Evidence for a Disease Complex Between *Pythium aphanidermatum* and Root-knot Nematodes in Cucumber

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Disease complexes are the result of synergistic interactions between two pathogens and are characterized by greater plant damage than the sum of plant damage from the individual pathogens (Back et al. 2002). Currently, *Fusarium oxysporum* f. sp. *cucumerinum* is the only fungal pathogen known to form a disease complex with nematodes in cucumber (*Cucumis sativus*) or other cucurbits (Choo et al. 1990). Root-knot nematodes (RKN, *Meloidogyne* spp.) are major pathogens of cucurbits in tropical and subtropical regions of the world (Zitter et al. 1996). These nematodes cause extensive root galling and yield reduction in host plants. Several species of *Pythium* cause damping-off and root rot in cucurbits worldwide (Zitter et al. 1996). *Pythium* spp. are also known to interact synergistically with RKN, causing disease complexes in tobacco (Melendez and Powell 1970) and chili pepper (Hasan 1985); however, in lettuce, *P. tracheiphilum* and *M. hapla* had only an additive effect on plant growth (Gracia et al. 1991).

In two earlier studies, we observed substantially greater damping-off of cucumber seedlings due to *Pythium* spp. when pots were inoculated with RKN compared to pots that were not inoculated, and in field plots where populations of RKN were not reduced by a nematicide compared to fluensulfone-treated plots. These two observations prompted the investigation of a potential synergistic interaction in cucumber between *M. incognita* and *P. aphanidermatum*.

*Pythium aphanidermatum* was isolated from symptomatic cucumber seedlings. Inoculum of *P. aphanidermatum* was grown for 9 days in a sand-cornmeal medium before infesting soil at a rate of 91 g of inoculum per pot. Inoculum of *M. incognita* was grown on eggplant for 90 days before culture roots with egg masses were placed in Baermann pans in a mist chamber to obtain second-stage juveniles (J2).

Treatments consisted of *Pythium* alone, RKN alone, *Pythium* + RKN, and a non-treated control. A soil medium consisting of 3:3:1 coarse sand, pasteurized field soil, and a germinating mix, respectively, was moistened and mixed with the *Pythium* inoculum. Approximately 480 cm³ of soil was then placed into 5-cm × 25-cm Cone-tainers (Stuewe & Sons, Tangent, OR). Nine-day-old ‘Rockingham’ cucumber seedlings were transplanted into each Cone-tainer. Nematode inoculum was pipetted around each transplant at 1,500 J2/plant and placed in a growth chamber for 3 weeks (28°C, 75% relative humidity, 12-h photoperiod). Plants were sprinkle irrigated every other day using low water pressure to minimize splashing. The experiment, which was conducted twice, had four replications per treatment and 10 plants per replication; the 10 sub-replicates were grouped together in a completely randomized design.

Plants were monitored daily for symptoms of damping-off; the presence of *P. aphanidermatum* was confirmed in all symptomatic plants by placing hypocotyl sections onto PDA and observing the colony morphology and microscopic characteristics. Final disease incidence was based on the percentage of the 10 plants per replication infected with *Pythium*. Disease incidence data was evalu-

![FIGURE 1](image)

Incidence of *Pythium* damping-off in cucumber inoculated with *Pythium aphanidermatum* singly or in combination with the root-knot nematode (RKN) *Meloidogyne incognita*. The presence of *P. aphanidermatum* was confirmed in all symptomatic plants. Bars are the mean of 10 plants/replication and four replications (N = 40). There was an interaction between treatments with *Pythium* and RKN for Trial 1 (P = 0.015) and Trial 2 (P = 0.0002).

The magnitude of damping-off differed between the two trials of the experiment (trial × treatment, \( P = 0.0007 \)); nevertheless, in both trials, there was greater Pythium damping-off when both RKN and \( P. aphanidermatum \) were present than when either pathogen was present alone (Fig. 1). The increase in plant mortality was confirmed to be synergistic and not additive based on a statistical interaction between the nematode treatment and the Pythium treatment (Trial 1, \( P = 0.015 \); Trial 2, \( P = 0.0002 \)). The reasons for the difference in the damping-off severity between the two trials is not known. Perhaps the viability of the nematode inoculum was lower in Trial 1 than in Trial 2 or conditions such as soil moisture were more favorable for Pythium in Trial 2. The low level of damping-off in the RKN-only pots in Trial 2 may have been due to splashing of Pythium inoculum during watering. Other \( Pythium \) spp. may also interact synergistically with RKN to cause greater disease in cucumber. In an earlier growth chamber experiment where greater damping-off was associated with RKN inoculated pots, \( P. myriotylum \) was isolated from the diseased cucumber plants (K. Morris, unpublished).

Control of seedling diseases in cucumber is heavily reliant upon pesticides. Mefenoxam and metalaxyl are commonly applied to cucumber to control soilborne oomycetes diseases. Our study demonstrates the potential of RKN to interact synergistically with \( P. aphanidermatum \) to cause greater disease in cucumber and indicates that control of these nematodes may also be important for controlling Pythium damping-off in cucumber. Field studies that combine fungicides and nematicides would help to confirm this synergism in the field and also elucidate management options for this disease complex.

**LITERATURE CITED**


