Population Densities of Nematodes Under Seven Tillage Regimes[1]

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Abstract: Numbers of plant-parasitic nematodes on corn growing under seven tillage regimes were monitored. Differences among treatments occurred for *Helicotylenchus pseudorobustus, Pratylenchus* spp., *Xiphinema americanum,* dorylaimids, and total numbers of nematodes. Except with members of the Tylenchinae, highest densities occurred in no-till ridge plots and lowest numbers occurred in spring- and fall-plowed pots. *Key Words:* corn, *Helicotylenchus pseudorobustus, Pratylenchus* spp., *Xiphinema americanum.*

Many species of nematodes parasitize corn (4, 6, 8, 10), but little information is available on the response of nematode populations to different tillage practices. Previous work with nematodes on corn grown under different tillage systems was conducted under two tillage practices. Fall-plowed plots contained 37% fewer *Meloidogyne incognita* than did spring-plowed plots (11). Caveness (5) found more *Pratylenchus* spp. in soil and corn roots in tilled than in nontilled plots, but *Helicotylenchus pseudorobustus* and *M. incognita* were more numerous in nontilled plots. The primary purpose of the present work was to determine the influence of seven tillage practices on parasitic nematodes on corn.

MATERIALS AND METHODS

The field consisted of Clarion-Nicollet-Webster loam (40.0% to 50.6% sand, 28.3% to 35.7% silt, and 21.1% to 26.2% clay) in Boone County, Iowa. The land had been repeatedly planted to corn from August 1971 through November 1975 and subjected to the seven cultural systems that follow. Tillage treatments included: fall plow, spring plow, chisel plow, offset disk, till-plant, no-till flat, and no-till ridge. Plots in replications 1, 2, and 3 were 174 m long and 28 or 30 rows wide. Plots in replication 4 were 18 to 20 rows wide by 260 m long.

All plots received dry fertilizer (447.4 kg/ha 0-26-26 NPK) in the fall of each year. Total nitrogen applied to all plots was 223 kg/ha. Anhydrous ammonia was applied to fall- and spring-plowed plots, and ammonium nitrate used in the other plots. Carbofuran (10G) was applied at 1.12 kg(a.i.)/ha to all plots for insect control. Funk's 'G4444' hybrid corn *(Zea mays)* was planted (ca 65,500 seeds/ha) in rows 76 cm apart. For weed control, atrazine plus alachlor was sprayed on all plots (2.24 kg(a.i.)/ha) before emergence of the corn. In addition, atrazine (2.24 kg(a.i.)/ha) and alachlor (1.12 kg(a.i.)/ha) were applied in 9.35 liters/ha of crop oil to no-till ridge and no-till flat treatments after emergence.

Each plot was divided equally perpendicular to the rows to reduce variability. Soil samples (2-cm x 15-cm core) were collected at monthly intervals, except when soil was frozen, from the rhizosphere of 10 corn plants in a band (5 m wide) in the center of each half plot and assayed for nematodes by the centrifuge-flotation method (7). Endoparasites were extracted by a thin-layer water method in petri dishes in 1974 and by the shaker method in 1975 (1). Nematode data were transformed as follows: log (X + 1), where X is the original nematode count.

RESULTS

Differences ($P = 0.05$) in numbers of nematodes/100 cm^3 soil occurred among the seven tillage practices. Only these significant differences will be discussed. Seasonal distributions were statistically similar for 1974 and 1975 unless otherwise indicated (Fig. 1, 2). The greatest numbers of nematodes usually occurred in no-till ridge plots, and the lowest numbers generally occurred in spring- and fall-plowed plots. Other tillage practices resulted in intermediate levels of nematodes. No-till flat was the only treatment with frequently erratic counts among nematode groups. Soil factors

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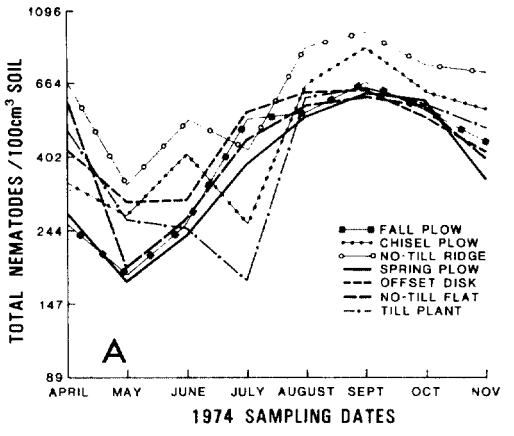

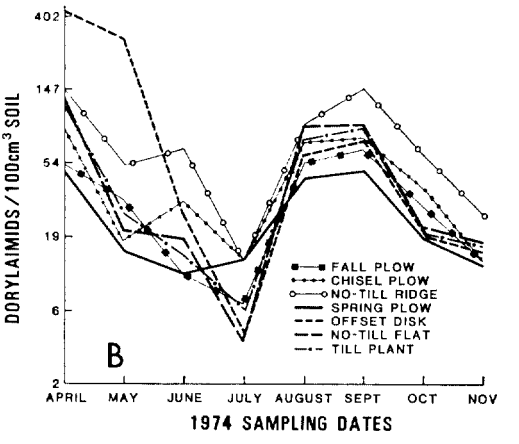

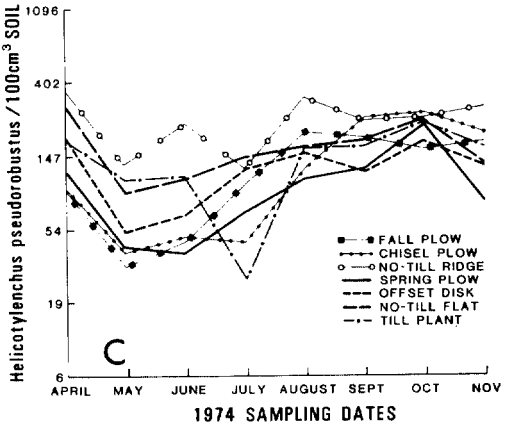

FIG. 1-(A-C). Seasonal fluctuations of logs of average densities for nematodes among different tillage systems in Boone County, Iowa. *A)* Total nematodes/100 cm³ soil during 1974. *B)* Dorylaimids per 100 cm³ soil during 1974. *C) Helicotylenchus pseudorobustus*/100 cm³ soil during 1974.

(pH, percentage organic matter, cation-exchange capacity, texture, field capacity, and saturation percentage) were not significantly different among the different tillage treatments. Fewest numbers of total nematodes usually occurred at planting, with the greatest densities occurring in late August and September (Fig. 1-A). Counts were greater in no-till ridge plots than in any other treatment, but no differences existed among the remaining treatments in 1974. Though similarly ordered, there were no differences in 1975 counts.

The greatest numbers of dorylaimids (excluding *Xiphinema americanum* Cobb) occurred in the no-till ridge treatment (Fig. 1-B) and were greater than in other plots in 1974 and than in all treatments except till-plant plots in 1975. Similarly, numbers of dorylaimids in the spring-plowed plots were lower than in chisel-plow or till-plant plots in 1974 and were lower than all other treatments except chisel-plow in 1975. Densities of dorylaimids in fall-plowed plots in 1975 were also lower than those in other treatments, except chisel-plow.

Seasonal fluctuation of *Helicotylenchus pseudorobustus* (Steiner) Golden varied less than that of other species (Fig. 1-C). Similar to dorylaimids, numbers of *H. pseudorobustus* were greater in no-till ridge than in other plots. Densities of this species in the no-till flat plots also were greater than in fall-plow, spring-plow, or chisel-plow treatments. In 1975, numbers of this species in the no-till ridge treatment differred only from the fall-plow treatment, which was lower.

Pratylenchus hexincisus Taylor and Jenkins and *P. scribneri* Steiner were the most commonly encountered members of this genus. Numbers of *Pratylenchus* in soil increased throughout the growing season under all tillage practices (Fig. 2-A). The maximum numbers occurred in August or September and remained near this level

through November. The densities of *Pratylenchus* spp. in no-till ridge plots were greater than in any other plots. The numbers of *Pratylenchus* spp./gm dry root were greatest in the no-till ridge plots and lowest in fall-plowed plots (Fig. 2-B).

Numbers of Tylenchinae were relatively stable throughout the sampling period in most plots (Fig. 2-C), but varied among treatments. The greatest numbers occurred in offset-disk, fall-plow, spring-plow, and chisel-plow plots. Densities were lowest in till-plant, no-till flat, and no-till ridge.

Densities of *Xiphinema americanum* Cobb were greater in no-till ridge plots (Fig. 2-D). Also, numbers in till-plant plots were greater than those in the fall-plowed plots. Maximum numbers of this species occurred in August or September, and minimal densities occurred from April until July (Fig. 2-D).

Numbers of *Aphelenchus* spp., *Aphelenchoides* spp., *Hoplolaimus galeatus* Filipj. and Shuur.-Stek., *Tylenchorhynchus nudus* Allen, members of the Psilenchinae and Mononchidae, and nonstylet-bearing nematodes were not affected by tillage treatments.

Average corn yields for 1974-75 were greater for till-plant and fall-plowed plots when they were compared with yields from no-till flat, no-till ridge, and chisel-plow treatments. No-till flat and no-till ridge plots also yielded less than spring-plowed plots during the same period.

DISCUSSION

The data presented indicate that dif-

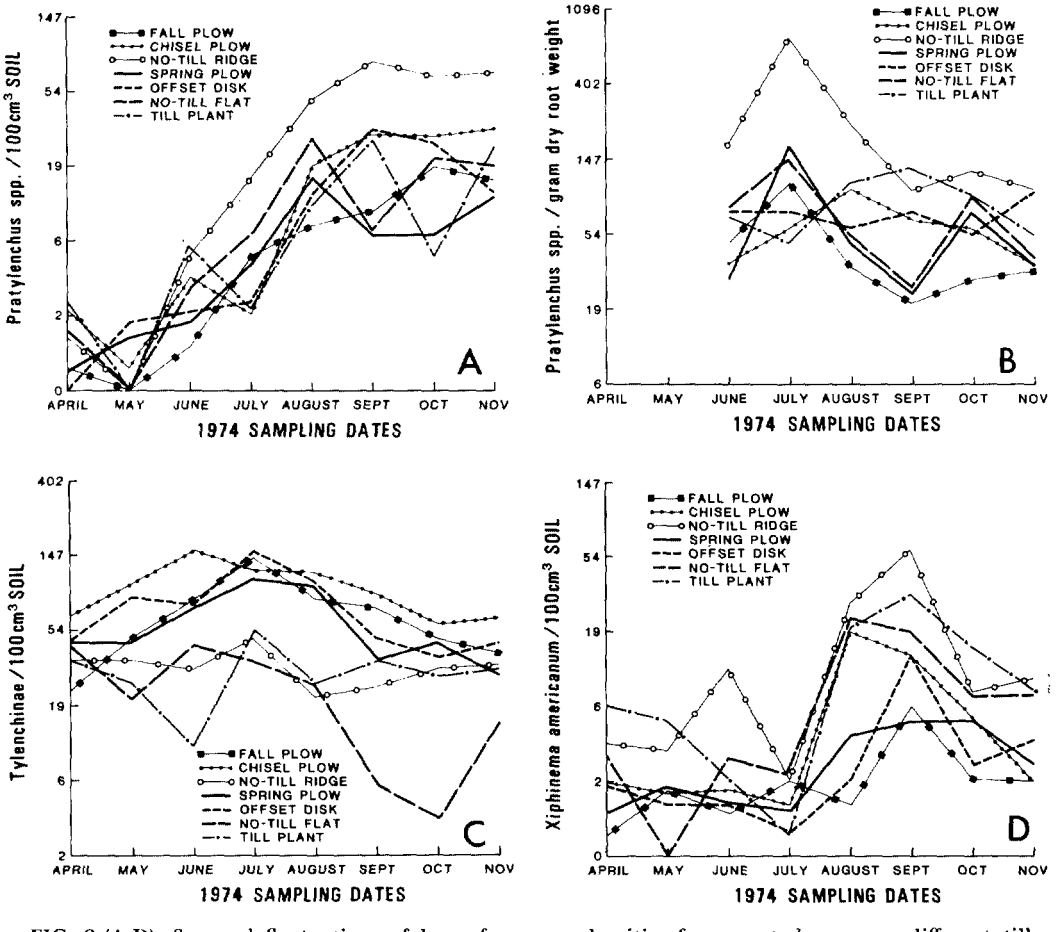

FIG. 2-(A-D). Seasonal fluctuations of logs of average densities for nematodes among different tillage systems in Boone County, Iowa. *A) Pratylenchus* spp. (mainly *P. hexincisus*)/100 cm³ soil in 1974. *B) Pratylenchus* spp. (mainly *P. hexincisus*)/gram dry root weight in 1974. *C)* Tylenchinae/100 cm³ soil during 1974. *D) Xiphinema americanum*/100 cm³ soil during 1974.

ferent tillage systems result in numerical differences among nematodes, with numbers generally being greatest in no-till plots and lowest in fall- or spring-plowed plots. Nematode densities, corn yields, and amounts of overwintered plant debris were inversely proportional to the degree of soil disturbance. Suggested explanations for the reduced nematode numbers after soil disturbance are: *(i)* there was a delay in egg hatching because the soil warmed more slowly after plowing (12), and *(ii)* accumulation of surface debris with reduced tillage may act as a mulch affecting moisture retention, warming rate, depth of root growth (9), and the increased spread of fungal pathogens (2, 3). No attempt was made to evaluate the importance of the increased nematode population densities resulting from reduced tillage, but they should increase damage to crops. Where nematode control in field crops is important, use of reduced tillage for soil and energy conservation might increase the damage caused by nematodes. Till-plant, offset disk, and chisel plow might offer suitable means of reducing soil erosion without significantly increasing nematode numbers. As the need for soil and energy conservation increases, the need for further studies on the biology and importance of nematodes and other pests in soil management systems increases also.

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