Pasteuria penetrans Suppression of Root-Knot Nematodes in Vegetables.

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Pasteuria penetrans, a bacterial parasite, causes suppression of root-knot nematode in agricultural fields in Florida. The bacterium is reported to be highly specific to species of root-knot nematodes, e.g., *P. penetrans* isolate P-20 is specific to *Meloidogyne arenaria* race 1, the peanut root-knot nematodes. Our objective was to determine whether soil suppressiveness could be maintained against this root-knot nematode species in vegetables or whether the field site would become infested with other root-knot nematode species, causing the suppression to break down. Generally speaking at least 3 years is required from time *Pasteuria* is added to soil until it reaches densities that cause suppression. In 2001, the *Pasteuria* isolate specific to *M, arenaria* race 1 was transferred from a known suppressive field site to a site that was clean of the organism. High densities of the nematode were added and peanut was grown over the summer months and common hairy vetch was grown over the winter months. Both crops are hosts to *M. arenaria* race 1. *P. penetrans* reached suppressive numbers within 3 years, which is considered to be the norm for the bacterium to reach suppressive densities. Peanut was grown over the site each summer for 9 years. In spring, 2011 the field was arranged in a split-plot design with eight replicates. Four vegetable crops grown on the site included tomato cv. Bella Rosa, cucumber cv. Cobra, okra cv. Clemson Spineless and squash cv. Golden Summer. The vegetables served as the main crop and the split plot was fumigated with 1,3-dichloropropene (1,3-D) applied broadcast at 112 L/ha. Each plot was covered with aluminized metallic reflective polyethylene film and irrigation and liquid fertilizer were applied via drip tubes. Plot size was 6 m long with rows arranged on 1.8 m centers. Data collected included root-knot nematode galling on each crop, number of root-knot nematode juveniles recovered from each plot, and the number of *P. penetrans* endospores attached per juvenile.

The root-knot nematode galling index was very low among treatments ranging from 0.3 on tomato to zero for okra and squash. Galling on tomato and cucumber was slightly lower in 1,3-D fumigated soil compared with nontreated soil (Table 1). There was a very low level of root-knot nematode galling on all vegetables, ranging from 0 to 0.3. There was also a low density of root-knot nematode second-stage juveniles extracted from soil samples taken after final harvest. The percentages of *P. penetrans* endospores attached to *M. arenaria* J2 ranged from a high of 79% to a low of 27.3%. There was no obvious difference in endospore attachment rate between 1,3-D treated plots vs. nontreated plots (Table 1). Lower numbers of juveniles were extracted from samples collected from cucumber, okra, and squash plots compared with tomato.

The laboratory bioassay demonstrated there was a high rate of survival of *P. penetrans*

endospores in the various treatments. *Pasteuria penetrans* endospores were attached to nearly all J2 from all plots. The percentages of J2 with endospores among the four treatments were very similar ranging from 72% to 78%. The highest percentage of endospore attachment was recorded for soils collected from okra followed by cucumber, tomato, and squash. There was no endospore attachment category greater than 4 (16 to 100 endospores/J2) (Table 2).

In summary, the field site was highly suppressive to *M. arenaria.*

1. The data suggests that *P. penetrans* isolate P20 played an important role in the nematode control and the reduction of plant damage.

2. A high degree of soil suppressiveness was maintained in the field site as we transition from peanut to vegetables.

3. Only a very low incidence of *M. incognita* females was extracted from galls on tomato.

4. *M. arenaria* remains the dominant root-knot nematode species in the field site.

Table 1. Number of second stage juveniles (J2), percentage of J2 with *Pasteuria penetrans* endospores attached to *Meloidogyne arenaria* race 1 per 250 cm^3 of soil and galling percentages on vegetable crops (treated or nontreated with 1,3-dichloropropene) grown in a root-knot nematodes suppressive site.

Plant cultivar	1,3-D	Nu. of J2	% of J2 with endospores attached	Galling indicies
Tomato	-	18.6	48.1	0.3
cv. Bella Rosa	+	10.9	31.0	0.2
Cucumber	-	2.9	30.4	0.2
cv. Cobra	+	1.4	63.6	0.1
Okra	-	2.4	79.0	0.0
cv. Clemson Spinless	+	3.3	46.2	0.02
Squash	-	0.4	33.3	0.0
cv. Golden Summer	+	1.4	27.3	0.0

Data are means of eight replicates

Galling indicies were determined on six plants per plot at harvest and was based on a scale of 0 to 10 (0 = no galls observed é é . 10 = 100% of root system galled.

Table 2. Bioassay[a] of the percentage of second-stage juveniles (J2) of *Meloidogyne arenaria* race 1 with endospores of *Pasteuria penetrans* attached in soil collected at harvest of vegetable crops.

Plant cultivar	% of J2 with endospores attached	Endospores/J2[b] (categories) None	1-2	3-5	6-15	16-100	>100
Tomato							
cv. Bella Rosa	75.0	5.0	4.3	2.6	3.5	4.6	0
Cucumber							
cv. Cobra	77.0	4.6	2.6	3.5	4.4	4.9	0
Okra							
cv. Clemson Spinless	78.2	4.4	2.9	3.5	3.3	6.0	0
Squash							
cv. Golden Summer	71.5	5.6	2.9	3.8	2.9	4.9	0

Data are means of eight replicates.

[a]Forty grams of air-dried soil was placed in a 50 ml polyethylene tube and 100 recently hatch J2 were added. Four days later the J2 were extracted via centrifuge-flotation method and the number of *P. penetrans* endospores attached was estimated based on the first 20 J2 that was observed.

[b]Based on 20 second-stage juveniles with endospores attached from each plot divided by six categories.