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Reaction of Six *Solanum tuberosum* Cultivars to *Pratylenchus penetrans*

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Abstract: Six potato cultivars—Superior, Yukon Gold, Monona, Norchip, Kennebec, and Russet Burbank—were grown in Tioga loamy sand in tile microplots noninfested or infested with 9,800–11,500 *P. penetrans*/kg soil. At midseason, soil nematode population densities on Superior potatoes were 39,800/kg compared with 17,500–25,800/kg on the other cultivars. At harvest, 118 or 139 days after planting depending on maturity date, the final soil *P. penetrans* population density was 24,400/kg with Superior and 34,100–51,500/kg with the other cultivars. No differences occurred in the rate of nematode build-up in soil on the six potato cultivars. The nematode suppressed yield of marketable tubers of Superior by 73% and of Yukon Gold by 25%. Losses for Russet Burbank (61%), Kennebec (55%), Monona (46%), and Norchip (43%) were intermediate.
Key words: Irish potato, root lesion nematode.

The root-lesion nematode, *Pratylenchus penetrans* Cobb, at population densities of 1,600–2,050/kg soil affected neither growth nor yield of five of six potato (*Solanum tuberosum* L.) cultivars tested (9). Marketable yield of only Russet Burbank was suppressed 15.7% by 1,850 *P. penetrans*/kg soil. Growth and yield of Russet Burbank was not affected by 500 *P. penetrans* per liter of soil in a recent study (5).

At least 12% of the potato fields found infested with *P. penetrans* in Simcoe County, Ontario, contained population densities in excess of 10,000/kg soil (11). Information on the relative host status and susceptibility of the main potato cultivars to such high densities would be useful to growers in selecting the most tolerant cultivar in the absence of other control measures.

The objective of this study was to determine the relative host status and susceptibility to damage of six potato cultivars at initial soil population densities (Pi) of *P. penetrans* found in fields commonly showing damage symptoms. A preliminary report of this study has been presented (10).

MATERIALS AND METHODS

Tioga loamy sand, heavily infested with *P. penetrans*, was removed from a grower's field at Alliston, Ontario, sieved to remove coarse roots, and thoroughly mixed. Control soil was prepared by steaming field soil for 30 minutes at 82 C. Either nematode-infested or steamed soil (10 kg) was placed in clay drainage tiles (20 cm i.d. and 30 cm long) buried vertically in fumigated field soil on 1.2 m centers. Microfloral restoration and fertilization was achieved by mixing, respectively, 33.5 g air-dried soil

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TABLE 1. Soil and root population densities of *Pratylenchus penetrans* under six potato cultivars in microplots at Jordan Station, Ontario.

	No. per kg soil			No. in roots at harvest*	
Cultivar and maturity	Initial	Midseason	Harvest*	Per root system	Per g dry root
Medium (118 days)					
Superior	10,100 az	39,800 ax	24,400 dy	1,100 c	3,400 c
Yukon Gold	11,400 az	20,500 dcy	34,100 cx	5,110 ab	5,100 bc
Monona	9,700 az	17,500 ey	40,500 cx	4,860 a	10,300 a
SEM			2,390	1,290	1,320
Late (139 days)					
Norchip	11,500 az	21,400 cdy	39,700 bx	2,140 bc	15,300 ab
Kennebec	10,700 az	24,600 bcy	43,300 bx	1,660 bc	3,800 c
Russet Burbank	11,200 az	25,800 by	51,500 ax	5,070 a	9,700 ab
SEM	680	1,570	1,900	640	3,290

Numbers are the means of 20 replicates. Column means followed by common letters a, b, c, d, or e, and row means followed by common letters x, y, or z are not significantly different ($P = 0.05$), according to Duncan's multiple-range test on data subjected to a log(x + 200) transformation. The transformed averages do not correspond fully to the average original nematode counts.

* Unequal harvest date analysed using orthogonal multipliers (5).

and 7.2 g 10-10-10 fertilizer (equivalent to 780 kg/ha of 15-15-15) with each 10 kg soil. Resistance-block moisture–temperature sensors (9) were placed in two tiles at depths of 15 and 30 cm. Each treatment was replicated 20 times for a total of 240 completely randomized microplots (tiles).

On 11 May 1983, Pi was determined by the Baermann pan method (14), after which whole 5-cm tubers of the six cultivars (Superior, Yukon Gold, Monona, Norchip, Kennebec, and Russet Burbank), treated with disulfoton 15 G at 0.23 g/tuber, were planted as described (9).

Plants were sprayed with carbaryl 50 WP at 2.25 kg formulation/ha 29 and 55 days after planting. Plants were sprayed with a mixture of the fungicide mancozeb M45 at 2.25 kg formulation/ha and the aphicide pirimicarb 50 WP at 500 g formulation/1,000 liters water 62 days after planting. Plants were sprayed with a mixture of carbaryl and mancozeb at the same rates 85 and 92 days after planting.

Top growth was rated by visually estimating the percentage of the tile surface covered with foliage 27 days after planting. After 49 days soil samples were collected and processed, and 75 days after planting all plants were visually rated for maturity based on the degree of shoot senescence.

Cultivars Superior, Yukon Gold, and Monona were harvested 118 days after planting, and Norchip, Kennebec, and Russet Burbank after 139 days. Shoot and root weights were determined after oven-drying; all tubers were individually graded and weighed as described previously (9). Final soil nematode population densities (Pf) were determined by the Baermann pan method (14) and root Pf after 2 weeks extraction in a mistifier (12). Nematode count data were transformed—log(x + 200)—before statistical analysis, and linear regression lines of nematode soil population increase rates were calculated (6) and compared (13).

RESULTS

Shoots of nematode-infected early maturing Superior, Yukon Gold, and Monona were smaller than noninfected control plants 27 days after planting; of the late maturing cultivars, only shoot growth of Russet Burbank was suppressed by nematode infection ($P = 0.01$). Shoots of only nematode-infected Superior plants were more senesced than the noninfected control plants 75 days after planting; no differences in time of maturity were observed among the other cultivars.

At midseason, the soil nematode population density had almost quadrupled on Superior and doubled on the other cultivars (Table 1). At harvest, the soil Pf on Superior was about 40% lower than at midseason, whereas on the other cultivars the

TABLE 2. Effect of *Pratylenchus penetrans* on shoot and root dry weights (in grams) of six potato cultivars grown in microplots at Jordan Station, Ontario.

	Shoots			Roots		
Cultivar and maturity	Control	Nematodes	Loss (%)	Control	Nematodes	Loss (%)
Medium (118 days)						
Superior	71 a*	10 d	86.8 a	0.58 c*	0.27 cd	51.4 a
Yukon Gold	61 b	43 bc	28.6 d	0.87 b	0.62 ab	24.0 ab
Monona	70 b*	30 c	54.3 c	0.81 bc*	0.44 bc	44.8 a
Late (139 days)						
Norchip	44 b*	12 d	65.5 bc	0.21 d	0.20 d	4.0 b
Kennebec	233 a*	55 ab	71.3 b	1.05 b*	0.47 b	47.8 a
Russet Burbank	268 a*	60 a	76.5 ab	1.64 a*	0.69 a	53.9 a
SEM	15	5	4.3	0.90	0.65	10.8

Weights are the means of 20 replicates. Column means followed by common letters a, b, c, or d are not significantly different ($P = 0.05$), according to Duncan's multiple-range test.
Asterisk (*) indicates a significant difference at $P = 0.05$ between nematode-infected potato and control.

population densities had doubled again since midseason.

No cultivar differences in the rate of nematode increase in soil were noted, as the residual variances were homogenous ($\chi^2 = 2.45$ at 5 df) and the slopes and elevations were not significant.

At harvest, the numbers of *P. penetrans* per root system were greatest in Yukon Gold, Monona, and Russet Burbank and lowest in Superior (Table 1). Superior and Kennebec contained fewer nematodes per gram of dry root than the other cultivars.

At harvest, shoots of all noninfected control plants were darker green than shoots of plants grown in nematode-infested soil. Dry shoot and root weights of all nematode-infected potato cultivars were smaller ($P = 0.01$) than comparable noninfected controls with the exception of Yukon Gold for both shoot and root weight and Norchip for root weight (Table 2).

Total and marketable numbers and weights of tubers of all six cultivars were suppressed ($P = 0.01$) by *P. penetrans* (Tables 3, 4). The percentage suppression in marketable yield ranged from 73% for Superior to 25% for Yukon Gold.

For most of the growing season, soil temperatures at 15 and 30 cm deep ranged between 19 C and 26 C (Fig. 1). During a dry period in June and July, supplementary water was provided on 11 July (1 liter/microplot) and 27 July (1.5 liter/micro-

TABLE 3. Effect of *Pratylenchus penetrans* on numbers of tubers per plant of six potato cultivars grown in microplots at Jordan Station, Ontario.

	Total			Marketable (5 cm†)		
Cultivar and maturity	Control	Nematodes	Loss (%)	Control	Nematodes	Loss (%)
Medium (118 days)						
Superior	21.1 c**	7.9 c	60.5 a	11.2 bc**	3.7 c	66.3 a
Yukon Gold	19.7 cd**	8.8 c	53.2 ab	9.6 c**	5.9 b	38.6 b
Monona	15.0 d**	9.4 c	29.2 cd	7.5 d**	4.7 bc	31.9 b
Late (139 days)						
Norchip	23.5 c**	13.1 b	40.2 bc	10.0 bc**	5.8 b	38.5 b
Kennebec	30.7 b**	20.5 a	23.1 d	15.4 a**	8.0 a	43.1 b
Russet Burbank	49.0 a**	18.5 a	61.3 a	11.7 b**	5.7 b	63.4 a
SEM	1.7	1.0	6	0.6	0.4	6

Numbers are the means of 20 replicates. Column means followed by common letters a, b, c, or d are not significantly different ($P = 0.05$), according to Duncan's multiple-range test.
Double asterisk (**) indicates a significant difference at $P = 0.01$ between nematode-infected potato and control.
† All cultivars except Russet Burbank which requires a minimum length of 7 cm.

TABLE 4. Effect of *Pratylenchus penetrans* on tuber weight per plant of six potato cultivars grown in microplots at Jordan Station, Ontario.

Cultivar and maturity	Total			Marketable (5 cm†)		
	Control	Nematodes	Loss (%)	Control	Nematodes	Loss (%)
Medium (118 days)						
Superior	1,468 b**	392 d	73 a	1,285 c**	302 d	73 a
Yukon Gold	1,268 bc**	834 b	32 c	1,107 cd**	778 b	25 d
Monona	1,077 c**	584 c	46 b	951 d**	507 c	46 bc
Late (139 days)						
Norchip	1,316 bc**	659 c	45 b	1,103 cd**	540 c	43 c
Kennebec	2,432 a**	1,148 a	50 b	2,187 a**	941 a	55 bc
Russet Burbank	2,534 a**	1,054 a	57 b	1,597 b**	715 b	61 ab
SEM	82	51	4	87	48	6

Weights are the means of 20 replicates. Column means followed by common letters a, b, c, or d are not significantly different ($P = 0.05$), according to Duncan's multiple-range test.
Double asterisk (**) indicates a significant difference at $P = 0.01$ between nematode-infected potato and control.
† All cultivars except Russet Burbank which requires a minimum length of 7 cm.

plot); during July, the soil moisture was below 8% at 30 cm deep and below 6% at 15 cm deep.

DISCUSSION

Although there were no differences in the rate of nematode increase on the six potato cultivars, population densities of *P. penetrans* in soil around all cultivars increased during the growing season by 2.4-fold on Superior to 4.6-fold on Russet Burbank. In contrast to results with relatively small Pi (9), there was no inverse relationship between soil Pf and root Pf in this study. Root Pf in this experiment averaged less than half the number found with a much smaller Pi in a previous study (9), probably because of greater root destruction (37.6%) with large Pi in the present study compared with only 11.0% destruction with the small Pi (9). The number of *P. penetrans* per gram of root in Superior was much smaller than in Russet Burbank, agreeing with the report of Bernard and Laughlin (2), but not with the author's previous study (9).

Several workers (1,4,7) have noted that damage by nematodes is usually much greater when the crop is subjected to drought. During 1982, when the previous study with small Pi was conducted (9), there were lower temperatures and higher precipitation than the long-term average, which may have lessened the damage by *P. penetrans* in five of the six cultivars. In the present experiment, soil moisture during tuber initiation and enlargement (mid June to end of July) was mostly below optimum levels, and this may have exacerbated the damage caused by the nematode.

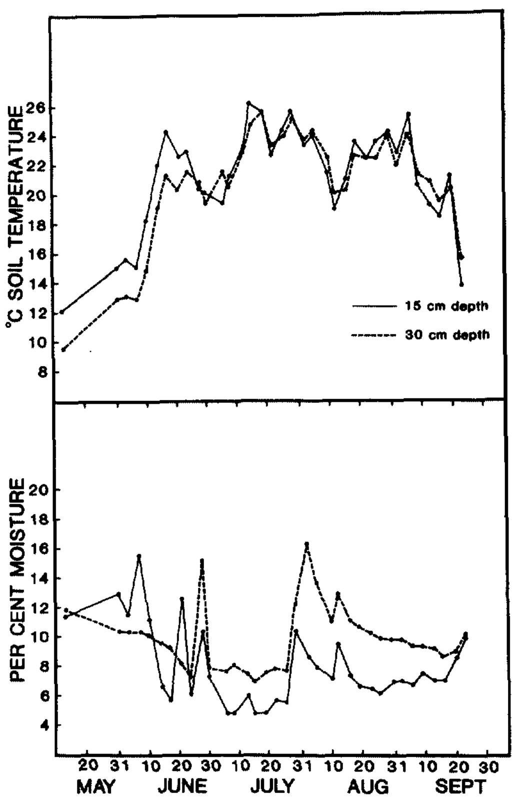

FIG. 1. Soil temperature and moisture in microplots cropped to potatoes at Jordan Station, Ontario, in 1983. Monitored twice weekly.

Differences in susceptibility to damage by *P. penetrans* were shown to exist among potato cultivars; however, total and marketable yields were suppressed by the nematode in all cultivars tested. Superior suffered the greatest loss in total weight of tubers, and Yukon Gold was damaged least. Suppression of shoot weight appears to be directly related to suppression in total tuber weight. Noling et al. (8) also showed that suppressions by *P. penetrans* in potato leaf dry weight were reflected in suppressed tuber weight and number. Although root destruction caused suppression in shoot and tuber weight, the relation between root and tuber weight in this experiment was less clear.

Early season Superior and late season Russet Burbank suffered most from root-lesion nematode in this experiment, suggesting that time of maturity bears no relation to resistance or susceptibility to damage by *P. penetrans*. Superior (3,7) and Russet Burbank (4) were found by others to be quite sensitive to damage by *P. penetrans* in the field.

This experiment has shown that differences exist among potato cultivars in their susceptibility to damage by *P. penetrans* Pi of 10,800/kg soil. In the absence of other nematode control measures, growers are advised to avoid planting the highly susceptible Superior and grow a less susceptible cultivar, such as Yukon Gold.

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