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Scantic, A New Fusarium-Wilt Resistant Broadleaf Tobacco Cultivar

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A new cultivar of Connecticut broadleaf cigar wrapper tobacco (*Nicotiana tabacum* L.) resistant to Fusarium wilt, caused by the fungus *Fusarium oxysporum* Schlechtend.:Fr. f. sp. *nicotianae* (J. Johnson) W.C. Snyder & H.N. Hans., has been developed at The Connecticut Agricultural Experiment Station's Valley Laboratory. This cultivar, 'Scantic', allows broadleaf tobacco production in soils infested with the Fusarium wilt pathogen. Yields and sorting quality of Scantic are equal to or better than the current standard wilt-resistant cultivar 'C9' or similar wilt-susceptible cultivars. Limited quantities of seed are available to growers and scientists.

Fusarium wilt has been the most persistent and important disease of broadleaf tobacco in the Connecticut River Valley over the last two decades. The most effective control of Fusarium wilt has been achieved through the development and use of wilt-resistant broadleaf tobacco cultivars (LaMondia and Taylor, 1991; Lucas, 1975). One wilt-resistant cultivar, C9, was released in 1991 and has been widely grown (up to 80% of the total acreage annually) throughout the Valley. Wilt-resistant cultivars are not immune to *Fusarium* infection and will develop wilt symptoms under high inoculum potential (LaMondia and Taylor, 1987). Resistance to *F. oxysporum* is conferred by an unknown number of small-effect genes (quantitatively inherited) (Gritton et al., 1965). Continuous growth of a single cultivar such as C9 over a number of years may eventually select for isolates able to cause disease on that cultivar. The development and production of additional wilt-resistant cultivars, likely with different numbers or types of resistance genes, is desirable as it may prolong the effective use of plant resistance over time.

BREEDING AND SELECTION

Scantic is an inbred derived from a bulk system of modified single seed descent. In this breeding system, the best individuals (approximately two percent in this case) are allowed to self-pollinate (inbreed) and resulting progeny are mixed together in equal proportions (bulked) prior to seeding for the next generation. Selection for traits such as disease resistance and agronomic type are made from the second (F2) generation on until plants are inbred for six to eight generations (F6-F8). The greatest variation occurs in the F2 generation and selection reduces variation and increases the frequency of desirable traits over time. After the F6-F8 generations, each plant represents a genetically uniform homozygous inbred line and a potential new cultivar.

The F2 generation of a composite of three crosses between wilt-susceptible Connecticut broadleaf tobacco lines and the wilt-resistant cultivar 'C2' (C2 x 'Winn'; C2 x 'Gogulski'; and C2 x 'Gradowski') was selected for resistance under greenhouse conditions. One thousand seedlings of the F2 composite were each inoculated with 1.0×10^7 microconidia of *F. oxysporum* per plant in greenhouse trays. Twenty-five of the most resistant and vigorous seedlings were selected and selfed. Each year, an additional 1,200 F3 to F8 progeny were planted annually into Merrimac fine sandy loam field soil (71.8% sand, 23.0% silt, 5.2% clay and 2.2% organic matter, pH 6.2) naturally infested with high levels of *F. oxysporum*. Transplants were placed in rows 1 m apart and 0.3 m apart within rows. Twenty-five superior wilt-resistant plants out of the approximately 1,200 individuals planted were selected, selfed, and seed was bulked each year from 1988 (F3) to 1993 (F8). Plants were also selected for growth habit, traits, and reduced sensitivity to weather fleck caused by ozone. Twenty superior F8 inbred lines were self pollinated in 1993 (given the designations A-1 to A-20) and evaluated as inbred lines in 1994 and thereafter.

EVALUATION AND PERFORMANCE

Scantic (evaluated as line A-7 in commercial field trials) was selected as a superior advanced inbred. Agronomic

characteristics and cured leaf quality were evaluated in both experimental plots and under commercial conditions with cooperating farmers. Yields and sorting characteristics of Scantic were compared to the wilt-resistant standard C9 on a commercial farm in South Windsor, CT in 1995, 1997, and 1998. Cured leaves were commercially graded into one of six grades representing wrapper, binder, or filler quality. The percent of the total yield in each grade was determined and value per acre calculated (Table 1). Economic return per acre for Scantic was significantly higher than for C9 in 1995 and 1997 and similar to C9 in 1998. Cured leaf weight per acre was higher in each year and percent wrapper grades were higher in two of the three years. In 1999, an additional commercial field trial in Whately, MA concluded that Scantic had 14.5% higher weight per acre than C9 and that 64.6% of the cured leaves of Scantic were wrapper quality, while 25% were binder and 10.4% were filler.

Leaf yields, wilt incidence and wilt severity were determined in field plots at the Valley Laboratory in 1996. Scantic, C9 and the wilt-susceptible cultivar Gogulski were compared in soils either infested or uninfested with the wilt pathogen *F. oxysporum*. Each cultivar was transplanted to six replicate two-row plots of 20 plants per plot in each *F. oxysporum*-infested or uninfested field. Plants were rated for disease incidence (number of 20 plants symptomatic) and severity (rated on a scale of 0 - 4 where 0 = healthy, 1 = stunted or off-color, 2 = one leaf symptomatic, 3 = more than one leaf symptomatic, and 4 = plant dead) on August 5, 1996. Ten plants per plot were harvested on August 16, 1996 and weighed. Wilt incidence and severity were low for both Scantic and C9 (Table 2). Scantic resulted in over 20% fresh weight yield increases in comparison to C9, regardless of whether soils were infested with the pathogen or not. Yield increases over the susceptible cultivar were approximately 5% in the absence of disease and dramatically different in *F. oxysporum*-infested soil.

Resistance to *F. oxysporum* is quantitatively inherited (Gritton et al., 1965). Previous observations in field and greenhouse experiments as well as in commercial production have shown that wilt expression on wilt-resistant plants is often mild and that plants often outgrow early symptoms (LaMondia and Taylor, 1987; LaMondia and Taylor, 1991). Differences in wilt severity between Scantic and C9 were not significantly different. Fusarium wilt severity, as determined by ratings of visible symptoms, was much greater for the wilt-susceptible Gogulski than wilt-resistant Scantic or C9 tobacco.

Wilt-resistant tobacco is not immune to *Fusarium oxysporum* infection. *F. oxysporum* has been isolated repeatedly from wilt-resistant broadleaf tobacco (LaMondia and Taylor, 1987). Resistance to *F. oxysporum* in other crops has been correlated with a lack of infection, or with reduced infection, of vascular tissues above the soil line (Elgersma, et al., 1972; Gordon et al., 1990; LaMondia and Taylor, 1987). Wilt-resistant broadleaf tobacco cultivars appear to minimize increases in *F. oxysporum* population densities in soil (LaMondia, 1995). These results are similar to the effects of wilt-resistant watermelon, pea or tomato on densities of pathogenic *F. oxysporum* in soil (Larkin et al., 1993; Reyes and Mitchell, 1962).

Wilt-resistant tobacco, while not providing a means of eliminating the pathogen from soil, continues to allow the successful production of broadleaf tobacco in fields infested with *F. oxysporum* (LaMondia and Taylor, 1991). The wilt-resistant cultivar C9 has been widely grown in *F. oxysporum*-infested soils. Scantic is an additional Fusarium wilt-resistant cultivar available for commercial production with a similar level of resistance and the advantage of increased cured weight yield per acre compared to C9.

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Table 1. Percent leaf grades, cured leaf yields and value per acre of Scantic and C9 broadleaf tobacco over three years under commercial production conditions (South Windsor, CT).

	1995		1997		1998	
Leaf Grade	Scantic (%)	C9 (%)	Scantic (%)	C9 (%)	Scantic (%)	C9 (%)
Wrapper	65.6	57.9	59.0	23.0	44.0	50.0
Binder	21.9	25.4	28.0	51.0	30.0	39.0
Filler	12.5	14.8	13.0	26.0	26.0	11.0
	Yield and value		Yield and value		Yield and value	
Pounds/acre*	2304	2016	2486	2373	2232	2000
Value/acre+	$13,202	$10,231	$13,171	$8,130	$9,812	$10,032

* Cured weight leaf yield per acre.
\+ Weight in each grade multiplied by price per pound for each grade.

Table 2. Fusarium wilt incidence, severity, and shoot fresh weight of wilt-resistant C9 and Scantic and wilt-susceptible Gogulski broadleaf tobacco in wilt-infested or uninfested fields.

Cultivar	Wilt Status	Field	Wilt Incidence*	Wilt Severity+	Yield^
Scantic	resistant	Infested	0.7	1.0	29.5
Scantic	resistant	Uninfested	0.0	0.0	34.0
C9	resistant	Infested	0.2	0.2	24.3
C9	resistant	Uninfested	0.0	0.0	27.8
Gogulski	susceptible	Infested	17.0	3.6	4.0
Gogulski	susceptible	Uninfested	0.5	1.0	32.4

* Number of 20 plants per plot with wilt symptoms evident.
\+ Disease rating (0=healthy, 4=dead) of plants.
^ Fresh weight (lb) per 10 plants.