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Growth of 'Bartlett' Pear Seedlings in Response to Number of Root-lesion Nematodes and Temperature

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Abstract. **The effects of temperature and root-lesion nematodes *[Pratylenchus penetrans* (Cobb)] on the growth of newly germinated 'Bartlett' pear seedlings *(Pyrus communis* L.) were examined. At five temperatures from 10 to 30C, *P. penetrans (five* per gram of soil) did not purple the leaves. After 8 weeks, leaf number, trunk height, and top and root weights were reduced only at 25C. The number of *P. penetrans* in the roots were greatest at 15 and 20C. At 20C, *P. penetrans* (16 per gram of soil) caused the leaves of seedlings to turn purple, and, by 6 weeks after treatment, the nematodes had reduced leaf production, trunk elongation, and top and root growth.**

In nurseries, pear seeds often are planted in the fall for rootstock production, then budded the following July and August. If the nursery soil is not fumigated, the root-lesion nematode, if present, may be destructive to the developing seedlings. In New York state, Mai and Abawi (1978) showed in growth room studies that *Pratylenchus penetrans* suppresses the growth of apple and pear seedlings. However, in their studies, apple and pear seed were germinated, then 1 to 2 cm seedlings were transplanted into sterile soil for 24 days before determining the effects of *P. penetrans.* The current paper presents data on the effects of *P. penetrans* on the growth of 'Bartlett' pear seedlings immediately after germination and the influence of temperature on nematode population development and plant growth.

P. penetrans isolated from strawberry in the Niagara peninsula in Ontario was reared on vetch *(Vicia sativa* L.) grown in a Vineland silt loam (61% sand, 28% silt, 11% clay). Nematodes were extracted by immersing thoroughly washed roots in an aerated 0.0004% ethoxy ethyl mercuric chloride-0.2% streptomycin solution, in 0.56-liter Mason jars. After 2 weeks, the nematodes were concentrated using a Millipore filter and resuspended in aerated distilled water.

'Bartlett' pear seeds were harvested, planted in trays in sterile compost soil, and placed in a 5C cold chamber for 90 days. After seed stratification, the trays were placed in a greenhouse at 20 to 22C. Two experiments were performed when seedlings were 2 to 3 cm high (7 to 9 days old).

In the first experiment, the effects of temperature on nematode population development and the growth of 'Bartlett' pear seedlings was determined. Thirty-five 1-kg lots each of Vineland silt loam were inoculated with 5500 *P. penetrans* and put into 850-ml clay pots; 35 other pots were prepared with uninoculated soil. Fourteen pots of soil, seven inoculated and seven uninoculated, were prepared for each of five growth rooms maintained at 10, 15, 20, 25, or 30C. The 35 pots of inoculated soil were prepared simultaneously and seven were randomly assigned to each of the five temperatures. In each growth room with a 16-hr day and 120 $\mu mol \cdot s^{-1} \cdot m^{-2}$ photosynthetic photon flux (PPF), the 14 pots were randomly placed in a 2 × 7 arrangement. At 8 weeks, trunk height, number of new leaves, and fresh trunk and root weights were determined. *P. penetrans* was extracted from the roots as described above. Data were subjected to analyses of variance using a completely randomized design.

In the second experiment, 5000 *P. penetrans* were mixed into 1-kg lots of sterile Vineland silt loam and put into 10 replicate 850-ml clay pots. An additional 11,000 *P. penetrans* were pipetted into the impressed planting hole in each pot. A further 10 clay pots were filled with 1 kg of uninoculated sterile soil. A pear seedling was planted in each pot. The pots were randomly placed in a growth room held at 18C at night and 20C during the day at 120 $\mu mol \cdot s^{-1} \cdot m^{-2}$ PPF for 16 hr. Trunk height was measured every 2 weeks, and, at 6 weeks, the number of new leaves were counted and trunk and root weights were determined. *P. penetrans* was extracted from the roots at 2-week intervals as described above. Data were subjected to analyses of variance using a completely randomized design.

At the end of 8 weeks of the first experiment, the effect of inoculation with *P. penetrans* varied with temperature for number of new leaves, top weight, and root weight ($P < 0.05$); the interaction was almost sig-

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Table 1. Analysis of variance for pear seedling characteristics and *Pratylenchus penetrans* in root system as related to temperature and inoculation (Expt. 1).

Source of variation	df	Trunk ht (cm) Mean square	Trunk ht (cm) Significance level	New leaves (no.) Mean square	New leaves (no.) Significance level	Top wt (g) Mean square	Top wt (g) Significance level	Root wt (g) Mean square	Root wt (g) Significance level	*P. penetrans*/ root system Mean square	*P. penetrans*/ root system Significance level
Temperature (T)	4	41.5	<0.001	103.6	<0.001	4.7	<0.001	1.9	<0.001	1288031	<0.001
Inoculated (I)	1	5.1	0.03	62.2	<0.001	1.0	0.07	0.9	0.02	---	---
T × I	4	10.6	0.07	16.4	<0.001	0.9	0.02	0.6	0.01	---	---
Residual	60	4.6		2.9		0.3		0.2		118391[z]	

[z]Degrees of freedom = 30.

Table 2. Pear tree seedling characteristics and *Pratylenchus penetrans* in root system as related to temperature (Expt. 1).

Temp (°C)	Trunk ht (cm) +	Trunk ht (cm) −	New leaves (no.) +	New leaves (no.) −	Top wt (g) +	Top wt (g) −	Root wt (g) +	Root wt (g) −	*P. penetrans*/ root system +[z]
10	4.1	3.5	3.4	4.4	1.0	1.0	0.7	0.8	349
15	5.7	5.1	7.0	7.3	1.8	1.9	1.6	1.5	1072
20	6.9	6.5	7.2	9.7	2.1	2.1	1.6	1.7	800
25	5.5	8.9	5.8	11.3	1.3	2.5	0.8	1.8	110
30	7.9	8.7	11.2	11.6	2.5	2.7	1.3	1.6	120
SED[y]	1.1		0.9		0.2		0.2		184

[z]None present in noninoculated samples.
[y]Pooled standard error of the difference of temperature by inoculation treatment means.

Table 3. Effect of *Pratylenchus penetrans* on the growth of 'Bartlett' pear seedlings over 6 weeks at 20C (Expt. 2).

Inoculation	Trunk ht (cm) Weeks after treatment 2	4	6	New leaves (no.)	Top wt (g)	Root wt (g)	*P. penetrans*/ root system
−	3.0	4.1	9.5	8	1.6	1.4	---
+	2.1	2.2	3.2	2	0.6	0.6	640
SED[z]	0.3	0.5	1.0	0.6	0.2	0.2	60[y]

[z]Pooled standard error of the difference of treatment means.
[y]Standard error of the mean.

nificant ($P = 0.07$) for trunk height (Table 1). For each of the response criteria, the largest differences between inoculated and uninoculated pots was observed at 25C (Table 2). The greatest numbers of *P. penetrans* after 8 weeks were extracted from the roots of seedlings grown at 15 and 20C, although the only significant difference in growth characteristics at these two temperatures was the number of new leaves at 20C ($P < 0.05$) (Table 2); the nematodes found in the root systems were substantially lower at ($P < 0.01$) 10, 25, and 30C. Leaves of inoculated seedlings did not become purple as in the second experiment; however, rosetting of inoculated seedlings was noted at 15C. For the uninoculated seedlings, trunk height, number of new leaves, and top weight increased ($P < 0.01$) with temperature; root weight did not differ ($P > 0.05$) at temperatures > 15C. Except at 25C, the same patterns were observed for the inoculated plants.

In the second experiment, the height of uninoculated 'Bartlett' pear seedlings was greater ($P < 0.01$) than those of inoculated seedlings at each determination (Table 3). At week 6, the number of new leaves and the fresh top and root weights of uninoculated seedlings were greater ($P < 0.001$) than those of inoculated seedlings (Table 3).

The original leaves on the pear seedlings grown in soil inoculated with *P. penetrans* turned purple during the 6 weeks of the experiment. The few new leaves that developed were smaller than those on uninoculated seedlings and began to turn purple toward the end of the experiment. The leaves of the uninoculated seedlings remained a deep green and normal size throughout the experiment. The root systems on inoculated seedlings were small compared to those of uninoculated seedlings. Few new lateral roots had developed and few feeder roots were present. Many original roots were completely discolored and collapsed. On new roots, orange-brown elliptical lesions were observed and many of these had coalesced and girdled the roots, resulting in the cortex splitting to the stele. By using a microscope, several nematodes were observed to have penetrated roots to a third of their body length, and necrosis had developed in the cortex two to three cells beyond the point of penetration.

This study demonstrated that a high concentration of *P.* penetrans can affect the quality of pear seedlings and possibly reduce the number of seedlings suitable for budding. The 25C level, in which *P. penetrans* is most destructive, occurs most commonly in July and August in southern Ontario. The few *P. penetrans* in the roots at 25C may have been the result of the nematodes abandoning the roots because of the extensive damage caused by their feeding (Townshend and Stobbs, 1981). Bunt (1973) made similar observations with apple seedlings: *P. penetrans* reduced seedling growth at higher temperatures, 25 to 30C, and the number of *P. penetrans* increased to a greater extent at lower temperatures, 10 to 15C. The purpling of pear leaves in the second experiment, when the *P. penetrans* population was very dense, suggests P deficiency. Leaf analyses were not performed; however, Trudgill (1977) showed in field trials that the cyst nematode *[Globodera rostochiensis* (Wollenweber)] reduced the concentration of P in potato, and Bird and Vitosh (1978) showed that the control of *P. penetrans* with the nematicide 2-methyl-2-(methylthio)propionaldehyde *O*-[(methyl)carbonyl]oxime (aldicarb) increased the concentration of P in potato. Treatment of nursery sites with nematicides to control *P. penetrans* is a practical procedure for the establishment of pear seedlings (Bunt, 1973; Colbran, 1979; Mai and Abawi, 1978).

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