Effects of Soil Texture on the Interaction Between Rhizoctonia solani and Meloidogyne incognita on Cotton Seedlings

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Abstract: Soils containing 60, 75, and 90% coarse particles (sand plus coarse silt) were prepared by dilution of a field soil with 246-μm (60-mesh) silica sand. As the coarse-particle content of the soils increased, the synergistic interaction between *Meloidogyne incognita* and *Rhizoctonia solani* on cotton seedlings increased. Increasing the coarse-particle content of the soil also increased damage from the nematode alone and slightly increased soreshin damage from *R. solani* alone. *Key Words:* nematode, root knot, fungus, soreshin, *Gossypium hirsutum*, sand.

Damage from *Meloidogyne* spp. in the field has been related to soil texture. Sleeth and Reynolds (6) found that infection of *Sesbania exaltata* (Raf.) Cory by *M. javanica* (Treub) Chitwood was much less in a fine-textured clay loam than in a coarse-textured loamy sand. Plants grown on a mixture of the soils had an intermediate level of infection. O'Bannon and Reynolds (4) also reported that root galling and lower yields of cotton by *M. incognita* (Kofoid and White) Chitwood were most pronounced on a coarse-textured soil.

Carter (1) showed interactions between temperature and inoculum concentrations of *M. incognita* in symptom expression of soreshin of cotton seedlings caused by *Rhizoctonia solani* Kühn. This paper reports effects of soil texture, particularly percentages of coarse particles, on severity of soreshin of cotton (*Gossypium hirsutum* L.) seedlings grown in soils infested with both *R. solani* and *M. incognita.*

MATERIALS AND METHODS

Soil from Field A-2 of the University of Arizona Cotton Research Center, Phoenix, was passed through a 2.14-mm (10-mesh) wire screen, to remove stones and large pieces of organic matter. Various amounts of commercial 246 μm (60-mesh) silica sand were added to this soil to give soils with about 60, 75, and 90% coarse particles (sand plus coarse silt). Percentages of sand, coarse silt, silt, and clay in the soils were determined by the method of Day (2). Moisture-holding capacities were determined by the method of Olmstead (5). Physical properties of the soils are given in Table 1. Soils were leached with distilled water to remove excess salts, and dried at 80 C for 12 h. The pH of these soils was 7.2 to 7.6.

The cotton cultivar, DP16, *M. incognita,* and *R. solani* strains used in the study and their maintenance, have been described (1). Preparation of soil, containers, planting of cottonseed, and addition of *R. solani* and *M. incognita* to soil also was as previously described (1), except that cottonseed was planted 3 days after infestation of soils with *R. solani.* Soils were watered at first with half-strength Hoagland's nutrient solution (3) and later with distilled water. Containers were weighed daily and water added as needed to maintain moisture level at 90% holding capacity. Four inoculation treatments were used for each soil as follows: *M. incognita,* 2,500 larvae per plant; *R. solani,* three infected kernels of grain sorghum (1 kernel = 1 unit) per container; *M. incognita* and *R. solani,* 2,500 larvae and three units, respectively; and noninoculated controls. Experiments were maintained at 21 C.

Criteria for measuring disease severity were rate of emergence and numbers of surviving seedlings, total fresh weight, and disease and galling indices after 21 days. Lesion indices for *R. solani* were: 0 = no infection; 1 = small lesions, yellowing on hypocotyl; 2 = large lesions, no girdling; 3 = lesion girdling hypocotyl; and 4 = dead plant. Galling indices for *M. incognita* were: 0 = no, 1 = light, 2 = moderate, 3 = moderate to heavy and 4 = heavy galling of roots. To test seedlings exposed to *R. solani,* segments of lesions were washed with sterile distilled water and plated on water agar. Roots were microscopically examined for extent of galling.

Each treatment was replicated eight times with three plants per replicate. Combined results were subjected to Duncan's multiple range test.

RESULTS AND DISCUSSION

Seedlings began to emerge in all treatments

Received for publication 16 January 1975.

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TABLE 1. Physical properties of the original field and three mixtures.

Physical property	Original field soil	Soil Mixtures[a] A	B	C
Approximate coarse particles (%)		60%	75%	90%
Soil (%)				
Sand (50 μm-2 mm)	34.5	46.5	69.0	87.0
Coarse silt (20-50 μm)	18.5	14.0	6.0	2.0
Silt (2-20 μm)	20.5	17.5	10.0	2.5
Clay (< μm)	26.5	22.0	15.0	8.5
Bulk density (g/cc)	1.3	1.3	1.4	1.4
Pore space (%)	43.8	42.8	40.1	38.1
Particle density (g/cc)	3.0	2.4	2.5	2.5
Moisture-holding capacity (%)	...	16.4	12.9	8.7

[a]Obtained by mixing original soil with 246-μm (60-mesh) silica sand.

TABLE 2. Effects of soil texture on growth and disease of cotton grown in soils infested with *Rhizoctonia solani* and *Meloidogyne incognita* at 21 C.

Treatment[v]	Coarse particles in soil[w] (%)	Seedlings survived/24 planted	Fresh weight/g seedling	Lesion index[x]	Gall index[y]
No inoculum:	60	24 b[z]	2.41 h[z]		
	75	24 b	2.32 fg[z]		
	90	24 b	2.25 efg		
R. solani:	60	24 b	2.37 gh	1.4 ab[z]	
	75	24 b	2.10 d	1.6 bc	
	90	23 b	2.01 cd	2.0 bc	
M. incognita:	60	24 b	2.25 ef		2.2 a[z]
	75	24 b	1.92 c		3.0 b
	90	24 b	1.59 b		3.1 b
R. solani + *M. incognita:*	60	23 b	2.21 e	1.2 a	2.0 a
	75	22 ab	1.65 b	2.2 c	2.9 b
	90	19 a	1.27 a	2.9 d	3.4 b

[v]Three kernels of grain sorghum infected with *R. solani* were used to infest each container; 2,500 *M. incognita* larvae were pipetted around each seedling.
[w]Table 1 describes the soils.
[x]Severity of *R. solani* infections was rated from 0 = no infection to 4 = dead plant.
[y]Galling frequencies were arbitrarily rated from 0 = no galling to 4 = heaviest galling.
[z]Values followed by the same letter do not differ significantly, $P=0.01$, as determined by Duncan's multiple-range test.

by the 3rd day, but the rate of emergence was slowest in soil with 60% coarse particles. Final numbers of emerged seedlings did not differ among soils or treatments. Seedling survival was lowest (79%) in soil with 90% coarse particles and both *R. solani* and *M. incognita* (Table 2). Seedling survival did not differ among treatments in soils with 60 or 75% coarse particles.

Fresh weights of seedlings decreased as soil coarseness increased (Table 2). Fresh weights of seedlings were lowest when they were grown in soils with 75 and 90% coarse particles and each soil was infested by either *M. incognita* alone or with *R. solani,* plus *M. incognita.*

Lesion indices increased for all treatments as sand content increased. Disease was most severe in soil with 90% coarse particles infested with both *R. solani* and *M. incognita.* Galling indices were greater in the two coarser soils than in the finer soil (Table 2).

These findings support previous reports that particle size is an important determinant of the incidence of *M. incognita* and its influence on cotton yield. Coarse-particle content of soil is important in disease-symptom expression in soils infested with both *M. incognita* and *R. solani*. Severity of soreshin increased in the presence of the nematode as sand content of the soil was increased. These data emphasize the importance of *M. incognita* in enhancing soreshin of cotton seedlings in fields where both organisms commonly occur in sandy soils.

LITERATURE CITED

1. CARTER, W. W. 1975. Effects of soil temperatures and inoculum levels of Meloidogyne incognita and Rhizoctonia solani on seedling disease of cotton. J. Nematol. 7:229-233.
2. DAY, P. R. [Chairman] 1956. Report of the committee on physical analyses, 1954-55. Soil Science Society of America. Proc. Soil Sci. Soc. Am. 20:167-169.
3. HOAGLAND, D. R., and D. I. ARNON. 1938. The water-culture method for growing plants without soil. Calif. Agric. Exp. Stn. Circ. 347. 39 p.
4. O'BANNON, J. H., and H. W. REYNOLDS. 1961. Root-knot nematode damage and cotton yields in relation to certain soil properties. Soil Sci. 92:384-386.
5. OLMSTEAD, L. B. 1937. Some moisture relations of the soil from the Erosion Experiment Stations. U.S. Dep. Agric. Tech. Bull. 562.
6. SLEETH, B., and H. W. REYNOLDS. 1955. Root-knot nematode infestation as influenced by soil texture. Soil Sci. 80:459-461.