Population Dynamics of Plant Nematodes in Cultivated Soil: Effect of Summer Cover Crops in Old Agricultural Land[1]

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Abstract: In a 6-year cover crop sequence study, nematode population densities varied with different cover crops. Millet favored rapid increase of *Belonolaimus longicaudatus* and supported relatively large numbers of *Pratylenchus brachyurus*. Beggarweed and 'Coastal' bermudagrass favored rapid increase of *B. longicaudatus* and to a lesser extent *P. brachyurus* and *Trichodorus christiei*. Hairy indigo and *Crotalaria* supported relatively large numbers of *P. brachyurus* but suppressed *B. longicaudatus*. Hairy indigo also supported increases of *T. christiei* and *Xiphinema americanum*. Marigold did not favor development of any parasitic nematode species present. Tomato transplant yield was inversely related to nematode population, particularly to *B. longicaudatus*. Largest yields were obtained from plots with smallest numbers of *B. longicaudatus* and smallest yields were from plots with largest numbers of *B. longicaudatus*. *Key Words:* *Belonolaimus longicaudatus*, *Pratylenchus brachyurus*, *Trichodorus christiei*, *Xiphinema americanum*, Summer cover crops, Crotalaria (*Crotalaria spectabilis*), Marigold (*Tagetes minuta*), Millet (*Panicum ramosum*), Hairy indigo (*Indigofera hirsuta*), Beggarweed (*Desmodium tortuosum*), 'Coastal' bermudagrass (*Cynodon dactylon*), Tomato (*Lycopersicon esculentum*).

Cover crops are grown for a variety of purposes and under a wide range of climatic conditions. They are most commonly grown for physical improvement of the soil. In the southeastern United States, the success of cover cropping depends largely on the relation of the cover crop to root-knot nematodes (*Meloidogyne* spp.) (7). This is particularly important when a root-knot-susceptible crop, such as tomato, follows the cover crop. Consequently, cover crops recommended for use in tomato transplant production have some degree of resistance to root-knot nematodes (8).

Root-knot nematode resistant plant species suitable for cover crops are available, but their use is usually limited by one or more undesirable characters. The value of *Crotalaria* spp. against root-knot nematodes has been known many years; however, because *Crotalaria* seeds are toxic to livestock, its use in rotations has been limited (3). More recently the value of marigold (*Tagetes minuta*) as a nematode-reducing crop was reported (4), but this plant species was later found to be extremely susceptible to bacterial wilt caused by *Pseudomonas solanacearum* (1). Furthermore, the use of root-knot resistant cover crops may lead to an increase in other nematode species. *Pratylenchus* spp. have increased on *Crotalaria spectabilis* (2, 3), and *B. longicaudatus* on millet (4) and 'Coastal' bermudagrass (4, 6, 11). Thus, the complexity of field populations of nematodes (3, 4) together with their rather broad host range (5, 9, 12) limits the choice of cover crops to use on land infested with plant-parasitic nematodes. However, in a short-term field experiment, marigold showed promise of controlling a wide range of nematode species (4).

The objective of this study was to evaluate the effect of selected root-knot-resistant cover crops on the total plant parasitic nematode fauna and the subsequent effect on tomato plant yield.

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MATERIALS AND METHODS

The experiment was established in Tifton sandy loam that had been in cultivation for over 40 years. Natural infestations of *B. longicaudatus* Rau, *P. brachyurus* (Godfrey) Filip & Schuurmans Stekh., *Trichodorus christiei* Allen, and *Xiphinema americanum* Cobb were present. Five cover crops were arranged in a randomized complete block design replicated 4 times. Each plot, representing an experimental unit, was 3.7 m × 15.2 m except bermudagrass plots which were 18.3 m × 15.2 m.

Cover crops, *Crotalaria* (*C. spectabilis* Roth); marigold (*T. minuta* L.); millet (*Panicum ramosum* L.); hairy indigo (*Indigofera hirsuta* L.); beggarweed (*Desmodium tortuosum* (Sw.) DC); 'Coastal' bermudagrass (*Cynodon dactylon* (L.) Pers.), were established on the plots in June 1963. All cover crops were seeded in 4 rows 91.4 cm apart except 'Coastal' bermudagrass which was sprigged over the entire plot. In March 1964, all plots except 'Coastal' bermudagrass were plowed and direct seeded to 'Heinz 1350' tomatoes (4 rows 35.5 cm apart on beds 183 cm wide). Fertilizer was applied in a 6.4 cm band 2.5 cm below seed depth at a dosage of 67 kg P, 39 kg K, and 67 kg N per ha. 'Coastal' bermudagrass plots received an additional 112 kg N per ha each year. Seven weeks after planting, tomato plants were hand-pulled, counted and graded for quality. Immediately afterwards, the cover crops were planted in the same plots in which they had previously grown. This cycle was repeated 5 times.

Three years after the experiment was established, 'Coastal' bermudagrass plots were plowed and prepared for seeding tomatoes (March, 1966). After tomato plants were harvested in May, 1966, 'Coastal' bermudagrass re-established itself in the plots. This cycle was repeated 3 times.

TABLE 1. Population (4-yr averages) of *Belonolaimus longicaudatus* and *Pratylenchus brachyurus* on tomato plants following different cover crops.

Cover crop	Nematodes/150 cc of soil	
	B. longicaudatus	*P. brachyurus*
Crotalaria	1.3	9.3
Marigold	0.8	0.4
Millet	40.9	19.6
Beggarweed	25.6	3.6
Hairy indigo	7.6	2.2
Coastal bermuda	15.0	5.8
LSD .05	25.0	n.s.

Soil samples were taken two times each year; during tomato plant growth (May) and during growth of cover crops (September). A sample consisted of 20 cores (2.1 × 20 cm) taken at random within each plot. Each sample was thoroughly mixed, and a 150 cc aliquant was wet-seived and Baermann-pan extracted 48 hr to separate nematodes from the soil.

RESULTS

After one summer's growth of cover crops, trends in nematode population differences were evident which were maintained during the course of the experiment. Millet was extremely favorable for increase of *B. longicaudatus* and to a lesser extent for *P. brachyurus* and *T. christiei* (Fig. 1). Beggarweed and 'Coastal' bermuda also favored increase of *B. longicaudatus*. None of the other species increased appreciably on beggarweed; however, *P. brachyurus*, *T. christiei*, and *X. americanum* increased on 'Coastal' bermudagrass. Hairy indigo, suppressed *B. longicaudatus* but supported increases of the other species. *Crotalaria* suppressed all species except *P. brachyurus*. None of the nematode species increased appreciably on marigold.

Populations of all nematode species were much smaller during growth of tomato plants (Table 1) than they were during growth of

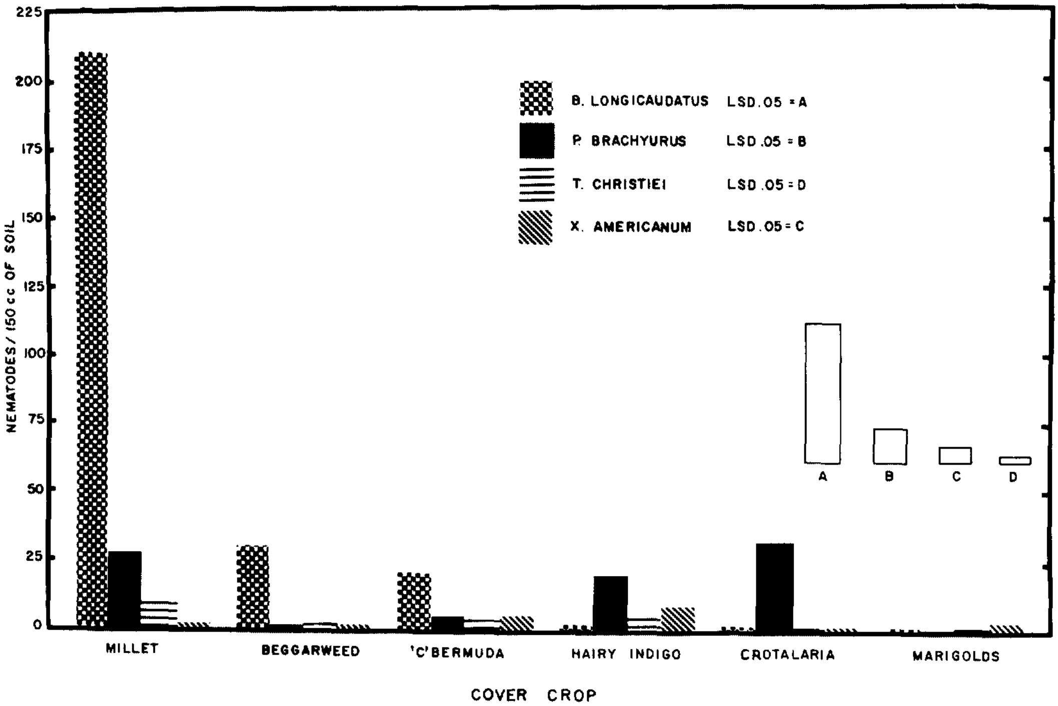

FIG. 1. Average (5 yr.) numbers of nematodes recovered from soil planted to different cover crops.

cover crops (Fig. 1). Although *B. longicaudatus* and *P. brachyurus* exhibited the same relative relationship to the cover crops, population differences were not as great during growth of tomato plants. *X. americanum* and *T. christiei* were not detected during growth of tomato plants.

TABLE 2. Yield of tomato transplants as influenced by summer cover crops.

Cover crop	Number transplants/ 3.66 m of row[a] Total	Marketable	Marketable plants per acre (thousands)
Marigold	164.17	97.83	237
Hairy indigo	141.25	81.48	197
Crotalaria	144.25	76.33	185
Coastal bermuda	131.67	67.17	163
Beggarweed	101.97	34.00	82
Millet	85.50	22.25	54
LSD .05	47.13	30.34	

[a] Average of 5 yr. except Coastal bermuda which is for 3 yr.

Yield of tomato transplants was inversely related to parasitic nematode population, particularly to *B. longicaudatus*. The smallest number of plants was harvested from plots that supported the largest number of *B. longicaudatus* (millet, beggarweed and 'Coastal' bermudagrass) (Table 2). Conversely, the largest number of plants were harvested from plots with the smallest number of *B. longicaudatus*, (marigold, hairy indigo and *Crotalaria*). Differences in number of marketable plants per acre were greater than differences in total plants per acre.

DISCUSSION

These data confirm and extend initial conclusions reported in an earlier study (4). With some minor variations, population trends observed after 1 year of cover crop-tomato plant growth were maintained during the remainder of the study. However, numbers of nematodes were larger on their preferred hosts after 6 years than they were after 1 year. We interpret this to mean that population ceilings were not reached in 1 year. This was particularly true of *B. longicaudatus* on millet and 'Coastal' bermudagrass.

Although millet supported a much larger population of *B. longicaudatus* than did beggarweed and 'Coastal' bermudagrass, damage to the succeeding tomato crop, as measured by yield of transplants, was not significantly greater. Apparently, severe damage to tomato seedlings can result from a very small number of *B. longicaudatus*. Numbers of *B. longicaudatus* in excess of the population level that causes severe damage are insignificant in terms of causing further measurable damage. During the growth of tomato plants (7 wk.), populations of *B. longicaudatus* tended to equalize in plots in which millet, beggarweed, and 'Coastal' bermudagrass had grown. This apparently was a function of temperature or the inability of tomato seedlings to support large numbers of *B. longicaudatus*; because of insufficient feeding sites, apparently large numbers of nematodes die. Furthermore, tomato is a poor host for reproduction of *B. longicaudatus* (3), and our results indicate that no appreciable reproduction occurred on 'Heinz 1350' tomato. Severe damage apparently resulted from attempts to establish a parasitic relationship. The small increase in numbers of *T. christiei* during growth of tomato were apparently a function of temperature since *T. christiei* is known to readily reproduce on tomato (12).

Differences in total emergence of tomato seedlings among the different treatments (cover crops) were evident. Detailed investigation into the cause of failure of seedlings to emerge revealed a concomitant attack by nematodes and the fungus *Pythium irregulare* Buisman. This nematode-fungus interaction is under investigation.

Differences between total emergence and numbers of marketable transplants reflects a failure of plants to reach marketable size (stem diameter .4 cm, height 15–25 cm) in a given period (7 wk.). In soil relatively free of nematodes where marigold had grown, differences between emergence and marketable plants are usually attributed to differences in emergence dates, fertilizer placement, and soil moisture. In soil that contains a large number of nematodes, such as soil in which millet had grown, differences between total emergence and marketable plants were much larger than those in nematode-free soil. We attribute this additional reduction in marketable plants to nematode damage.

Marigold and hairy indigo appear promising as nematode-reducing cover crops for the southeastern United States. The lack of economic value and difficulties in establishing field plantings of marigold will limit its use. Although hairy indigo was not as effective as marigold in reducing nematode numbers, its excellent soil-building capacity and the apparent ease of establishing field plantings favor its use as a nematode-reducing cover crop. However, the susceptibility of hairy indigo to *Meloidogyne hapla* and *M. arenaria* (10) suggest avoidance of using this crop in combination with a root-knot susceptible crop such as tomato.

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