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we have evidence that the bicarbonate ion concentration in the river water used in this study was indeed lower in the winter than in the summer.

The results indicate that sodium bicarbonate is considerably more efficient than calcium bicarbonate in promoting cell division and cell orientation of *Pediastrum*. Further work has been planned to study this difference.

ACKNOWLEDGEMENT

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Nematode Populations in Corn Plots Receiving Different Soil Amendments[1]

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Abstract: The magnitude of nematode populations in corn plots receiving manure, lime, or a fertilizer supplying N-P-K was compared with populations in corn plots not receiving manure, lime, or an N-P-K fertilizer. *Pratylenchus* spp. populations were highest in N-P-K fertilized plots and in manured plots. *Helicotylenchus microlobus* were highest in in plots in which no N-P-K had been applied. *Xiphinema americanum* populations were highest in limed plots. Seasonal population patterns for the three nematodes appeared to be characterized by two peaks, one in the early spring prior to the planting of corn, and the other in the late summer or fall related to the growth of corn. Only *Pratylenchus* spp. appeared to feed endoparasitically in corn roots.

Various parasitic nematodes have been associated with corn roots in Iowa. A primary step toward understanding the relationship of these nematodes to corn was to record the population changes that occurred throughout the year and to correlate these changes with associated factors.

It has been found that population patterns were usually related to the seasons (1, 2, 3). Climate and host-crop can also exert important influences on population patterns (1, 2, 4, 5, 6).

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Relatively little information on the relationship of parasitic nematodes to corn was available (1, 7, 8). I undertook this investigation to study nematode population changes around corn roots in Iowa.

Materials and Methods

A modified Christie and Perry (9) method was used to extract nematodes from the soil in all experiments. The nematodes were allowed 40 hours to migrate through a muslin cloth to a water trap. Root populations of nematodes were determined by placing washed and weighed root samples from plots C and F in petri dishes filled with water. The nematodes were recovered after 70 hours.

In an overwintering experiment, three to five 500 ml soil samples were taken at intervals between October 17 and April 30, 1962, from a plot at the Iowa State University Agronomy Farm in which corn had been grown the previous summer.

In a soil amendment experiment, four 500 ml soil samples were taken at semimonthly intervals between June 12 and September 25, 1962, from eight plots cropped continuously to corn since 1915. From 1915-1952, these plots received the following soil amendments. Plots C and F received no amendments. Plots M and MF received manure applied every four years at the rate of two tons per acre every year. Plots ML and MLF received manure as above plus enough ground limestone to adjust the soil pH to near 6.0. Plots L and LF received limestone as above but no manure. In 1953, these treatments were discontinued, and no further amendments were applied to plots C, M, ML, and L, while 160 lbs of nitrogen, 26 lbs of phosphorus, and 50 lbs of potassium per acre per year were applied to plots F, MF, MLF, and LF (Table 1).

Samples in all cases were taken at the 3 to 7 inch depth. From the soil amendment plots, samples were taken six inches from the north side of each corn hill.

Pratylenchus penetrans (Cobb, 1917) Filipjev and Schuurmans-Stekhoven, 1941; *P. hexincisus* Taylor and Jenkins, 1957; *Hoplolaimus galeatus* (Cobb, 1913) Thorne, 1935; *Helicotylenchus microlobus* Perry, 1959; and *Xiphinema Americanum* Cobb, 1913, were studied in these experiments. The *Pratylenchus* spp. were treated collectively.

Results

In the overwintering experiment I found that following the low occurrence of *Pratylenchus* spp., *H. microlobus* and *X. americanum* in February, populations increased through April until the planting of corn on May 4, 1962 (Figure 1).

Table 1. Relative prevalence of 3 parasitic nematodes estimated on June 12 and on September 26, 1962, in corn plots receiving different soil amendments.

Plots	Amendments	Nematodes per 500 ml of soil					
		H. microlobus		*Pratylenchus spp.*		*X. americanum*	
		6/12	9/25	6/12	9/25	6/12	9/25
C	None[a]	600	920	20	440	210	270
F	f	210	40	40	580	420	420
M	m	270	880	00	440	350	940
MF	m,f	00	40	270	2250	40	790
L	l	210	830	60	330	420	600
LF	l,f	20	20	460	1290	1190	1440
ML	m,l	810	1420	60	230	230	400
MLF	m,l,f	40	80	190	2350	350	790

[a]f = 160 lbs. of N, 26 lbs. of P and 50 lbs. of K per acre per year;
m = manure every four years at the rate of two tons per acre per year;
l = ground limestone to adjust soil pH to near 6.0.

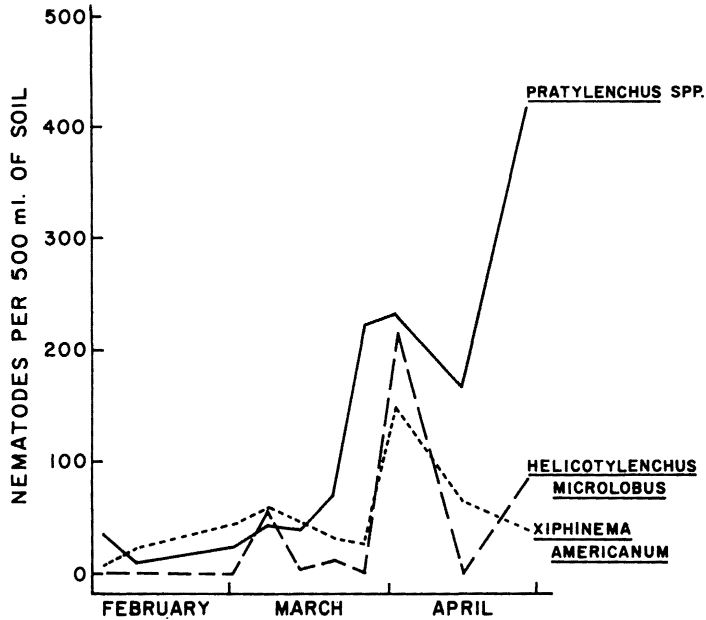


Figure 1. Relative prevalence of 3 parasitic nematodes in an overwintering corn plot from February 4 to April 30, 1962

In the soil amendment experiment there was a consistent relationship between the soil amendment used and the magnitude of parasitic nematode populations (Table 1).
More *Pratylenchus* spp. were obtained from plots receiving N-P-K than from plots not receiving N-P-K treatments (Fig. 2). In contrast, more *H. microlobus* were obtained from plots not receiving N-P-K than from plots receiving N-P-K treatments (Fig. 3). *Xiphinema americanum* populations were higher in limed plots than in unlimed plots (Fig. 3). These differences were statistically significant at the 1% level. *Pratylenchus* spp. were higher in manured plots than in unmanured plots. This difference was statistically significant at the 5% level.

Populations of *Pratylenchus* spp. within roots were higher on a per gm of root basis in the plot to which no N-P-K had been applied than in the N-P-K fertilized plot (Fig. 2). Only two root samples during the entire experiment contained parasitic nematodes other than *Pratylenchus* spp. One sample in August contained one *H. galeatus* and one sample in September contained seven *H. microlobus*.

Parasitic nematode populations increased during the growing season under all treatments, with the exception that *H. microlobus* populations did not increase in the N-P-K fertilized plots (Fig. 3).

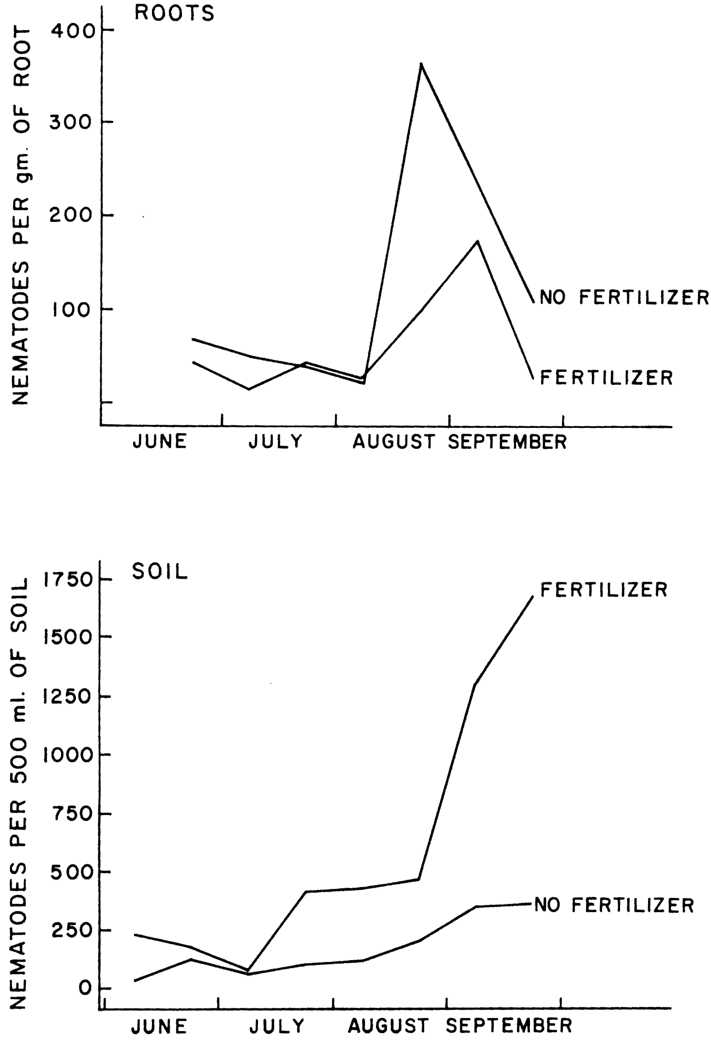
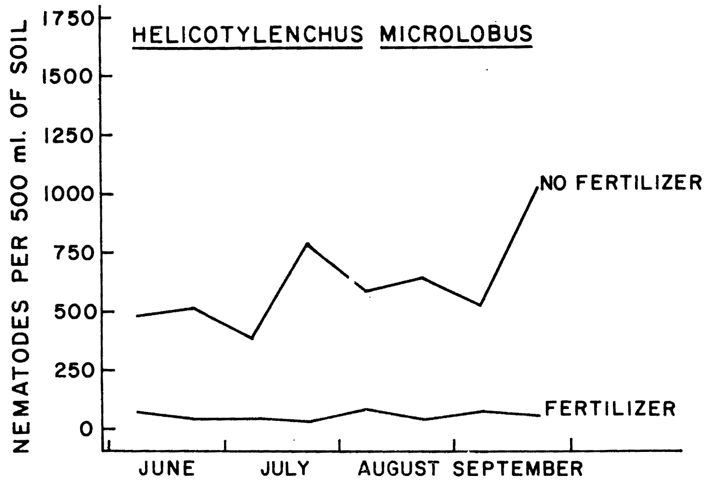


Figure 2. Relative prevalence of *Pratylenchus* spp. in N-P-K fertilized plots and in plots in which no N-P-K was applied

Discussion

The seasonal soil population patterns of *Pratylenchus* spp., *H. microlobus,* and *X americanum* appeared to be marked by two peaks. One peak occurred before the planting of corn in the early spring, and the other occurred during the late summer and fall. High spring populations have also been noted by Norton (6), who found that *X. americanum* populations around alfalfa were high during the early spring, and by Townshend (10), who reported a conspicuous increase in the number of *P. pene-*



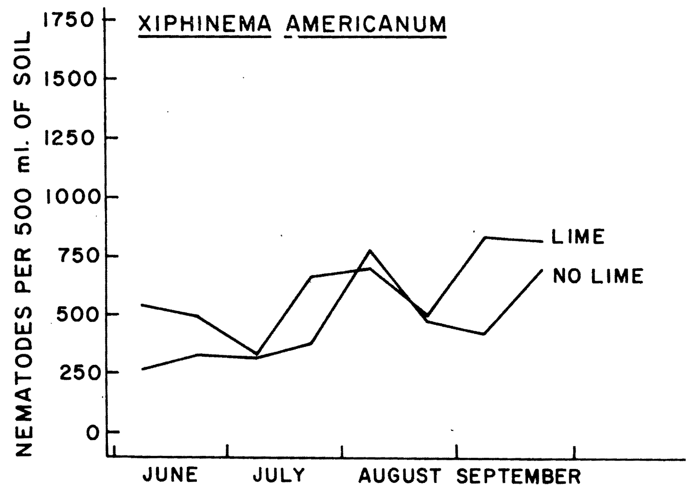


Figure 3. Relative prevalence of *Helicotylenchus microlobus* in N-P-K fertilized plots and in plots in which no N-P-K was applied and of *Xiphinema americanum* in limed and unlimed plots

trans extracted from overwintering celery roots during February and March for two consecutive years.

Although fully matured adults were observed throughout the winter, it was probable that eggs provided the major means of overwintering, and that the hatching of eggs was responsible for the pre-growing season population build-up. This build-up was considered important for the preservation of the species because it increased both the chances of locating host roots and the chances of survival of a population normally low because of a high mortality or a low reproductive rate.

Although root populations of *Pratylenchus*/gm-of-root were higher in plot C, which received no N-P-K, than in plot F, which received N-P-K, the absolute number of *Pratylenchus* within the roots in a unit volume of soil was probably higher in plot F. In plot F the observed root growth was vigorous enough to dilute any invasions by *Pratylenchus* and thus decrease the relative density of nematodes per unit of root (2). In plot C the lack of fertilizer limited root growth enough so as not to provide any such dilution effect. I suggest, therefore, that the measurement of endoparasitic nematode populations should correlate these three estimates: 1) the number of nematodes within a unit volume of soil, 2) the weight of roots within the unit volume of soil, and 3) the number of nematodes within these roots.

The root population pattern of *Pratylenchus*/gm-of-root (Fig. 2) was characterized by three periods: 1) the rapid growth of corn actually decreased the number of *Pratylenchus*/gm-of-root (late July to early August), 2) the number of *Pratylenchus*/gm-of-root was increased by both a slowing root growth and by the presence of newly hatched juveniles (early August to early September), and (3) the number of *Pratylenchus*/gm-of-root was decreased by the migration of *Pratylenchus* from dead or dying roots (after early September). It is probable that local conditions will affect the length and occurence of these periods.

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