The Effect of *Meloidogyne incognita* and Tissue Wounding on Severity of Seedling Disease of Cotton Caused by *Rhizoctonia solani*

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Meloidogyne incognita (Kofoid & White) Chitwood combined with *Rhizoctonia solani* Kühn damage cotton (*Gossypium hirsutum* L.) seedlings more than either pathogen alone (1,2,3,6). It is unlikely that the nematode provides additional penetration sites for the fungus since the two organisms attack spatially separate tissues (2). Brodie and Cooper (1) demonstrated that artifical root-pruning neither reduced growth of cotton seedlings nor increased damping-off from *R. solani* alone or combined with *M. incognita*. However, puncturing hypocotyls of cotton seedlings increased the severity of disease caused by *R. solani* (5).

The purpose of this study was to determine if hypocotyl-wounding and/or root-wounding, in conjunction with *M. incognita* infection, enhanced disease severity of *R. solani* on cotton hypocotyls.

Plastic containers (5.5 × 20 cm) were filled with soil (87% sand, 2% coarse silt, 2.5% silt, and 8.5% clay) to within 7 cm of the container top. Open-ended glass tubes (5 cm × 0.5 cm i.d.) for the introduction of fungus inoculum were placed vertically in the center of each container and an additional 3 cm of soil was added. Preparation of the soil containers, soil, planting of cottonseed, and inoculation with the nematode and fungus have been previously described (2). The containers were placed in a growth chamber at 30 C with a light intensity of 25,000 lux and a 14-h day and 10-h night. When all seedlings had emerged, 2,500 larvae of *M. incognita* were pipetted into a depression next to each seedling. After 48 h, a 7-d-old culture of *R. solani* grown on steam-sterilized grain sorghum seed (2) was macerated in sterile distilled water and 3

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ml of the suspension was pipetted into each glass tube. The temperature in the growth chamber was then lowered to 21 C to provide more favorable conditions for disease development (2). Forty-eight hours after inoculation with *R. solani*, seedlings were wounded by transversely puncturing the hypocotyl 1 cm below the soil line on the side facing the glass tube or by mechanically wounding the roots. Treatments consisted of all possible combinations of root and hypocotyl wounding and *R. solani* and *M. incognita* inoculations. Each treatment was replicated six times, three plants per replication, for a total of 18 plants per treatment. Plants were harvested 23 d after emergence. Each plant was weighed and rated for damage by *R. solani* (disease index) and *M. incognita* (gall index).

Statistics included an analysis of variance, determination of least square means, and a Duncan's multiple range. The experiment was repeated once.

Root-pruning was not a significant factor, singly or combined with other treatments, on fresh weight or the *R. solani* disease and *M. incognita* gall indicies. This agrees with Brodie and Cooper (1). Root-pruning treatments were then eliminated from the data sets to aid in identifying true effects, and all statistical analyses were repeated.

The least square mean arrays of treatments showed *M. incognita* to be the significant factor affecting fresh weights of cotton seedlings. Fresh weights were highest with *M. incognita* alone or in combination with other treatments (Table 1). *R. solani* or hypocotyl wounding did not significantly affect fresh weights compared to controls. Fresh and dry weights had a correlation coefficient, $r = 0.953$.

M. incognita, singly or combined with hypocotyl wounding, was the significant factor in increasing severity of disease induced by *R. solani*. Hypocotyl puncture also significantly increased the severity of disease compared to *R. solani* singly. There was a significant additive effect between *M. incognita* and hypocotyl wounding; this combination had the highest disease rating for *R. solani*. The least mean square arrays did not indicate a synergistic interaction between *M. incognita* and hypocotyl wounding on disease severity.

No treatment had a significant effect on the *M. incognita* galling index (Table 1). *R. solani* was not found on galls or in freehand sections of gall tissue examined microscopically.

Hypocotyl abrasions occur through movement of soil particles by wind and during emergence and growth and development of seedlings. Khadga et al. (4) showed that isolates of *R. solani* usually penetrated seedlings through wounds. Wounds allowed more rapid penetration and development of the fungus within host tissues. However, in most cases, penetration through wounds is not the only way in which the fungus enters the plant; direct penetration of intact cuticle and epidermis often occurs from complex infection structures formed to effect penetration. *M. incognita* can induce

Table 1. The effect of cotton hypocotyl wounding on fresh weight, *Rhizoctonia solani* disease index and *Meloidogyne incognita* gall index.

Treatments	Fresh weight (gms)	Disease index*	Gall index†
Control	2.60 bc‡	...	...
Hypocotyl wound	2.47 c	...	...
R. Solani alone	2.53 bc	1.2 d	...
R. Solani + hypocotyl wound	2.75 abc	1.6 c	...
M. incognita alone	2.81 ab	...	65 a
M. incognita + hypocotyl wound	2.90 a	...	70 a
R. solani + *M. incognita*	2.79 ab	2.1 b	67 a
R. solani + *M. incognita* + hypocotyl wound	2.80 ab	2.6 a	69 a

**R. solani* disease index: 0 = no lesion; 1 = small lesion; 2 = large lesion, no girdling; 3 = lesion girdling hypocotyl; 4 = dead plant.

†*M. incognita* gall index: 0 = no gall; 1–25 = light; 26–50 = moderate; 51–75 = moderate to heavy; and 76–100 = heavy gall.

‡Mean separation in columns by Duncan's multiple-range test, $P = 0.05$.

physiological alterations within plants (5). These alterations may increase the susceptibility of cotton seedlings to *R. solani*.

Hypocotyl wounding and infection by *M. incognita* were independent in enhancing seedling disease caused by *R. solani*, although combined effects were additive. Considering the spacially separate parts of tissue attacked by *M. incognita* and *R. solani*, the data indicate a localized effect from hypocotyl wounding but a systemic effect from the presence of *M. incognita*. Root wounding did not increase susceptibility of the cotton seedlings to *R. solani*. This indicates that root wounds caused by *M. incognita* larva penetration into roots would not be a predisposing factor to seedlings infection by *R. solani*.

LITERATURE CITED

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