Population Dynamics of Plant Nematodes in Cultivated Soil: Effect of Sod-based Rotations in Cecil Sandy Loam[1]

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Abstract: In a 6-year study of four nematode species in sod-based corn (*Zea mays*) rotations, population densities varied with different cropping systems. Continuous corn, with or without a winter rye (*Secale cereale*) or vetch (*Vicia villosa*) cover, favored an increase of *Pratylenchus zeae* and suppressed *Trichodorus christiei, Helicotylenchus dihystera,* and *Xiphinema americanum.* A four-year sod-based rotation (3 years sod, 1 year corn) of 'Coastal' bermudagrass (*Cynodon dactylon*) and fescue (*Festuca arundinacea*) was less favorable for *P. zeae* than was monocultured corn but was more favorable for *T. christiei.* Alfalfa (*Medicago sativum*) and fescue favored an increase of *T. christiei* but suppressed the other three species. 'Coastal' bermudagrass and 'Pensacola' bahiagrass (*Paspalum notatum*) were not favorable for extensive development of any nematode species present. In longer term studies, of which these are a part, all four species survived for 10 years in relatively low numbers in bermudagrass and bahiagrass sods.

Crop rotation is a long standing fundamental of crop production. In addition to physical soil improvement, proper crop sequences suppress certain soil-borne fungal plant pathogens (7) and plant parasitic nematodes (6, 14). Where continuous row-cropping seriously deteriorates tilth, reduces organic matter, and promotes soil erosion, rotations including forage grasses and legumes have gained wide acceptance (1, 2). To date the effects of perennial grass and legume culture upon endoparasitic nematode populations have been studied more extensively (9, 10, 11, 13, 17) than similar effects upon ectoparasitic nematodes (16).

Ectoparasitic nematodes such as *Trichodorus christiei, Helicotylenchus dihystera, Pratylenchus* spp. and *Xiphinema* spp. are common in forage crop fields (11). Large populations of one or more of these species can be present on alfalfa, fescue, lespedeza, and clovers without causing measurable plant damage until after several clippings (3, 11, 12). Their ability to readily reproduce on these crops indicates a rather broad host range. A limited number of host-range studies show that the range of suitable hosts of *T. christiei* embrace 42 plant species in 14 different plant families (15). Host range of *Pratylenchus* varies depending upon the species involved (4, 5, 8, 12). Finally, the diversity of species of *Pratylenchus* and their varying host range has raised doubts as to the effectiveness of crop rotation in controlling *Pratylenchus* spp. (13).

Nematode population changes were monitored in established sod-based rotations to determine the suitability of certain forage grasses and legumes as nematode-reducing crops in rotation schemes. Yield data from this experiment have been published (1).

MATERIALS AND METHODS

The plots were established in 1955 on Cecil sandy loam, naturally infested with *P. zeae* Graham, 1951; *T. christiei* Allen, 1957; *H. dihystera* (Cobb, 1893) Sher, 1961; and *X. americanum* Cobb, 1913. Previous cropping consisted of several years of rescuegrass (*Bromus willdenowii* Kunth) and crimson clover (*Trifolium incarnatum* L.). The crop-

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ping systems established were: (i) monocultured corn (*Zea mays* L.) without winter cover; (ii) monocultured corn with winter cover of legume (vetch, *Vicia villosa* Roth); (iii) monocultured corn with nonlegume winter cover (rye, *Secale cereale* L.); (iv) 4-year sod-based cropping systems consisting of 3 years of sod of either (a) 'Coastal' bermudagrass (*Cynodon dactylon* (L.) Pers.) or (b) fescue (*Festuca arundinacea* Schreb.) followed by 1 year of corn; and (v) continuous sods of alfalfa (*Medicago sativa* L.), 'Pensacola' bahiagrass (*Paspalum notatum* Fluegge), 'Coastal' bermudagrass, or fescue. Fertilization consisted of 454 kg per .405 ha of 0-10-20 each year. Lime was applied to maintain a soil pH of about 6.5 as indicated by annual soil tests. The rye winter cover and all sod grasses received an additional 36.3 kg of nitrogen per .405 ha.

The experimental design was a randomized complete block with each cropping system replicated 4 times. Plots 7.6 × 7.6 m represented an experimental unit.

Nematode assay commenced when the rotation experiment was in its sixth year and continued for 6 successive years. Soil samples (1000 cc) taken during June and August of each growing season, consisted of twenty 2.1 × 20 cm cores randomly located within each plot. These were thoroughly mixed and a 150 cc aliquant was wet-seived (20 and 325-mesh) and Baermann pan-extracted 48 hr to separate nematodes from the soil.

Results

Populations of *P. zeae, T. christiei, H. dihystera*, and *X. americanum* were uniform in the experimental area, as evidenced by lack of significant population differences between replications. Populations of all species were much larger in late summer than in the spring (data not given).

Population densities were markedly influenced by different cropping systems. *P. zeae* developed best in monocultured corn plots and were favored by winter cover of vetch and suppressed by winter cover of rye. Populations of *T. christiei, H. dihystera,* and *X. americanum* survived at very low levels in monocultured corn plots. Winter cover of vetch was more favorable for *T. christiei* development than was rye (Fig. 1).

Four-year sod-based rotation of 'Coastal' bermudagrass and corn (1 year corn after 3 years 'Coastal') supported a relatively large population of *H. dihystera*, medium populations of *P. zeae* and *T. christiei*, and a small population of *X. americanum*. A similar rotation involving fescue and corn (1 year corn after 3 years fescue) suppressed *P. zeae* but favored *T. christiei* development. In both rotation schemes the number of *X. americanum* remained at a very low level (Fig. 1).

Continuous sods of alfalfa and fescue favored development of *T. christiei* population but suppressed *P. zeae*. Populations of *X. americanum* and *H. dihystera* were maintained at low levels in alfalfa and fescue sods. Continuous sods of bermudagrass and bahiagrass did not favor large population increase of any of the nematode species. Bahiagrass was less favorable for nematode development than was bermudagrass. Although sods of both grasses were unfavorable for population increase, small populations of all species survived for 10 years (Fig. 1).

Discussion

Our data support the often-expressed opinion that no single cropping system will reduce all parasitic nematodes under various crop and soil conditions. The beneficial effects of soil improvement from sod-based rotations may be negated by nematode population increases, if the proper sod crop is not used. This was true of alfalfa and fescue, which were unfavorable for *P. zeae* yet increased *T. christiei*. Since alfalfa and fescue also are favorable for development of root-

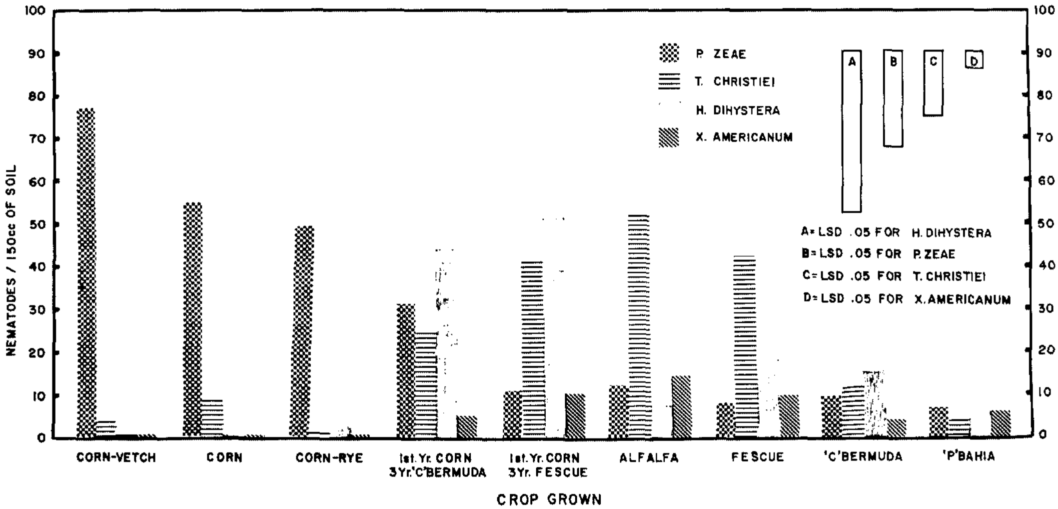

FIG. 1. Average number of nematodes recovered from soil in which different cropping systems were maintained for 6 years.

knot nematodes (*Meloidogyne* spp.) (11), their use in rotations would be further limited, particularly in sandy soils where *Meloidogyne* species are widespread.

The use of 'Coastal' bermuda and 'Pensacola' bahia sods appear promising as nematode-reducing sods in rotation schemes, except in the case of *Belonolaimus longicaudatus* infestations (6). Although *P. zeae, T. christiei, H. dihystera,* and *X. americanum* survived on bermudagrass and bahiagrass, populations after 10 years of sod were not large enough to cause economic damage to the succeeding row crops. We did not determine how many successive years of row crops could be grown after bermudagrass and bahiagrass before nematodes would limit production, but other studies (6) indicate that large populations can become established within 3 years after a nematode-reducing crop sequence. Besides suppressing *P. zeae, T. christiei, H. dihystera* and *X. americanum,* 'Coastal' bermudagrass is also resistant to several species of root-knot nematodes (10, 11). This further increases the value of this grass as a nematode-reducing crop. 'Pensacola' bahiagrass is susceptible to certain species of root-knot nematodes (11) which limits its usefulness in areas where root knot is a problem.

These data, do not relate nematode population density to crop performance. Although large population differences were shown in some cases, we present no experimental evidence that population levels would be of economic importance in crop production. However, an earlier report (1) of yields from this experiment showed a significant increase in the yield of corn in sod-based rotations, and a decline in yield from monocultured corn plots. This rotation effect was attributed to an increase in soil nitrogen level caused by growing sod. Our data support the theory that nematodes are involved in the rotation effect and we believe these data can be used as a guide in selecting rotation crops in nematode-infested soil.

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