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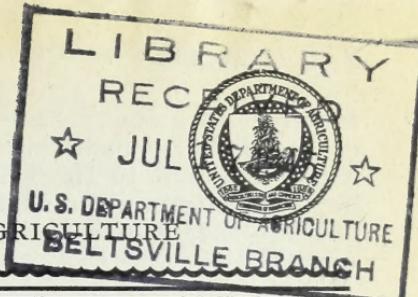
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## Flue-Cured Tobacco Resistant to Bacterial (Granville) Wilt

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**B**ACTERIAL (Granville) wilt is one of the most common and destructive diseases of tobacco. First reported in 1903 in localized areas of southern Granville County, N. C., the disease has since become widespread in the flue-cured belt of North Carolina and Virginia and is also present in South Carolina and Georgia. Within recent years the disease has caused increased losses in the most intensive tobacco-producing areas of eastern North Carolina, but the greatest loss has occurred in the north central part of the State.

About 20 percent of the crop has been destroyed each year in Granville, Wake, and Durham Counties, and losses on some farms have been as high as 90 percent. From repeated surveys it has been estimated that during the past 10 years bacterial wilt has reduced the tobacco crop by 10 million pounds annually. This means an average loss each year of 2 million dollars on the basis of the price for the 6-year period 1935-40. Tobacco production has been so badly disrupted in southern Granville County and in adjoining areas that the value of wilt-infected farms has been greatly depreciated.

Much research on wilt has been conducted during the past 40 years both in this and in other countries. Crop rotation and sanitary practices have reduced the losses, with the result that growers having infected fields have been able to continue tobacco production. That these practices have not been adequate, however, is shown by the continuing spread of the disease and resulting increased losses. Soil treatment with urea in combination with a rotation of corn has been found to provide satisfactory control, but the cost of the chemical is

<sup>1</sup> Acknowledgment is made to F. R. Darkis, of the Chemistry Department of Duke University, for evaluation of quality; and to H. R. Garriss, North Carolina Extension Service, E. K. Vaughan, formerly of the Virginia Agricultural Extension Service, and W. A. Jenkins, of the Virginia Agricultural Experiment Station, for supervision of trial plantings at many locations in these two States.

too great to permit its use on the large acreages where wilt usually causes slight to moderate losses. Discovery of strains of tobacco highly resistant to the wilt disease<sup>2</sup> has finally made possible the development of resistant strains of the flue-cured type and of a control measure that is now available and is both effective and easy to use (fig. 1).

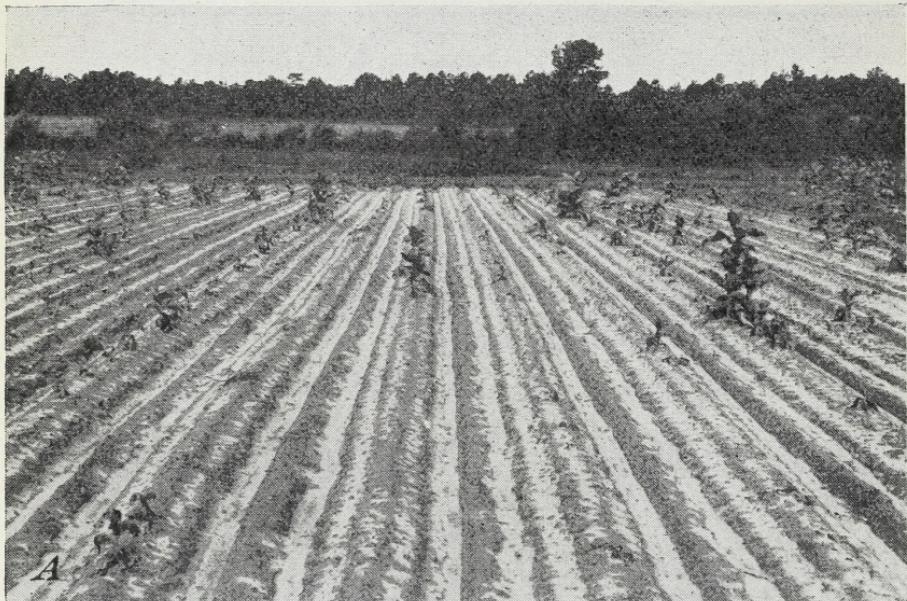


FIGURE 1.—*A*, In this field standard varieties were killed 100 percent by bacterial wilt each year from 1935 through 1944. *B*, On a part of this same land, a crop of Oxford 26 grown in 1944 produced tobacco at the rate of more than 1,100 pounds per acre.

<sup>2</sup> CLAYTON, E. E., and SMITH, T. E. RESISTANCE OF TOBACCO TO BACTERIAL WILT (BACTERIUM SOLANA-CEARUM). Jour. Agr. Res. 65: 547-554, illus. 1942.

## DESCRIPTION OF THE DISEASE

Bacterial wilt in tobacco is caused by *Bacterium solanacearum* E. F. Smith, an organism that attacks many other plants also, including tomato, potato, and some common weeds. As it survives in the soil indefinitely, tobacco plants may develop the disease at any time after they are set. The first symptom is usually the wilting of a single leaf, and then several leaves on one side of the plant (fig. 2, A), but under conditions very favorable for the disease all leaves may wilt at the same time. To distinguish bacterial wilt from other diseases, split the stalk longitudinally. The presence of dark streaks, resembling pencil marks, extending in the woody part of the stem for 12 or 18 inches above the soil line is a distinctive symptom of the disease (fig. 2, B). In advanced stages of wilt, a slimy type of soft rot may affect the roots and pith.

## SOURCE OF RESISTANCE

Tests with all available flue-cured varieties showed that 400 and Davis Special are slightly less susceptible than such varieties as Gold Dollar and Virginia Bright Leaf, but this resistance did not stand up under severe wilt conditions. These results were similar to those obtained by earlier workers who tested varieties of all commercial types of tobacco and found none with adequate resistance. Hence, strains not previously grown in this country seemed the only prospect for isolation of highly resistant breeding stocks.

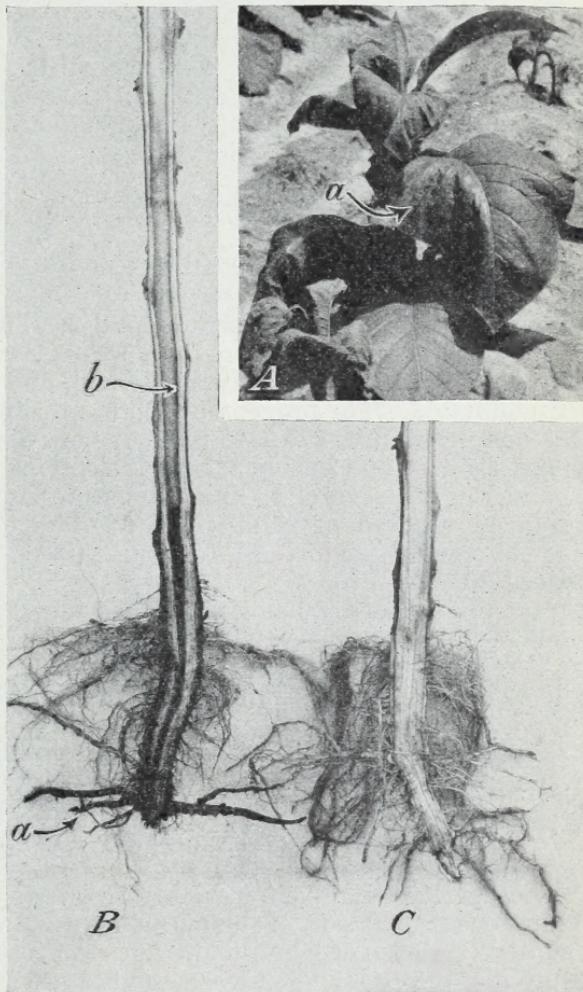


FIGURE 2.—Symptoms: A, Young plant, showing (a) the one-sided wilting of green leaves characteristic of the disease early in the season. B, Diseased plant, with decayed roots (a) and dark streaks (b) in the wood next to the pith and extending well up the stem. C, Healthy plant.

For the purpose of obtaining wilt resistance, an extensive collection of tobacco varieties was made from Mexico, Central America, and South America. Preliminary tests conducted in the greenhouse with 1,034 lots eliminated all but 129. These were tested on field soil so badly infected by wilt that standard varieties were usually killed 100 percent by midsummer. One South American lot was found with a high degree of resistance, and, fortunately, its growth characteristics were similar in many respects to those of flue-cured tobacco. This collection, T. I. 448A,<sup>3</sup> obtained from Colombia, was first tested in the field in 1938. It showed consistently a high degree of wilt resistance in succeeding years, including 1939 and 1943, seasons of exceptional wilt severity. The cured leaf of T. I. 448A was of fair color and had no undesirable aroma, but otherwise its quality was poor. Further information on this strain and other breeding stocks was given in an earlier publication.<sup>4</sup>

## BREEDING WORK

To develop wilt-resistant strains of good quality, T. I. 448A was crossed with 7 flue-cured varieties. Most of the F<sub>1</sub> hybrids were grown in winter in the greenhouse, and seedlings of the F<sub>2</sub> were planted in spring for field tests. More than 5,200 plants of the F<sub>2</sub> were grown in 1940 and 1941 on wilt-infected field soil, and resistant selections were self-pollinated. The progeny of 166 F<sub>2</sub> selections were tested in the F<sub>3</sub>. One line, from T. I. 448A × 400,<sup>5</sup> was of outstanding promise in both wilt resistance and curing trials. Selections of this line made in the F<sub>3</sub> and F<sub>4</sub> gave several F<sub>5</sub> lines that were highly resistant to wilt and produced tobacco of good quality. The most promising selection was distributed for increase to certified seed growers under the name Oxford 26.

Breeding trials are being continued with hybrids from the original cross of T. I. 448A × 400 and considerable material from the first backcross to the flue-cured type (T. I. 448A × 400 × 401). Improved wilt-resistant strains similar to standard varieties in all growth characteristics are clearly in prospect. The need for a flue-cured strain with resistance to wilt was so acute, however, that it was necessary to make Oxford 26 available for immediate use.

## DESCRIPTION OF OXFORD 26

The variety Oxford 26 is highly resistant to bacterial wilt (fig. 3). As many as 20 percent of the plants may show wilt early in the season, but nearly all recover and make normal growth except for one or two stunted leaves. Under disease conditions, where less than 1 percent of standard varieties remained alive, survival of Oxford 26 was 95 to 100 percent.

The plant has a small stalk, flowers 3 to 7 days later than standard varieties, appears to withstand drought better, and has a vigorous

<sup>3</sup> Refers to accession number, Division of Tobacco Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering.

<sup>4</sup> See footnote 2, p. 2.

<sup>5</sup> MOSS, E. G., and BULLOCK, J. F. TWO NEW VARIETIES OF FLUE-CURED TOBACCO, 400 AND 401. N. C. Agr. Expt. Sta. Bul. 337, 8 pp., illus. 1942.



FIGURE 3.—Left and right, Oxford 26; center, one of the standard flue-cured varieties, showing severe damage by bacterial wilt.

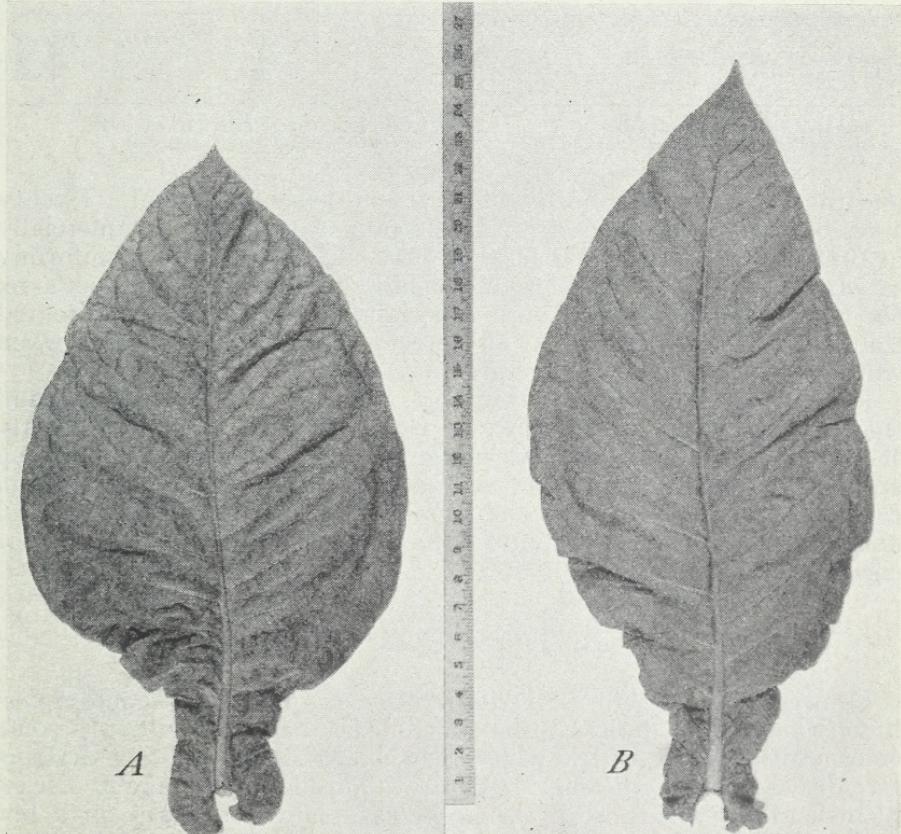


FIGURE 4.—Leaves removed from halfway up the stem: A, On Oxford 26; B, on Gold Dollar.

root system. The plant grows as tall as the large broadleaved strains, such as 400, but in size of leaf it more closely resembles such strains as Gold Dollar. The leaves are somewhat rounded (fig. 4), averaging 15 percent shorter and 15 percent wider than Gold Dollar. In a comparable planting, untopped plants of Oxford 26 averaged 12 inches taller than Gold Dollar, but the two varieties had the same number of leaves, indicating longer internodes on Oxford 26. The leaves curve downward as they approach maturity, forming an angle of more than 90 degrees between leaf tip and stem.

## TESTS OF YIELD AND QUALITY

In plot trials conducted on soil heavily infected with wilt, Oxford 26 produced on the average nearly five times as much tobacco as Gold Dollar. When grown on soils where wilt was not a problem, however, the yields of the two varieties were approximately the same (table 1),

TABLE 1.—*Comparative yields,<sup>1</sup> in cured leaf per acre, of tobacco varieties Oxford 26 and Gold Dollar, grown on wilt-infected and healthy soils*

Variety	On wilt-infected soil <sup>2</sup>	On healthy soil	
		Location 1 <sup>3</sup>	Location 2 <sup>4</sup>
Oxford 26	Pounds 1,123.0	Pounds 1,500.5	Pounds 1,069.2
Gold Dollar	238.5	1,438.0	1,083.2

<sup>1</sup> Averages from replicated plots.

<sup>2</sup> On Enon sandy loam, 1943 and 1944.

<sup>3</sup> On Creedmoor sandy loam, 1943 and 1944.

<sup>4</sup> On Enon sandy loam, 1943 and 1944.

<sup>4</sup> On Creedmoor sandy loam, 1944.

and there were no significant differences in price per pound. Twenty acres of Oxford 26 or closely related strains were grown commercially in 1943 and well over 2,500 acres in 1944. The results were uniformly satisfactory, many growers producing more than 1,000 pounds per acre. On farms where wilt had been especially severe, growers estimated that their yields were 25 to 50 percent higher than in years when wilt-susceptible varieties were grown.

Federal inspectors who examined much of this tobacco found that it compared favorably with the usual offerings, but it was slightly shorter and had a higher percentage of the total weight in the lug and cutter grades. In quality evaluations, obtained on samples from the 1943 and 1944 crops by commercial leaf experts and by chemical analyses, the tobacco was found to be of good quality and suitable for cigarette production.

## SUGGESTIONS FOR CULTURE

Growers who plan to use Oxford 26 for the first time should determine whether the disease to be controlled is bacterial wilt. In some communities where wilt is widespread, black shank, another destructive disease, is present on a few farms. Through a mistake in disease identification, wilt-resistant tobacco was planted in 1944 on a few fields where black shank was the problem to be met, and losses as high as 75 percent resulted. The black-shank-resistant strains

recently developed<sup>6</sup> should be grown wherever this disease occurs. Oxford 26 is recommended only for soils on which wilt occurs. In the absence of wilt, one of the other varieties would be preferable.

The leaves on the lower part of the plant tend to break if handled roughly, and the first two primings should be handled with reasonable care.

Rotations are being generally used on wilt-infected farms, and this practice should be continued in combination with Oxford 26. Among crops that considerably reduce the severity of bacterial wilt are corn, cotton, redtop, crotalaria, cowpeas, soybeans, or lespedeza, and it is suggested that some of these be grown for 2 years between tobacco crops. A systematic program of rotation planned to meet local needs will help maintain high yields and at the same time reduce the hazard from other tobacco diseases. For more detailed information on rotations, the reader is referred to a recent Farmers' Bulletin.<sup>7</sup>

## SEED SOURCES

Foundation tobacco stocks are being maintained by the Tobacco Branch Station at Oxford, N. C. Certified growers under the supervision of the North Carolina Crop Improvement Association are producing seed for commercial distribution; in 1944 they produced enough seed for approximately 40,000 acres.

<sup>6</sup> BULLOCK, J. F., and MOSS, E. G. STRAINS OF FLUE-CURED TOBACCO RESISTANT TO BLACK SHANK. U. S. Dept. Agr. Cir. 682, 9 pp., illus. 1943.

<sup>7</sup> CLAYTON, E. E., GAINES, J. G., SMITH, T. E., and others. CONTROL OF FLUE-CURED TOBACCO ROOT DISEASES BY CROP ROTATION. U. S. Dept. Agr. Farmers' Bul. 1952, 12 pp., illus. 1944.

