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Abundance and Vertical Distribution of *Longidorus breviannulatus* Associated with Corn and Potato[1]

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Abstract: *Longidorus breviannulatus* was detected in a field planted to corn after 13 years of potato. Nematode populations were maintained in this field in adjacent corn and potato plots for 2 years but did not increase significantly on either crop. Population levels increased until approximately 60 days after planting and then declined until the end of the growing season. Overwinter mortality was negligible. The vertical distribution of the nematode population changed during the course of the season. More nematodes were recovered from depths of 0–15 cm in early season samples and from depths of 15–30 cm in late season samples. Data indicated that this redistribution was due to nematode migration.

Key words: corn, corn needle nematode, *Longidorus breviannulatus*, migration, potato, *Solanum tuberosum*, vertical distribution, *Zea mays.*

Longidorus breviannulatus Norton & Hoffmann, 1975, the corn needle nematode, is a damaging parasite of corn (*Zea mays* L.). First described from Iowa (9), it has been found in Ontario, Canada (1), and in the northeastern United States (3,5,7,9). Injury thresholds may be as few as 10 nematodes per 100 cm^3 soil (7). Symptoms are most severe during late May and June; they include stunted and chlorotic shoots and reduced root systems.

Some factors affecting the population dynamics and distribution of *L. breviannulatus* have been identified. In addition to corn, other grasses, including graminaceous crops, support nematode populations (3,7). Population increase is greatest in soils that are irrigated (7), have high phosphorus levels (5), or contain more than 90% sand (9).

Longidorus breviannulatus has been found in sandy soils at four sites in southern and central Wisconsin. In 1985, it was detected in research plots planted with corn after 13 years of continuous potato (*Solanum tuberosum* L.). Patches of stunted corn were evident soon after planting. Beginning in 1986, nematode populations were monitored to determine the host status of potato for *L. breviannulatus* and to study the effect of host crop and seasonal changes on the vertical distribution of nematodes.

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Materials and Methods

Plots were established on irrigated Plainfield loamy sand (92% sand, 5% silt, 3% clay) at the Hancock Agricultural Research Station, Plainfield, Wisconsin. Potato was grown on the site from 1972 to 1984; corn was grown in 1971 and 1985. In 1986 and 1987, eight rows of corn ('WIS 4763') and potato ('Russet Burbank') were planted in adjacent strips 90 m long and separated by a 3.6-m-wide alley. The site was plowed on 8 April 1986 and 14 April 1987. Potato was planted 24 April 1986 and 29 April 1987; corn on 8 May 1986 and 30 April 1987. Potato plots were hilled the first week in June. Fertilizer, herbicides, and insecticides were applied according to recommended practices. Soil temperature was monitored in the potato plots during 1987 with five thermocouples buried at 7.5-cm intervals 3.6–33.6 cm deep and recorded by a CR-21X micrologger (Campbell Scientific). Potato was harvested on 30 September 1986 and 2 October 1987. Corn was harvested on 22 October 1986 and 15 October 1987. There was no fall tillage.

The strips of continuously planted corn and potato were divided for sampling purposes into 10 plots, 6 m long with 3 m between plots. Samples were collected on nine dates at intervals of 2–4 weeks, including immediately after planting and before harvest. Soil cores, 2.5 cm d × 37.5 cm deep, were collected with a sampling tube from the six inner rows. In 1986, six cores were collected from each plot. In 1987, 10 cores were collected from each of six plots; plot 7 was fallowed and plots 8–10 were not sampled. The cores were divided into five 7.5-cm sections corresponding to position in the vertical soil profile and composited by depth.

One day before harvest in 1987, additional samples were collected from the 45–60-cm depth in the corn plots. A sampling tube was inserted into the holes made by the removal of the 0–37.5-cm sample core. Two, four, and eight weeks after planting, 10-core samples were collected to a depth of 30 cm from each of the two fallow plots.

A 100-cm^3 aliquot of soil from each sample was processed by a centrifugal-flotation technique (6) using nested 250-μm-pore and 38-μm-pore sieves. Roots and debris retained on the 38-μm-pore sieve during the soil washing procedure were placed on Baermann funnels for 2 days. *L. breviannulatus* were counted from entire samples using a dissecting microscope and categorized as juvenile or adult. Counts were not adjusted for extraction efficiency because of the high recovery (> 90%) by the techniques employed (MacGuidwin, unpubl.). After removing the subsample for nematode extraction, replicate soil samples from each depth were combined and the percentage of soil moisture, by weight, was determined.

Analysis of variance (ANOVA) and regression procedures were performed ($P \leq 0.05$) on raw nematode counts for the five soil strata collected among and between sampling dates. The percentage of the nematodes at each depth was calculated for each replicate sample by dividing the number of nematodes at each depth by the sum of the counts from all depths. For analyses of population levels over time, data from all five depths were pooled for each sampling date.

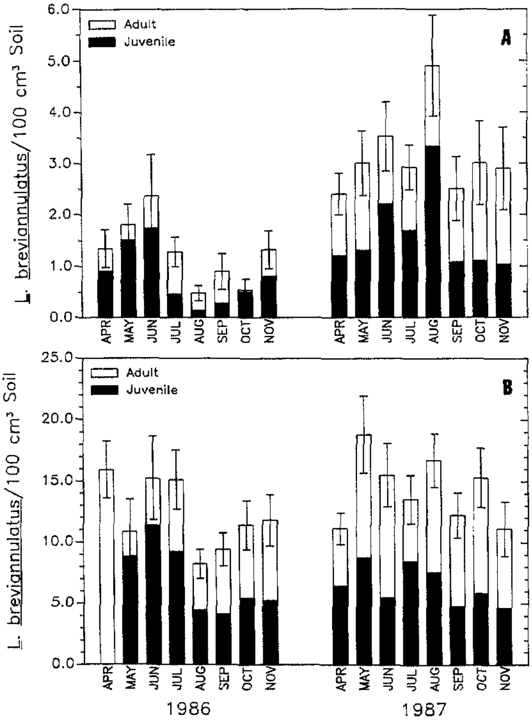

FIG. 1. Mean numbers of adult and juvenile *Longidorus breviannulatus* (± SE of total) extracted from potato (A) and corn (B) plots during 1986 and 1987. In months with multiple sampling dates, only one is reported. Samples were collected in April 1986 from corn plots when potatoes were planted; only total nematode numbers were recorded.

RESULTS

Longidorus breviannulatus populations reproduced on both potato and corn (Fig. 1). All juvenile stages and nongravid and gravid females were recovered from soil samples. The frequency of males in the population was less than 1%. Initial population levels were 1.3 nematodes/100 cm^3 soil on potatoes and 12 times greater on corn. There were no consistent trends in the population dynamics between years or crops. Total numbers of nematodes increased ($P \leq 0.05$) by June 1986 and August 1987 in potato plots. Populations in corn plots increased ($P \leq 0.05$) only in May 1987. Mean ratios of juveniles to adults ranged during the season from 0.5 to 4.4 for corn and from 0.4 to 12.5 for potato. Population levels associated with corn and potato did not decline from the fall of 1986 to the spring of 1987 (Fig. 1). Few nema-

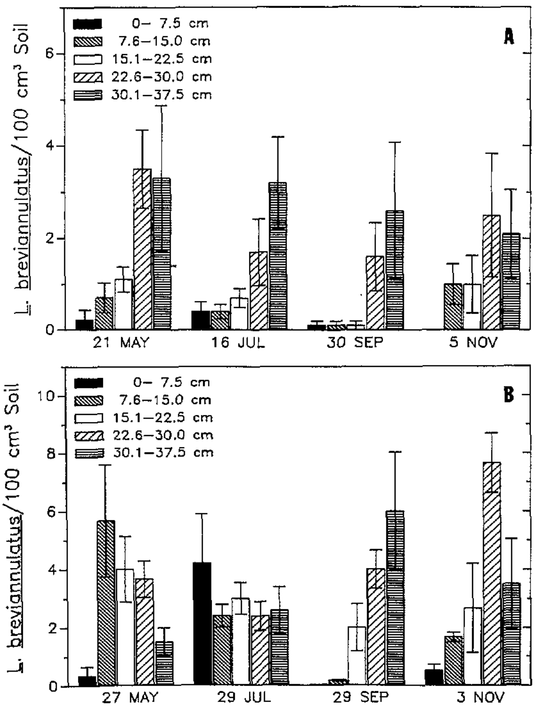

FIG. 2. Mean numbers (± SE) of *Longidorus breviannulatus* extracted from five soil depths in potato plots during 1986 (A) and 1987 (B).

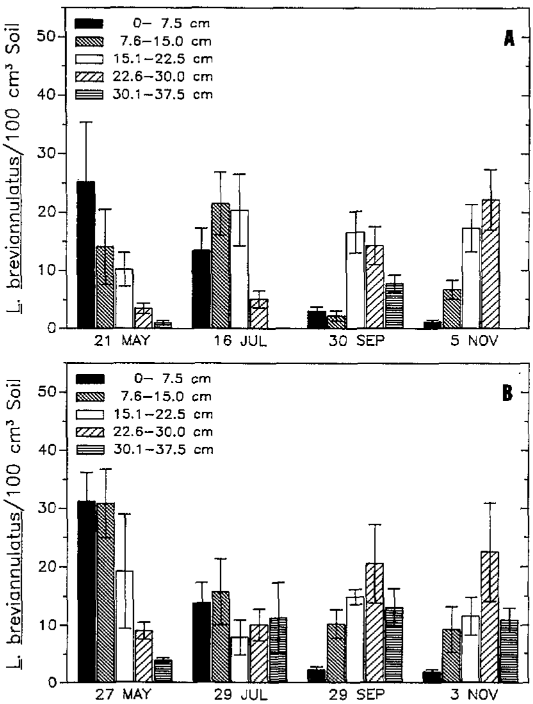

FIG. 3. Mean numbers (± SE) of *Longidorus breviannulatus* extracted from five soil depths in corn plots during 1986 (A) and 1987 (B).

todes (< 5/100 cm³ soil) were recovered from fallow plots 2 and 4 weeks after planting; no nematodes were detected after 8 weeks.

The distribution of *L. breviannulatus* among the sampling depths changed over time for corn in both years and for potato in 1987. Data from four sampling dates are representative of the seasonal population changes noted in the plots (Figs. 2, 3). Numbers of nematodes were greatest ($P \leq 0.05$) in the upper sampling depths at the beginning of the season and in the lower depths at the end of the season. At mid-season, nematodes were distributed evenly among the depths. Population densities were greatest ($P \leq 0.05$) in the lower sampling depths of potato plots throughout the 1986 season. Similar results were obtained when juvenile or adult counts alone were analyzed.

The ratio of final *L. breviannulatus* population density at harvest (Pf) to the initial population density at planting (Pi) was less than 1.0 for samples collected at depths of 0–15.0 cm, ca. 1.0 at 15.1–22.5 cm deep, and greater than 1.0 for the 22.6–37.5-cm-depth samples for corn and potato. A mean of 6.2 (± 3.6) nematodes were recovered from samples collected at depths of 45–60 cm in the corn plots on 14 October 1987.

The vertical distribution of nematodes changed ($P \leq 0.05$) during the winter of

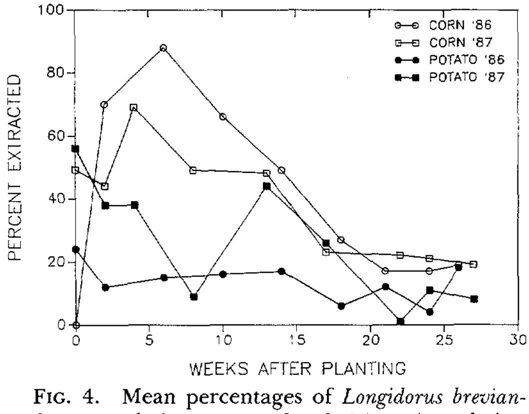

FIG. 4. Mean percentages of *Longidorus breviannulatus* population extracted at 0–15 cm (population estimate based on samples collected at 0–37.5 cm) in corn and potato plots in 1986 and 1987.

1986–87 in both potato and corn plots (Fig. 4). In November 1986, 26 weeks after planting, ca. 20% of the population was located in the top 15 cm of soil. By April 1987, this proportion had increased to ca. 50%.

Soil moisture content (percentage by weight) ranged from 3.6 to 6.7 in potato plots and from 4.0 to 8.2 in corn plots. Variation among depths was greatest at the beginning and end of the season for both crops. Daily average, minimum, and maximum soil temperature was consistent among the sampling depths below 7.5 cm, generally varying by not more than 1 degree.

Discussion

The host range of *L. breviannulatus* is not as restricted as first reported (7). Although all previously reported field infestations of *L. breviannulatus* were on corn or other graminaceous crops, an infestation of this nematode was maintained in a potato field. Nematode population density in this field after 13 years of continuous potato was sufficient to produce noticeable symptoms the first year corn was planted. The decline of the nematode population in fallow alleys by late June indicated that nematodes probably did not persist on graminaceous weeds that did not establish until late July or August when potatoes began to senesce.

Potato is a fair host for *L. breviannulatus*: nematode reproduction occurred on potato and population levels increased 30–60 days after planting. Population densities were lower in potato plots than in corn plots, but the differences were present from the onset of the study. The failure of the nematode population to increase within a season may be due to the reproductive potential of the nematode rather than the host status of the associated crop, because similar findings were reported for other *Longidorus* and *Xiphinema* spp. (2).

Longidorus breviannulatus successfully overwinters in Wisconsin. Additional samples collected in 1988 showed that population levels did not decline between November 1987 and April 1988, confirming the previous data. The discrepancy between our results and a recent report of the overwinter decline of an Iowa population (8) may be due to differences in geographic isolates of the nematode or environmental conditions.

The seasonal redistribution of *L. breviannulatus* vertically within the soil profile is a previously reported (7,10) but unexplained phenomenon. Natality, mortality, immigration, and emigration are population level processes that cause nematode densities to fluctuate at a particular depth. These processes are controlled largely by factors that may vary with soil depth (e.g., temperature and host resource availability).

The consistency in the change of nematode distribution in the soil profile for two crops over 2 years, the synchronous rise in the number of juveniles and adults at the same depth, and the long nematode life cycle strongly indicate that in this study the vertical distribution of *L. breviannulatus* was due mainly to migration. Stimuli that might prompt vertical migration of *L. breviannulatus* were not readily apparent. Nematodes did not appear to be responding to host-related stimuli, since upward movement began before host roots were present and downward movement commenced when the majority of roots were located in the top 15 cm of soil. Although environmental factors elicit nematode movement, the role of soil temperature and moisture in the downward migration of *L. breviannulatus* is unknown. In our study, daily average, minimum, and maximum soil temperatures during the growing season varied little among depths below 7.5 cm. Soil moisture varied more among depths than did temperature and may have influenced *L. breviannulatus* distribution.

Literature Cited

1. Allen, W. R. 1986. Effectiveness of Ontario populations of *Longidorus diadecturus* and *L. breviannulatus* as vectors of peach rosette mosaic and tomato blackring viruses. Canadian Journal of Plant Pathology 8:49–53.

2. Flegg, J. J. M. 1968. The occurrence and depth

distribution of *Xiphinema* and *Longidorus* species in southeastern England. Nematologica 14:189–196.

3. Forer, L. B. 1977. *Longidorus breviannulatus* associated with a decline of bentgrass in Pennsylvania. Plant Disease Reporter 61:712.

4. Huff, D. E., R. F. Davis, and R. F. Myers. 1987. *Longidorus breviannulatus* as a vector for brome mosaic virus. Journal of Nematology 19:143–145.

5. Huff, D. E., and R. F. Myers. 1982. *Longidorus breviannulatus* in New Jersey field corn. Journal of Nematology 14:446–447 (Abstr.).

6. Jenkins, W. R. 1964. A rapid centrifugal-flotation technique for extracting nematodes from soil. Plant Disease Reporter 48:692.

7. Malek, R. B., D. C. Norton, B. J. Jacobsen, and N. Acosta. 1980. A new corn disease caused by *Longidorus breviannulatus* in the Midwest. Plant Disease 64:1110–1113.

8. Norton, D. C., and J. Edwards. 1988. Age structure and community diversity of nematodes associated with maize in Iowa sandy soils. Journal of Nematology 20:340–350.

9. Norton, D. C., and J. K. Hoffmann. 1975. *Longidorus breviannulatus* n. sp. (Nematoda: Longidoridae) associated with stunted corn in Iowa. Journal of Nematology 7:168–171.

10. Willut, J. M., and R. B. Malek. 1979. Spatial distribution of plant-parasitic nematodes associated with corn. Phytopathology 69:544 (Abstr.).