Free and Bound Microsclerotia of Verticillium albo-atrum in Soils

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ABSTRACT

The numbers of viable microsclerotia of *Verticillium albo-atrum* were determined in undistrubed soil profiles and in adjacent profiles immediately following rototillage. Rototillage forced release into soil of microsclerotia bound in intact debris of infected cotton plants. All viable microsclerotia were essentially free in moist soil, at depths of 20-30 cm, approximately one year after cotton plants were disked into soil. But up to 90% of the viable microsclerotia in essentially air dry soil were still bound in infected plant debris after the same length of time.

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A concept of apparent (or effective), versus total, inoculum density of *Verticillium dahliae* Kleb. (microsclerotial form of *V. albo-atrum* R. & B.) was presented by Menzies (5). He suggested that effective inoculum consists of microsclerotia freed in soil, as a result of decay of infected plant residues, and which are prone to dispersion in soil during land preparation and cultivation procedures. Other microsclerotia are held within infected host residues for various lengths of time. These microsclerotia, which we refer to as bound microsclerotia, contribute to total but not to effective inoculum density until they are released and dispersed in soil (5). The term "free microsclerotia," as used here, describes those dispersed singly and as clusters in microscopic-sized bits of old host tissue (4). They are distinguished from microsclerotia held by intact plant parts, which our assay does not measure (2). Reports by Evans et al. (3) and by Ashworth et al (1) support the view that microsclerotia, essentially free in soil, account for infection of cotton (*Gossypium hirsutum* L.). The latter workers found a close relationship between the numbers of free viable microsclerotia in soil and infection percentages of cotton (1). To our knowledge, however, the relative contributions of effective or free microsclerotia and bound microsclerotia to total inoculum density at a given time have not been described. We attempt to do that in this report.

MATERIALS AND METHODS.—Free and bound sources of microsclerotia were determined in a sandy loam soil (field capacity, about 7.5% moisture) and in a clay loam soil (field capacity, about 15% moisture). Cotton was grown in both fields in 1971. Following harvest, plant residues were shredded, then disked into the soil which then was bedded into rows about 1.0 m apart. Soils were irrigated during the winter of 1971-72 in sufficient quantities to wet to depths of 90-120 cm, without further irrigation during the summer. The sandy loam soil was kept free of plant growth during 1972. This plot consisted of eight rows about 60 m long. In the clay loam soil, bare fallow plots were compared with plots planted with safflower (one row/planting bed). Safflower was used to dry the soil as a comparison with the moist fallow soil treatment. This experiment had three replications, each four rows wide and about 30 m long. Soil of neither plot was disturbed during the summer, except for a limited amount of hand-hoeing.

A portion of each treatment was tilled to a depth of 30 cm with a Howard Rotovator in late-Sept. or early-Oct., 1972 in order to force release of microsclerotia from intact plant debris. Immediately following tillage, samples of soil were taken at depths of 1-10 cm, 10-20 cm, and 20-30 cm of profiles of both undisturbed and tilled treatments, at immediately opposite locations. Moisture content determinations were made. Then within treatments, soil samples of like depth were bulked, air-dried for two days, thoroughly mixed, and assayed for free viable microsclerotia (1, 2).

RESULTS AND DISCUSSION.—Differential numbers of free microsclerotia were detected at different depths in undisturbed sandy loam and clay loam soils.

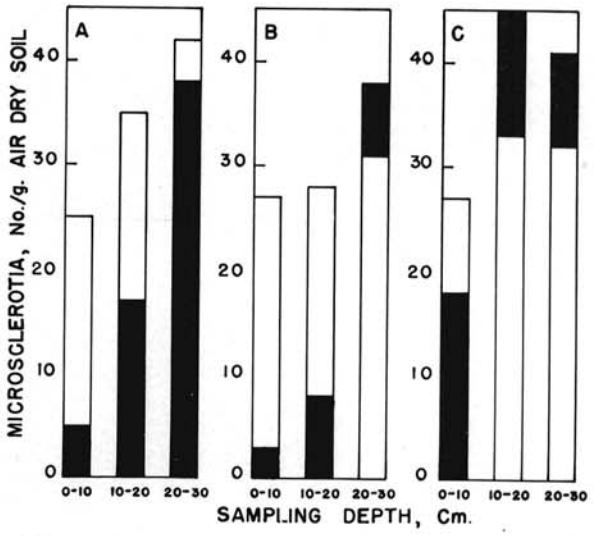

Fig. 1-(A to C). The numbers of viable microsclerotia of *Verticillium albo-atrum* in adjacent profiles of undisturbed (shaded bars) and of rototilled soils (unshaded bars); **A)** a sandy loam soil; **B)** a clay loam soil planted with safflower; and **C)** a moist fallow clay loam soil. LSD (P=0.05) = 11.1 microsclerotia/g soil.

Within the sandy loam soil and the safflower treatment of the clay loam soil, the fewest microsclerotia were detected at the 0-10 cm depth, intermediate numbers were detected at 10-20 cm depth, Fig. 1-A, B. The relative prevalence of microsclerotia by depth, within soils, appeared to be related to moisture content of soils at the different depths. For the fallow sandy loam soil, moisture contents were 1.0, 2.2 and 3.7% at respectively, the 0-10, 10-20, and 20-30 cm depths. For the safflower treatment, they were 6.2, 8.0, and 9.9% at the same depths. In contrast with these situations, similar numbers of microsclerotia were detected at 10-20 and 20-30 cm depths of the moist fallow clay loam soil where moisture contents ranged from 13.2 to 13.7%. But, as in the other treatments, the fewest microsclerotia were detected at the 0- to 10-cm depth (Fig. 1-C) where soil was driest, 6.2%.

Rototillage evidently induced release of microsclerotia bound in plant residues into soil. For immediately following rototillage, greater numbers of microsclerotia were detected at 0-10 and 10-20 cm depths of the sandy loam soil, and the safflower treatment of the clay loam soil, than were detected in the undisturbed portions of the same treatments, Fig. 1-B. In all treatments, however, numbers of microsclerotia at the 20-30 cm depth were about equal regardless of rototillage, Fig. 1. Likewise, numbers of microsclerotia in undisturbed and rototilled portions of the moist fallow treatment were equal at the 10- to 20-cm depth (Fig. 1-C); moisture content of soil at 10-20 and 20-30 cm was about equal, 13.2 and 13.7%, respectively.

Our observations on free, versus bound, microsclerotia at different depths in soils suggest that a significant number of these propagules were bound in plant debris located in drier soil zones approximately 1 yr after a cotton crop. This conclusion seems plausible considering that rototillage induced an immediate increase in inoculum density as measured by our assay. In contrast, inoculum density was not affected by rototillage at the greatest soil depths. Presumably, microsclerotia were free in the moist deeper soil as a result of infected plant residue decay.

Results of these experiments quantitatively support the concept of free and bound microsclerotia suggested by Menzies (5).

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