

## Movement of Potato Root Diffusate Through Soil

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**Abstract:** Movement of potato root diffusate (PRD) through soil was examined by using the hatch of eggs from *Globodera rostochiensis* cysts as an indicator. Porous bags containing cysts were placed at increasing distances and depths from potato roots, whose growth was restricted by nylon mesh. Significantly greater hatch was observed up to 50 cm laterally away from potato roots, compared with hatch in fallow soil. Eight weeks after plant emergence, we detected a concentration gradient of PRD, as measured by egg hatch, that decreased with increasing lateral and vertical distance from the root zone. Egg hatch beyond 5 weeks after plant emergence was not attributed to PRD.

**Key words:** potato root diffusate, *Globodera rostochiensis*, hatch.

Persistence in soil of the unknown factor in potato root diffusate (PRD) that stimulates hatch of *Globodera rostochiensis* has been examined with conflicting results (1,3,7). Although this factor is generally considered unstable in soil (1), it retains its activity in sterile solution (5) and is stable in partially purified form (J. L. Riopel, pers. comm.).

Four weeks after emergence of field-grown susceptible and resistant potato cultivars, we detected a decline in *G. rostochiensis* population densities midway between potato rows that was significantly greater than decline in fallow soil (4). The absence of potato roots between rows indicated considerable movement of PRD in soil. To better understand movement of PRD away from potato roots, we monitored its movement under controlled conditions using *G. rostochiensis* egg hatch as an indicator.

### MATERIALS AND METHODS

Wooden boxes (90 cm long × 30 cm wide × 50 cm deep) were built with 5-cm holes centered every 10 cm vertically and horizontally along the sides (Fig. 1). Two boxes were used for each of several horizontal and vertical root restriction treatments and two were left fallow. Root growth was restricted by two layers of nylon

mesh (130 μm) stretched across rectangular wooden frames. Boxes were filled with sterile potting compost (peat moss and loam in unknown proportions) and nylon bags (2 cm<sup>2</sup>, 250-μm mesh) containing cysts were implanted at appropriate intervals (Fig. 1). To reduce edge effects, outermost bags were placed 8 cm from the wooden sides. Each bag contained 10 uniformly sized (0.35–0.45 mm) *G. rostochiensis* cysts (mean content of 347 viable eggs per cyst) produced 3 months previously in pot culture on the susceptible potato cultivar Katahdin. Each bag was removed at sampling with a nylon cord leading to the exterior of the box. The holes in the boxes were sealed with 5-cm rubber stoppers.

Uniformly sized and sprouted tuber pieces of the susceptible potato cultivar Katahdin were planted in the nonfallow boxes, and all boxes were placed on benches in a greenhouse with supplemental illumination. Soil temperature was maintained at 20 C. Equal amounts of water were applied uniformly and daily to all boxes, and a slow release fertilizer, Osmocote, was applied to the planted boxes.

Two replicate bags were removed from each position at 2, 3, 4, 5, 6, and 8 weeks after plant emergence (AE). Cysts were removed from the bags and crushed, and the number of viable eggs per cyst was determined.

### RESULTS

Plant emergence was 100% in all planted boxes. Shoot growth was normal for potatoes cultivated under greenhouse conditions. Flowering occurred 25 days AE.

Received for publication 16 October 1985.

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The authors thank M. Brucato and D. Thurston for technical assistance and S. Rawsthorne for help with the manuscript.

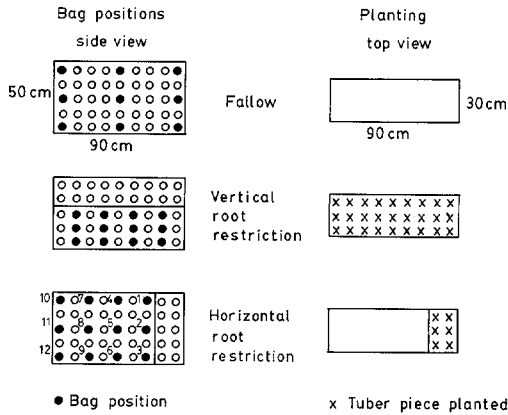


FIG. 1. Diagrammatic representation of growth boxes used, indicating positioning of bags containing cysts, planting of tuber pieces, and root restriction zones.

Roots that were restricted horizontally reached the bottom of the boxes 10 days AE and some lateral breakthrough was first observed 11 days later. After the boxes were dismantled 8 weeks AE, we observed limited root growth between the frames and box walls, and in all boxes many fine lateral roots had penetrated the mesh, extending 3–4 cm past the barrier.

Hatch in the fallow boxes was not affected by bag position. Fallow decline steadily increased about 5% weekly, reaching a maximum of 39.9% 8 weeks AE. To estimate hatch caused by PRD alone, the average decline of viable eggs per cyst each week in fallow boxes was subtracted from the amount of decline recorded in planted boxes.

In boxes where vertical root growth was restricted, downward movement of PRD

TABLE 1. Number of *Globodera rostochiensis* eggs per cyst remaining at depths of 10, 20, and 30 cm below vertically restricted potato root growth throughout a 9-week growth period.

Depth (cm)	Weeks after emergence					
	2	3	4	5	6	8
10	176	123	62	23	15	9
20	179	153	165	53	19	12
30	199	157	165	78	38	12
LSD ( $P = 0.01$ )	NS	24.9	28.5	27.0	8.5	2.6

Each value is the mean of 16 replicates.

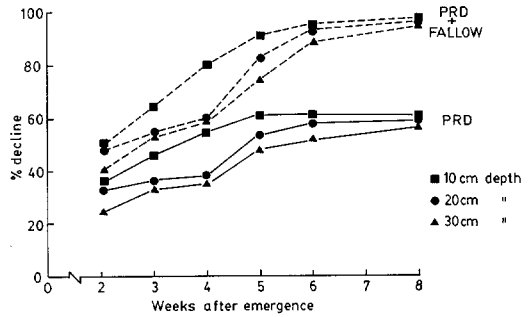


FIG. 2. Actual decline and decline due to PRD alone of encysted *Globodera rostochiensis* eggs at 10, 20, and 30 cm below a vertically restricted root zone throughout the growth period.

to 30 cm, as indicated by decline in the number of viable eggs per cyst, was detected 2 weeks AE (Table 1, Fig. 2). The number of eggs per cyst remaining at each depth decreased with time but at a slower rate with increased depth. Significantly greater hatch occurred at all samplings beyond 3 weeks AE in cysts 10 cm below the root zone than in those 20 and 30 cm deep. Hatch 20 cm deep was significantly greater than hatch 30 cm deep only at 6 weeks AE. Over 95% hatch occurred at all depths 8 weeks AE. Hatch caused by PRD alone took place during the first 5 weeks AE. Subsequent decreases in viable eggs per cyst was caused by unstimulated hatch or egg mortality (Fig. 2).

Lateral movement of PRD 50–70 cm from the root zone was detected 6 weeks AE (Fig. 3). Numbers of viable eggs per cyst decreased with time, but this decrease was less as distance from the root zone increased. Movement of PRD also decreased with depth but to a lesser extent after the period of maximum hatch caused by PRD alone (Fig. 2, Table 2). Maximum decrease in viable eggs per cysts (95%) occurred closest to the root zone at the top of the box (position 1). The least decrease in viable eggs (36%) occurred in cysts furthest away from the root zone at the top of the box (positions 10 and 11, Table 2, Fig. 1). As observed for vertical PRD movement, most hatch stimulation occurred within 5 weeks AE and subsequent decreases in viable eggs per cyst was caused by unstimulated hatch or egg mortality (Table 2).

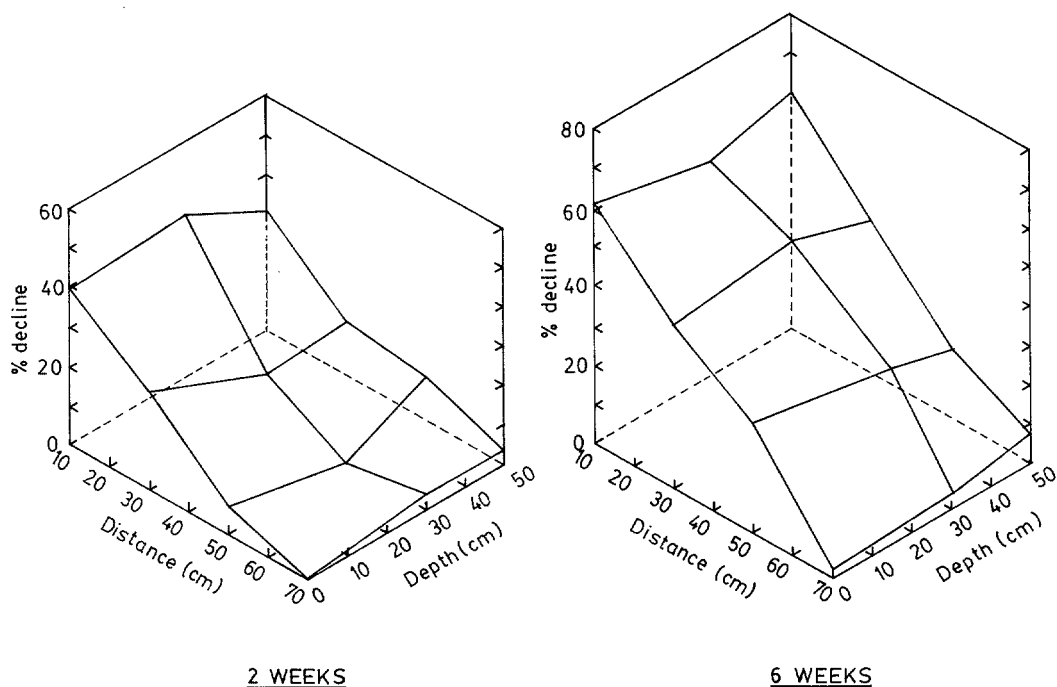


FIG. 3. Decline due to the effect of PRD alone of encysted *Globodera rostochiensis* eggs positioned at various depths and distances away from a horizontally restricted root zone, 2 and 6 weeks after emergence.

Generally, lateral movement of PRD throughout the box was uniform with depth but did not extend as far as did downward movement. Six weeks AE, there was 89.7% and 73.0% decline in viable eggs per cyst 30 cm away from the root zone in boxes with vertical and horizontal root restriction, respectively.

TABLE 2. Number of *Globodera rostochiensis* eggs per cyst remaining at various depths and distances away from horizontally restricted potato root growth during a 9-week growth period.

Distance (cm)	Depth (cm)	Weeks after emergence					
		2	3	4	5	6	8
10	0	157	161	134	42	36	18
	30	175	216	141	26	32	23
	50	192	185	108	39	39	20
30	0	215	262	157	69	94	86
	30	251	254	179	114	96	73
	50	253	276	192	142	96	84
50	0	274	231	219	142	133	128
	30	328	242	225	192	154	138
	50	263	278	237	195	164	174
70	0	300	253	238	233	214	196
	30	275	247	247	228	212	198
	50	259	306	271	227	196	169
<i>F</i> ratios†							
Distance (Dis)		16.2**	12.2**	27.6**	60.0**	109.5**	212.5**
Depth (Dep)		0.9	4.0*	0.7	1.7	0.1	0.3
Dis × Dep		1.3	1.5	0.7	1.0	0.8	1.7

Each value within the table is the mean of four replicates.

† *F* ratios are indicated as significant at \*0.5% or \*\*0.1%.

## DISCUSSION

Vertical and lateral movement of PRD occurred through the rooting medium, and concentration gradients clearly existed as indicated by egg hatch within cysts placed at various distances from the root zone. The decline in nematode populations previously observed midway between potato rows in the absence of roots (4) can now be explained in terms of PRD movement. In this study, stimulation of hatch occurred more than 50 cm away from the root zone. Soil type, moisture content, aeration, and temperature obviously influence PRD movement, and further work is needed to elucidate these effects. The influence of soil microflora on the PRD breakdown in soil also should be investigated.

Effective PRD is reported to be produced up to 9 weeks AE (6); therefore, hatch stimulation by PRD more than 5 weeks AE is possible. However, hatch beyond levels achieved in fallow soil boxes occurred only during the first 5 weeks AE. Subsequent decline resulted from unstimulated hatch or egg mortality. It could be that PRD already present in the soil lost its activity, and that the PRD being produced was not in sufficient concentrations to stimulate further hatch. Alternatively, all eggs within cysts that were capable of

hatching may have hatched within 5 weeks and further decline may have been due to mortality. Forrest and Farrer (2) discussed differences in the abilities of *G. pallida* eggs to hatch in response to PRD and categorized eggs within single cysts of *G. rostochiensis* by their hatching potential.

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