The 2.5% span length and the length uniformity were measured with the Fibrograph (530) and the micronaire with a Micronaire instrument. The other fiber parameters, short fiber content (SFC %), maturity ratio, fineness, immature fiber content (IFC %), neps, seed coat neps (SCN) and trash were measured with an AFIS (Advanced Fiber Identification System).

Results and Discussion

For better interpretation of the results, the data on fiber characteristics were divided in three categories, the first including the length parameters (Table 1), the second the fineness-maturity (Table 2) and the third the neps and trash (Table 3).

The 2.5% length was generally the least affected by wilt, as expected, because length is established by about 25 days after anthesis when infection minimal. The significant decrease in the highest degree is obviously the effect of fiber breakage. Unlike fiber length, the SFC % was significantly affected by severe infection although a gradual increase was observed from the first degree. SFC % was nearly doubled in the last degree as a result of fiber breakage because fiber weakness. As with fiber length, length uniformity was also significantly decreased in the highest degrees by fiber weakness. The cultivar Christidis was least affected in length parameters.

Compared to length the severity of damage caused in the fiber maturity parameters is pronounced because the disease disturbs fiber nutrition leading to poor fiber development. Significant decrease in micronaire values was found from the 2nd or the 3rd degree, depending on the cultivar. Note that the micronaire of Christidis was satisfactory even in the 3rd degree of infection.

Although fineness is a strongly genetical character not affected by external factors (Kechagia, 1977) a decrease in fineness equal to that of micronaire was found, but a varietal impact was also pronounced. Fineness in cultivars Eva and Christidis remains the same till the 3rd degree and drastically declines in the last, while in 4S and Korina decreases from the 2nd degree onwards. Fineness by AFIS is expressed as linear density and is therefore biased by secondary wall deposition, perfectly explaining our results.

The effect of the disease on fiber maturity is intriguing and the varietal impact is very difficult to understand. Maturity declines only after the 3rd degree in the early and more sensitive cultivars Eva and 4S. In the relatively tolerant cultivar Christidis, maturity progressively decreases and from the 2nd degree significant differences were found. The micronaire and maturity of Korina was at the lower spinnable limits even with no foliar symptoms. Other factors are probably responsible for this immaturity.

The IFC % is not a good measure of immaturity because even in the 4th degree where deterioration in

fiber maturity is actually extremely high, the IFC % is relatively low.

There is a detrimental increase in the number of neps only in the last degree of infection in all cultivars while in the other degrees, neps are more or less at the same level. A negative effect was found on the percentage of seed coat neps that actually decreases from the 1st to the 3rd degree in Eva and Christidis and remains the same in Korina. Nevertheless seed coat neps are relatively high in the highest level.

Trash is dramatically increased in the highest level in all cultivars except Christidis where no differences were found.

Conclusions

Generally fiber damage in the wilted plants was analogous to the severity of infection. It depends on the severity or degree of infection and the damage equally affects the spinnability of the fiber. Fibers from the highest degree are seriously damaged in all cultivars and therefore cannot be used for spinning because they are below the spinnable limits. In the lower degrees of infection, the fiber damage and consequently the spinnability depends on the cultivar.

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Table 1. Verticillium wilt effect on cotton quality parameters.

Degree of damage	Fiber length 2.5 %				Short Fiber Content				Uniformity			
	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis
0	30,62 ab	29,06 ab	29,92 a	29,90 a	13,89 a	13,98 a	14,22 ab	8,34 ab	49,91 ab	48,08 ab	50,44 a	49,78 a
1	31,06 a	30,80 a	29,95 a	30,23 a	10,76 a	15,75 ab	11,51 a	7,84 b	50,74 a	48,54 ab	49,42 ab	49,92 a
2	31,03 a	29,97 ab	29,59 a	29,51 ab	13,13 a	15,38 ab	13,27 ab	10,24 a	50,67 a	49,81 a	50,17 ab	49,81 a
3	30,71 ab	29,14 ab	29,22 ab	28,81 b	20,04 b	18,95 b	14,64 b	10,01 a	48,16 b	46,84 b	48,11 bc	49,68 a
4	29,61 b	28,61 b	28,45 b	29,40 ab	29,62 c	26,76 c	18,99 c	15,33 c	44,40 c	44,36 c	46,61 c	46,71 b
LSD ₀₅	1,157	1,518	0,993	0,869	4,964	3,683	2,863	2,374	2,173	1,840	2,243	1,649

Table 2. Verticillium wilt effect on cotton quality parameters.

Degree of damage	Micronaire				Maturity ratio				Fineness				I.F.C.%			
	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis
0	4,46 a	3,90 a	3,3 a	4,24 a	0,928 ab	0,898 a	0,842 a	0,949 a	179,9 a	160,1 a	151,1 a	167,3 a	7,6 a	9,4 a	13,06 a	6,74 a
1	4,10 ab	3,91 a	3,43 a	4,15 a	0,931 ab	0,890 a	0,845 a	0,922 ab	174,7 a	162,2 a	152,1 a	162,2 a	7,5 a	10,2 a	12,08 a	8,29 a
2	4,02 b	3,55 ab	3,19 a	4,00 a	0,938 a	0,881 ab	0,829 a	0,890 b	154,5 b	157 ab	140,5 b	163,1 a	7,7 a	10,3 a	13,81 a	8,53 a
3	3,51 c	3,00 b	2,74 b	4,02 a	0,889 b	0,845 b	0,829 a	0,862 b	171,3 a	148,4 b	131,3 b	170,1 a	10,1 b	11,5 a	14,3 a	10,99 b
4	2,40 d	2,40 c	2,54 b	2,96 b	0,803 c	0,778 c	0,776 b	0,829 c	131,5 c	127,2 c	119,5 c	143,3 b	13,8 c	15,6 b	17,41 b	12,75 b
LSD ₀₅	0,439	0,436	0,331	0,362	0,043	0,0396	0,0351	0,0322	13,78	10,80	10,20	9,21	2,269	2,23	2,312	2,053

Table 3. Verticillium wilt effect on cotton quality parameters.

Degree of damage	Neps				Seed Coat Neps				Trash			
	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis	Eva	4S	Korina	Christidis
0	88,64 a	66,82 a	126,82 a	76,3 a	20,55 b	3,82 a	13,45 a	17,3 a	26,36 a	21,36 a	54,45 a	47,4 ns
1	92,64 a	66,36 a	100,09 a	82,82 a	15,18 ab	5,18 a	11,55 a	15,64 ab	22,55 a	29,73 a	51,82 a	45,45 ns
2	79,36 a	83,09 a	105,00 a	73,27 a	11,45 a	5,91 a	13,36 a	11,45 ab	29,18 a	23,27 a	65,91 a	38,45 ns
3	86,82 a	159,36 b	148,27 a	69,1 a	9,18 a	12,55 b	13,45 a	10,5 b	30,36 a	63,55 b	63,18 a	37,20 ns
4	426,91 b	319,91 c	381,64 b	142,09 b	29,09 c	13,27 b	23,91 b	17,64 a	134,36 b	87,00 c	116,64 b	55,18 ns
LSD ₀₅	55,861	45,895	79,896	19,309	7,451	2,681	8,295	6,535	11,598	12,334	41,203	22,768

