T-1 VERTICILLIUM STRAIN

. . . a major factor in cotton and olive wilt

W. C. SCHNATHORST · G. S. SIBBETT

Isolations of Verticillium albo-atrum **from olive trees in Tulare County indicated that the T-1 strain was most often associated with severe verticillium wilt in Manzanillo and Sevillano varieties. T-1 was also associated with severe wilt in Acala cotton in Tulare and several adjacent counties. The SS-4 strain, which causes only mild symptoms in Acala cotton varieties, was isolated from olive trees and was a relatively mild pathogen in the Manzanillo olive variety. These results indicate that the T-1 strain is a major factor in the severe wilt problem in both cotton and olives in Tulare County.**

VERTICILLIUM WILT, caused by the fungus *Verticillium albo-atrum* Reinke & Berth, has become a serious problem to producers of olives (*Olea europaea* L.) and cotton (*Gossypium hirsutum* L.) in Tulare County. In some instances cotton has been interplanted with olives, and it is rather common to find cotton growing adjacent to olive orchards. Increasing incidence and severity of verticillium wilt in both crops during the same period suggested to many observers that the two diseases may be related.

Investigations on verticillium wilt in cotton in Tulare and adjacent counties showed that a strain of *V. albo-atrum* designated as T-1, was associated with extreme severity of the disease in Acala cotton varieties. Another strain of the fungus, SS-4, was common in areas of the San Joaquin Valley where tolerance of Acala varieties was still effective.

Relationship

To resolve the question of a possible relationship between the diseases, it was necessary to determine the strains of the fungus associated with severe wilt in both crops. If the strains of the fungus in olive and cotton were different and not cross-infective, it would be unlikely that wilt in the two crops was related. If the strain in olive was SS-4, it would be unlikely that cotton played a major role in increasing the disease in olive groves in Tulare County or that olive would contaminate presently grown Acala cotton varieties. However, if the T-1 strain predominated in both olive and cotton it would appear possible the diseases were related. Thus studies on the effects of disease in one crop on the increase in disease in the other would be justified. This report presents results of a study made to determine which strains of *V. albo-atrum* were associated with severe wilt in olive and their comparison with SS-4 and T-1 strains from cotton.

Verticillium strains in cotton

Since 1963 intensified efforts have been made to determine the relative distribution and number of strains of *V. albo-atrum* in cotton in the San Joaquin Valley. To date most of the isolates have been assigned to two major groups: SS-4 and T-1. The SS-4 strain is widespread in California, but causes only mild symptoms and little or no yield loss in Acala

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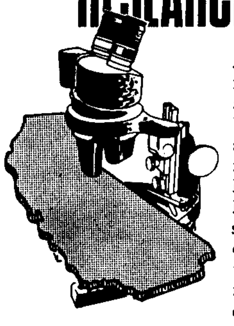
RESEARCH PREVIEWS



A continuing program of research in many aspects of agriculture is carried on at University campuses, field stations, leased areas, and many temporary plots loaned by cooperating landowners throughout the state. Listed below are some of the projects currently under way, but on which no formal progress reports can yet be made.

THE CHEMISTRY OF APPETITE

Scientists in the Department of Physiological Sciences at the School of Veterinary Medicine, Davis, have identified a part of the brain which allows an animal to sense changes in the dietary ratios of amino acids. This in turn affects the animal's appetite. This discovery should improve our understanding of the factors that influence food acceptance.

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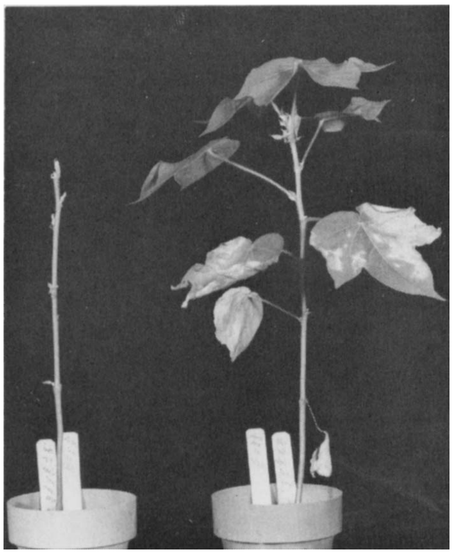
COLOR TESTING WINE

A new method of evaluating the color of white wine has been developed by scientists in the Department of Nutritional Sciences, Berkeley. They have helped design a photoelectric colorimeter that is capable of differentiating light white wine samples with enough precision and reproducibility to meet Federal requirements.



Differential response of Acala 4-42 cotton to strains of Verticillium albo-atrum from olive trees in Tulare County. Plant to left shows typical defoliation characteristic of the T-1 strain. Plant on the right shows the milder non-defoliating symptoms typical of the SS-4 strain in tolerant Acala cotton varieties.

cotton varieties. However, the T-1 strain can kill most varieties of cotton under field and greenhouse conditions and can cause sharply lower yields. T-1 is associated with severe symptoms expressed in cotton in Tulare, Kings, and portions of Fresno and Kern counties. Most of the isolates from cotton with verticillium wilt in Tulare County have been T-1.

Verticillium strains in olive

Portions of roots and branches from Manzanillo and Sevillano varieties thought to have verticillium wilt were taken from 17 orchards in Tulare County in the fall of 1968. Small sections were cut from the field samples which were surface sterilized, plated on water agar and held at 75°F. When *V. albo-atrum* was recovered from tissue, sub-transfers of the fungus were made to potato-dextrose agar (PDA). These cultures were used to make conidial suspensions for inoculating a series of plants that differentiate strains of *V. albo-atrum*. The differential host series in these tests consisted of Deltapine 15 and Acala 4-42 cotton, and New Improved Pearson tomato (*Lycopersicon esculentum* Mill.).

Conidial suspensions were prepared from 5 to 7-day-old cultures on PDA slants held at 75°F. Cultures were flooded with 10 ml of sterile glass-distilled water, the conidial suspension filtered through two layers of cheesecloth and adjusted to approximately 10 million viable conidia per ml. Sterile serological syringes were used to puncture-inoculate upper stems of young cotton and tomato plants with at least one isolate from each olive grove that yielded *V. albo-atrum*.

V. albo-atrum was isolated from 8 of the 17 orchards sampled. The response of the differential hosts indicated that seven of the isolates were T-1 and one was SS-4 (see photos).

Susceptibility of Manzanillo olive

To determine if commercial olive varieties differed in susceptibility to SS-4 and T-1 strains, young trees of the Manzanillo variety, propagated from rooted cuttings, were inoculated in three separate trials. Trees were pruned to lessen transplant shock, and removed from their containers. Roots were thoroughly washed to free them of soil, inoculated with 10 ml of adjusted conidial suspensions with an aerosol spray kit, and repotted. Control plants were similarly treated except that roots were sprayed with sterile water without the pathogen. The trees were placed in a greenhouse where temperatures ranged from 72 to 80°F. Three weeks after inoculation, observations were made for disease symptoms and continued for three months.

Symptoms were usually apparent 30 days after inoculation. The Manzanillo variety was susceptible to both SS-4 and T-1 strains from cotton, but T-1 caused much more damage than SS-4 (photo below). Three of 12 trees inoculated with SS-4 showed wilt symptoms and only one died. In sharp contrast, all 11 plants inoculated with T-1 expressed symptoms, nine died, and the two surviving trees were severely damaged. All five control plants remained symptomless—demonstrating that T-1 causes severe wilt in both cotton and olive, whereas SS-4 is a mild pathogen in both hosts.

Conclusions

The high degree of susceptibility of Manzanillo, and no doubt Sevillano olives to the T-1 strain agrees with the frequency that T-1 was isolated from diseased trees in Tulare County. The more virulent strain would be expected to predominate. Also, the high frequency of recovery to T-1 (nearly 90%) from diseased olives is in agreement with the high frequency of occurrence of T-1 in diseased Acala cotton in the same area. It still remains to be demonstrated that the disease in one crop brings about an increase of the disease in the other. Future research should include a study of disease distribution patterns within olive groves that have been interplanted with cotton, or where cotton has been planted adjacent to olives. Disease distribution in the above groves should be compared with that in groves isolated from cotton with verticillium wilt. Studies on the ability of *V. albo-atrum* to survive in olive and cotton refuse may aid in explaining distribution patterns. Such knowledge would help to determine if refuse from either crop is capable of contaminating the other.

Screening rootstock

Demonstration of the occurrence of both T-1 and SS-4 in olive groves emphasizes the need to screen olive rootstocks for resistance against both strains. Tests using SS-4 as the challenge strain would likely result in rootstocks of inferior resistance. Fortunately the clonal rootstock

The comparative susceptibility of Manzanillo olive to T-1 (left) and SS-4 (right) strains of Verticillium albo-atrum from cotton. Plant inoculated with T-1 is in the final stages of a lethal reaction. Plant inoculated with SS-4 shows no visible symptoms.

Oblonga, that was recently shown to be resistant to verticillium wilt, was challenged with both strains in greenhouse evaluations. Although a resistant rootstock, (to which susceptible commercial olive varieties may be grafted) is available, measures also are needed that will prevent spread of the disease within established groves.

The disease problems associated with the culture of cotton and olives in the San Joaquin Valley indicate that culture of other perennial and annual crops susceptible to verticillium should be more critically evaluated in the future.

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Importation of wild strain JAPANESE QUAIL (*wild coturnix*) *offers new game bird possibility*

W. O. WILSON · B. ANDERSON · T. D. SIOPES

Domestic coturnix, or Japanese quail, have been used for research in several disciplines at the Avian Sciences Department, Davis, since 1957—including investigations in environmental physiology, nutrition, genetics, cancer, environmental toxicology, and embryology. The small, fast-maturing birds allow savings in research time and money. Studies reported here show differences in viability, hatchability, fertility, egg production and weight and age at sexual maturity between the recently imported wild species and the domesticated coturnix—leading to speculation that the bird might still be established as a game bird in this country, despite previous unsuccessful attempts with the domesticated strains.

BODY WEIGHTS OF WILD AND DOMESTICATED STRAINS OF COTURNIX AT DIFFERENT AGES (MEAN AND STANDARD ERROR)

	Day old	1 week	8 weeks	Median age at sexual maturity	Non-layers at 9 weeks of age
	g	g	g	days	%
Females wild	6.4 ± .16	14.9 ± .42	104.2 ± 2.7	59	50
Females tame	6.2 ± .20	20.0 ± 1.73	139.2 ± 3.2	44	0
Males wild	5.6 ± .20	13.8 ± .50	92.6 ± 2.2		
Males tame	6.2 ± .11	12.6 ± 1.47	108.8 ± 4.0		

DOMESTICATED COTURNIX or Japanese quail have been used as the pilot animal for research in several disciplines since 1957 in the Aviah Sciences Department at Davis. The small birds weigh approximately one quarter of a pound, and cost much less to feed the numbers of birds required to produce statistically significant results. Their size also allows the use of very small growing chambers, taking up much less space than is needed for chickens or turkeys (particularly in physiological research and photoperiodic studies). Experimental results with reproduction may be obtained more quickly with coturnix as they mature in five to six weeks after hatching—as compared with chickens which require five months to mature. In production, domesticated coturnix lay as many eggs per year as most chickens. Because the egg size is relatively much larger than chickens, the coturnix, (laying at 75% production rate) produces eggs equivalent to body weight every 19 days.

The quail *Coturnix coturnix* has a long life history depicted in both Egyptian hieroglyphics and references in the Old Testament. Since ancient times the quail have been kept under domestication in Japan. Their meat and eggs, both of economic value, were easily grown. When wild, the birds' diet consisted of seeds and insects injurious to agriculture.

In the United States a number of importations of coturnix (starting in about 1870) were made in unsuccessful attempts to establish it as a game bird. In 1957 over 200,000 coturnix were reared and released by the Missouri Conservation Commission. After hundreds of thousands of birds had been imported by many states, it became established only in Hawaii on the islands of Maui, Kauai and Hawaii. The state has open season on coturnix with a bag limit of fifteen.

At the Toyohashi Quail Farming Cooperating Association in Japan, coturnix females have a productive life of one year and produce at an 80% rate during this time. The eggs are packed in cartons of 10 eggs for retail sale to be cooked and served in many ways. From May to November is a period of low egg prices, and some of the eggs produced during this period are saved for incubation. It normally takes 40 days to reach sexual maturity under artificial light at night. The Toyohashi Association reported a growing mortality of from 5 to 20%, hatchability of 60 to 70% and fertility of 75 to 90%. The Japanese sell both young fryers and adult birds for meat.