Verticillium albo-atrum: the Quantitative Relationship Between Inoculum Density and Infection of Cotton

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ABSTRACT

The threshold of infection for cotton plants by *Verticillium albo-atrum* was about 0.03 microsclerotia/g soil, under field conditions. Twenty to 50% infection occurred at the end of the growing season when the inoculum density was 0.3 to 1.0 microsclerotia/g soil, and essentially 100% infection occurred where the inoculum density was 3.5 or more microsclerotia/g soil.

Additional key words: *Gossypium hirsutum* L., epidemiology.

*Verticillium albo-atrum* Reinke & Berthe, is a destructive soil-borne plant pathogen in the temperate zones of the world. It systemically invades the vascular systems of numerous plant species, causing wilting of foliage and, often, death of the entire plant. Members of the families *Compositae, Malvaceae, Rosaceae, Solanaceae, Cucurbitaceae,* and *Leguminosae* are among the important hosts of the fungus.

Rotations with nonsusceptible crops can be helpful in control of *V. albo-atrum* because its persistent infective propagule, the microsclerotium (4), germinates repeatedly in moist soil (2) and, therefore, contributes to its own eventual demise in the absence of susceptible hosts (5, 6). This is an important factor since the fungus is not strongly saprobic in soil (5). The potential of crop rotation as a means for controlling this fungus has not been fully realized because of the lack of procedures for quantitatively determining survival of the fungus under different cropping practices, except for the laborious procedure of growing hosts in potentially infested soils (4, 6). Several substrates have been reported for trapping the fungus from soils (4), but none appear to have gained widespread acceptance, since their usefulness is limited because of interference from other microorganisms in naturally infected field soils that overgrow and obscure slow-growing *V. albo-atrum* (3). This criticism may not apply to a sorbose-containing substrate recently
detected in 2 of the 24 fields, and plants in these fields were free from infection by *V. albo-atrum*. Microsclerotia were detected, however, in the other 22 fields, and infected plants also were present. A positive log-log relationship between inoculum density in soil and infection of cotton plants was observed (regression coefficient \( r = .941 \)). The equation \( \log Y = 0.752 \log X - 0.746 \) accurately expresses this relationship between trace- and essentially 100% infection. Inoculum density values first were converted to the number of microsclerotia per kg soil (Fig. 1) in order to avoid use of a negative logarithmic plot. This procedure allowed use of parallel legends showing the actual number of microsclerotia detected in soils.

The threshold number of microsclerotia required for trace amounts of infection was about 0.03/g soil under field conditions (Fig. 1). Infection always was less than 10% where 0.1 or fewer microsclerotia/g soil were detected. Above this critical inoculum density, amounts of infection increased sharply. Twenty to 50% infection occurred when inoculum density was 0.3 to 1.0 microsclerotia/g soil. Essentially 100% infection occurred in soils containing 3.5 or more microsclerotia/g soil. Thus, the amount of disease observed at the end of the growing season in November was closely associated with the number of microsclerotia detected at about the same time (Fig. 1). This relationship also held for microsclerotial assays of the same soils made in June, except in one instance. In this case, there was a dramatic decrease in the number of microsclerotia between June and November (from 38.9/g to 0.48/g soil), but the amount of disease observed in November agreed with the results of the November microsclerotial assays. The cause for the apparent decline in inoculum density in this case is not known.

These data show, for the first time, that the amount of infection from *V. albo-atrum* in a crop plant can be quantitatively estimated before the end of the growing season. The data also show that crop rotations may not always be satisfactory for cotton production because essentially 100% infection can occur whether a soil contains 3.5 or 50 microsclerotia/g soil (Fig. 1). Thus, a short-term rotation may be satisfactory for a field containing 3.5 microsclerotia/g soil, whereas a similar rotation might fail in a field containing 50 microsclerotia/g soil. Results of these tests should provide a basis for selection of fields safe for planting cotton so as to avoid severe losses from *Verticillium* wilt. Additional data are needed on the seasonal changes in inoculum density. These data also provide a basis for determining the survival of microsclerotia of *V. albo-atrum* in different soils and under different cropping practices which should be useful for determination of efficient crop rotation systems.

**LITERATURE CITED**


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Fig. 1. The logarithmic relationship between the inoculum density of *Verticillium albo-atrum* in field soils and infection of cotton plants at the end of the growing season.
5. WILHELM, S. 1951. Is Verticillium albo-atrum a soil invader or a soil inhabitant? Phytomopathology 41:944-945 (Abstr.).