Supplement to Journal of Nematology 26(4S):761–766. 1994.

Phytoparasitic Nematodes Associated with Three Types of Blueberries in Arkansas[1]

J. R. Clark[2] and R. T. Robbins[3]

Abstract: Research and commercial blueberry plantings were sampled in October 1991 to determine the population densities and species of phytoparasitic nematodes associated with rabbiteye (*Vaccinium ashei*), southern highbush (*Vaccinium* sp.), and highbush (*V. corymbosum*) blueberry cultivars and the sod middles between the blueberry rows. In the research planting at Clarksville, Arkansas, samples from the highbush cv. Bluecrop, the southern highbush cv. Cooper and Gulf Coast, and the sod middles had similar numbers of total vermiform phytoparasitic nematodes (125–451/250 cm^3 soil), whereas the samples from rabbiteye cv. Climax and Tifblue had significantly lower numbers (4/250 cm^3). The major nematode species associated with blueberries and sod was *Xiphinema americanum*. In a research planting at Bald Knob, Arkansas, which contained Bluecrop and rabbiteye cultivars only, samples from Bluecrop and the sod had similar numbers (288 and 334/250 cm^3), and the rabbiteye samples had significantly lower numbers (6–14/250 cm^3). *Xiphinema americanum* was the major species found in the blueberry samples, whereas *Mesocriconema ornata* was the major species in the sod. Nematode population densities and species distribution in commercial rabbiteye plantings in nine counties in central and southwestern Arkansas varied greatly. The average population density for rabbiteye samples was 129/250 cm^3 and for sod was 577/250 cm^3. Weed infestations in the blueberry rows in the commercial plantings probably increased the population size and species distribution.

Key words: Arkansas, *Aorolaimus christiei*, blueberry, *Criconemella ornata, Gracilacus acicula, Hoplolaimus magnistylus, Helicotylenchus dihystera, Hemicycliophora zuckermani, Meloidogyne* sp., *Mesocriconema ornata, Paratylenchus* sp., *Paratrichodorus minor, Paratrichodorus* sp., *Paratrichodorus christiei, Pratylenchus* sp., nematode, nematode survey, *Tetylenchus sp., Tylenchorhynchus ewingi, Tylenchorhynchus* sp., *Vaccinium ashei, Vaccinium corymbosum, Vaccinium* sp., *Xiphinema americanum.*

Blueberry production in northwestern Arkansas and the Ozark Region consists exclusively of highbush (*Vaccinium corymbosum*) cultivars. Most commercial plantings in the nonmountainous regions of central and southern Arkansas are of the rabbiteye blueberry (*V. ashei*). A new group of hybrid blueberry cultivars, referred to as southern highbush or low-chill highbush, has been introduced that should be adapted to central and southern Arkansas as well as most of the southern United States. Southern highbush cultivars are hybrids of two or more *Vaccinium* species, of which the major species in the parentage is *V. corymbosum* and the secondary species is *V. darrowi* (1). Arkansas does not currently have commercial plantings of southern highbush cultivars, although they are being tested in research plantings.

Several phytoparasitic nematode genera and species have been reported on highbush blueberry. These include *Tetylenchus* in New Jersey and Massachusetts (5,12), in vitro parasitism by *Trichodorus christiei* (11), *Pratylenchus* sp., *Xiphinema americanum* and *Trichodorus* sp. in Oregon (3), and *Meloidogyne carolinensis* in North Carolina (4). It should be noted that *P. christiei* and *T. christiei* are now considered synonyms of *P. minor* (7,10). *Paratrichodorus christiei* and *X. americanum* were the predominant species associated with highbush blueberry in northwestern Arkansas in a previous report (2). The report indicated no cultivar effect on nematode population densities, although mulched plants had fewer *P. christiei* than nonmulched plants. Nematode numbers per liter of soil on mulched plants in the 19-year-old research planting were 173 *X. americanum* and 336 *P. christiei.*

We found no report of nematodes associated with rabbiteye or southern highbush blueberries. This study was undertaken to determine the phytoparasitic nematode species and population densities associated with southern highbush and rabbiteye blueberry compared with those on high-

Received for publication 2 February 1994.

[1] Published with approval of the Director, Arkansas Agricultural Experiment Station, Manuscript No. 94005.

[2] Associate Professor, Department of Horticulture and Forestry, University of Arkansas, Fayetteville, AR 72701.

[3] Professor, Department of Plant Pathology, Nematology Laboratory, University of Arkansas, Fayetteville, AR 72701.

bush blueberry and the sod middles in two research plantings, and to determine nematode species and population densities in commercial rabbiteye plantings.

Materials and Methods

Samples were taken in October 1991 from two mulched research plantings. One planting was in west-central Arkansas at the University of Arkansas Fruit Substation, Clarksville, where 'Climax' and 'Tifblue' rabbiteye, 'Cooper' and 'Gulf Coast' southern highbush, and 'Bluecrop' highbush cultivars were sampled. The planting was established in 1987. A second research planting was located at the University of Arkansas Strawberry Substation, Bald Knob, in east-central Arkansas. This planting consisted of 'Premier', Tifblue and Climax rabbiteye, and Bluecrop highbush cultivars, established in 1977. Soil type at both locations is a Linker fine sandy loam (54% sand, 40% silt, 6% clay). At each location, two plants within each of four replications of each cultivar were sampled at 0.3 to 0.5 m from the crown of the plant. Four soil cores 2.5-cm-d × 20 cm deep constituted a sample. Similar samples were taken from each replication within the sod middles between the blueberry rows at a distance of 1.5–2.0 m from the blueberry plants. The sod middles consisted mainly of grasses, which were most commonly crabgrass, bermudagrass, or fescue. In both research plantings, the cultivars were arranged in a randomized complete block design.

Samples were taken from 14 commercial rabbiteye plantings in nine counties in central and southwestern Arkansas in October 1991. One to three samples were taken from each planting and were limited to Climax, Premier, and Tifblue. Each sample consisted of soil from four cores, 2.5-cm-d × 20 cm deep, taken from two plants from four locations within each planting for each cultivar.

All commercial plantings were mulched with sawdust and (or) woodchips, and the age of the plantings ranged from 3 to 12 years. Weed control in the plant row was variable in the commercial plantings; some plantings were free of weeds and grasses, whereas others had significant infestations. Samples were also taken from the sod middles in each planting.

All samples were transported to the University of Arkansas Nematode Assay and Diagnostic Laboratory, Fayetteville, for nematode extraction, identification, and counting. Nematodes were extracted from a 250-cm^3 soil subsample by a sieving and centrifugal-flotation method (6).

Analysis of variance was conducted for total nematodes and the species density among cultivars at each research location. Nematode counts were transformed to $\log_{10}(x + 1)$ values before subjected to analysis of variance. Data were subjected to analysis of variance as a randomized complete block (due to the randomized complete block design of the plantings) and

Table 1. Total phytoparasitic nematodes and nematode species distribution associated with highbush, southern highbush, and rabbiteye blueberries and sod middles at the Fruit Substation, October 1991, from 250 cm^3 soil.

Cultivar	Type†	Total nematodes	*Xiphinema americanum*	*Paratrichodorus minor*	*Tylenchorhynchus martini*	*Pratylenchus scribneri*
Bluecrop	HB	451 a‡	429 a	22 a	0 b	0 b
Cooper	SHB	228 a	226 ab	0 b	2 b	0 b
Gulf Coast	SHB	384 a	384 a	0 b	0 b	0 b
Climax	RE	4 b	4 c	0 b	0 b	0 b
Tifblue	RE	4 b	4 c	0 b	0 b	0 b
Sod middles	—	121 a	77 b	0 b	33 a	11 a

Values are means of four replications of each cultivar.
† HB = highbush; SHB = southern highbush; RE = rabbiteye.
‡ Mean separation in columns by Waller-Duncan k-ratio *t* test (k = 100).

means separated by the Waller-Duncan k-ratio *t* test (k = 100).

Results

Samples from the highbush and southern highbush cultivars and sod had the highest population densities of nematodes in the planting at the Fruit Substation, ranging from 121–451/250 cm^3 of soil (Table 1). The rabbiteye cultivar samples averaged four nematodes for each sample. *Xiphinema americanum* was the most numerous nematode species in either blueberry or sod samples and was the only nematode found associated with Gulf Coast southern highbush and the rabbiteye cultivars. *Paratrichodorus minor* was associated with Bluecrop highbush blueberry, although at a lower level (22/250 cm^3). A few *Tylenchorhynchus martini* and *Pratylenchus scribneri* were found in the sod samples.

Similar findings were revealed in samples from the Strawberry Substation; samples from Bluecrop highbush and the sod middles had the highest nematode densities (Table 2). The rabbiteye cultivars had few nematodes. *Xiphinema americanum* was the predominant species in the Bluecrop samples, which also had low numbers of *P. minor* and *Helicotylenchus dihystera.* Rabbiteye samples contained low levels of *X. americanum* and *P. minor,* and Premier averaged two each of *H. dihystera* and *Tylenchorhynchus ewingi.* The sod middles had a different profile, with *Mesocriconema ornata* as the predominant species, followed by *T. ewingi, H. dihystera, Pratylenchus* sp., and *P. minor.* No *X. americanum* were found in the sod samples.

The samples from the 14 commercial rabbiteye blueberry plantings varied greatly in nematode numbers and species, for both the blueberry and sod samples (Table 3). Overall, total nematode levels for rabbiteye blueberries ranged from 1–851/250 cm^3 soil, with an average of 129 per sample. The sod samples ranged from 29–1295/250 cm^3 soil, with an average of 577 per sample.

Xiphinema americanum was found in 8 of

Table 2. Total phytoparasitic nematodes and species distribution associated with highbush, and rabbiteye blueberries and sod middles at the Strawberry Substation, 1991, from 250 cm^3 soil.

Cultivar	Type†	Total nematodes	*Xiphinema americanum*	*Paratrichodorus minor*	*Pratylenchus sp.*	*Helicotylenchus dihystera*	*Tylenchorhynchus ewingi*	*Criconemella ornata*
Bluecrop	HB	334 a‡	300 a	14 a	1 b	19 b	0 b	0 b
Climax	RE	6 b	3 b	1 a	0 b	0 b	2 b	0 b
Premier	RE	13 b	8 b	1 a	0 b	2 b	2 b	0 b
Tifblue	RE	14 b	0 b	14 a	0 b	0 b	0 b	0 b
Sod middles	—	288 a	0 b	11 a	25 a	34 a	61 a	157 a

Values are means of four replications of each cultivar.
† HB = highbush; RE = rabbiteye.
‡ Mean separation in columns by Waller-Duncan k-ratio *t* test (k = 100).

TABLE 3. Mean number of total phytoparasitic nematodes and of each nematode species identified from 14 commercial rabbiteye plantings (RE = Rabbiteye Blueberry, Sod = grassy area between rows) in nine counties in central and southwestern Arkansas from samples collected in October 1991.

County	Site	Area sampled	Number cultivars or sod sampled	Mean number of nemas†	Plant-parasitic nematodes/250 cm³ soil‡																	
					X. a.	*P. m.*	*M. o.*	*M.* sp.[1]	*T. e.*	*T.* sp.	*P. z.*	*P. s.*	*P.* sp.[1]	*H.* sp.	*H. p.*	*H. d.*	*A. c.*	*P.* sp.[2]	*G. a.*	*M.* sp.[2]	*H. m.*	*H. z.*
Clark	1	RE	3	16	—	—	2	—	12	—	1	—	—	—	—	—	—	—	—	1	—	—
		Sod	3	304	1	1	—	—	2	—	84	—	—	—	—	—	—	48	—	168	—	—
Columbia	1	RE	3	95	—	12	36	—	—	—	—	—	6	41	—	—	—	—	—	—	—	—
		Sod	3	294	—	14	23	—	—	—	188	—	—	63	—	—	—	2	—	4	—	—
	2	RE	2	131	61	2	17	—	25	—	1	—	—	—	25	—	—	—	—	—	—	—
		Sod	1	419	—	5	246	—	74	—	10	—	—	—	—	84	—	—	—	—	—	—
Hempsted	1	RE	3	200	3	20	2	—	—	—	—	—	—	—	174	—	—	1	—	—	—	—
		Sod	3	1,065	9	7	385	—	19	—	38	—	—	—	—	601	—	6	—	—	—	—
	2	RE	2	9	—	—	6	—	—	—	—	—	—	—	3	—	—	—	—	—	—	—
		Sod	2	394	6	2	188	—	—	—	—	56	—	—	137	—	—	5	—	—	—	—
Howard	1	RE	2	9	—	—	—	—	—	—	—	—	—	—	—	9	—	—	—	—	—	—
		Sod	1	29	—	—	—	—	—	—	6	—	—	—	—	12	—	11	—	—	—	—
Jefferson	1	RE	1	1	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	—	—
		Sod	1	78	12	—	—	—	—	—	21	—	—	—	—	45	—	—	—	—	—	—
Lonoke	1	RE	2	43	25	—	—	—	—	—	—	—	—	18	—	—	—	—	—	—	—	—
		Sod	2	451	74	3	—	3	—	—	51	—	—	127	—	—	—	3	—	187	3	—
Miller	1	RE	2	105	29	30	8	—	—	—	—	—	—	—	—	38	—	—	—	—	—	—
		Sod	2	742	53	27	240	—	—	—	48	—	—	—	—	258	21	—	—	27	—	68
	2	RE	2	851	48	54	426	—	—	—	—	—	—	—	—	58	155	—	—	110	—	—
		Sod	2	1,292	99	49	365	—	—	—	9	—	—	—	—	—	768	2	—	—	—	—
Pulaski	1	RE	2	5	—	—	—	—	—	—	—	—	—	—	—	5	—	—	—	—	—	—
		Sod	2	468	66	—	—	—	—	—	164	—	—	—	—	239	—	—	—	—	—	—
	2	RE	1	45	5	24	—	—	—	1	1	—	—	—	—	14	—	—	—	—	—	—
		Sod	1	252	—	12	—	6	—	—	51	—	—	—	—	39	—	—	72	72	—	—
White	1	RE	1	27	7	—	—	—	—	—	—	—	—	—	—	20	—	—	—	—	—	—
		Sod	1	1,295	99	—	—	—	—	—	204	—	—	—	—	992	—	—	—	—	—	—
	2	RE	1	169	9	—	—	—	—	—	—	—	—	60	—	—	—	—	—	—	—	—
		Sod	1	675	36	—	—	—	—	—	138	—	—	477	—	—	—	24	—	—	—	—
Overall	14	RE	27	129	13	11	38	0	3	<1	<1	0	<1	8	21	9	11	<1	0	8	0	0
Total: Mean++		Sod	25	577	31	10	122	<1	5	0	76	4	0	37	11	159	63	9	3	41	<1	5

+ Mean of four cultivar or sod samples.

‡ Mean number in four soil samples: *X.a.* = *Xiphinema americanum*, *P.m.* = *Paratrichodorus minor*, *M.o.* = *Mesocriconema ornata*, *M.*sp.[1] = *Mesocriconema* sp., *T.e.* = *Tylenchorhynchus ewingi*, *T.*sp. = *Tylenchorhynchus* sp., *P.z.* = *Pratylenchus zeae*, *P.s.* = *P. scribneri*, *P.*sp.[1] = mixture of *P. zeae* and *P. scribneri*, *H.*sp. = Mixture of *Helicotylenchus dihystera* and *H. pseudorobustus*, *H.p.* = *H. pseudorobustus*, *H.d.* = *H. dihystera*, *A.c.* = *Aorolaimus christiei*, *P.*sp.[2] = *Paratylenchus* sp., *G.a.* = *Gracilacus acicula*, *M.*sp.[2] = *Meloidogyne* sp., *H.m.* = *Hoplolaimus magnistylus*, *H.z.* = *Hemicycliophora zuckermani*.

++ Total: for sites, number of cultivars or sod sampled; mean: for mean number of all nematodes and species of nematodes.

14 rabbiteye sites, with a range of 0–61 and an average of 13/250 cm^3 and in 10 of 14 sod sites, with a range of 0–99 and an average of 31/250 cm^3. *Paratrichodorus minor* occurred in 6 of 14 rabbiteye samples, with a range of 0–54 and a mean of 11/250 cm^3. In all plantings where *P. minor* was found associated with blueberry, this nematode was also found in the accompanying sod sample. *Tylenchorhynchus* sp. were found in 3 of 14 rabbiteye samples, with a range of 0–25 and a mean of 3/250 cm^3. Four of 14 rabbiteye samples contained *Pratylenchus* sp., with a range of 0–6 and an average of <1/250 cm^3. However, this genus was found in all 14 sod samples and ranged from 6–204/250 cm^3. Of the 14 plantings sampled, seven had *M. ornata* associated with rabbiteye, with a range of 0–426 and a mean of 38/250 cm^3. *Paratylenchus* sp. were not found in any samples from rabbiteye, whereas *Helicotylenchus* sp. were found in 13 of 14 rabbiteye samples. The mean population of *Helicotylenchus* sp. was 38/250 cm^3 for rabbiteye but was highest of all species found in sod samples (207/250 cm^3). Two samples from rabbiteye contained *Meloidogyne* spp.

Discussion

The data from the research plantings reveal that rabbiteye blueberries are not good hosts for the phytoparasitic species and *V. ashei* is different from *V. corymbosum* in nematode associations. Data from the commercial plantings support this finding, although more nematodes were found associated with rabbiteye plants in commercial plantings than in the research plots. We think this is probably due to significant weed infestations in the commercial plantings, although we collected no supporting data for this observation. The data from the research planting, which contained the southern highbush cultivars, indicated that these cultivars were similar to Bluecrop in serving as a host for nematodes. This is understandable, since *V. corymbosum* contributes the majority of the genes in these southern highbush cultivars (1).

Data in this report agree with that of Clark et al. (2), who found that *X. americanum and P. christiei* were the major phytoparasitic nematodes associated with highbush blueberry in northwestern Arkansas. Nematode levels reported by Clark et al. (2) in a 19-year-old planting were lower (43/250 cm^3) for *X. americanum* and higher (84/250 cm^3) for *P. christiei* than the levels found in either research planting in this study. This could be due to soil type, planting age, time of sampling, or seasonal environmental variation.

The major concern with nematodes in blueberry production has been the transmission of viruses. Tobacco mosaic virus, which causes necrotic ringspot disease, is transmitted by *X. americanum* (8). This disease has been reported in Arkansas on highbush blueberry (9). Necrotic ringspot disease has not been reported on rabbiteye blueberries, and this may be because rabbiteye is not a suitable host for the nematode vector.

Literature Cited

1. Ballington, J. R. 1990. Germplasm resources available to meet future needs for blueberry cultivar improvement. Fruit Varieties Journal 44:54–62.

2. Clark, J. R., R. D. Riggs, and J. N. Moore. 1987. Plant parasitic nematodes associated with highbush blueberry in Arkansas. HortScience 22:408–409.

3. Converse, R. H., and D. C. Ramsdell. 1982. Occurrence of tomato and tobacco ringspot virus of dagger and other nematodes associated with cultivated highbush blueberries in Oregon. Plant Disease 66: 710–712.

4. Eisenback, J. D. 1982. Description of the blueberry root knot nematode, *Meloidogyne carolinensis* n. sp. Journal of Nematology 14:303–317.

5. Hutchinson, M. T., J. P. Reed, and S. R. Race. 1960. Nematodes stunt blueberry roots. New Jersey Agriculture 42:12–13.

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

7. Loof, P. A. A. 1975. Taxonomy of Trichodoridae. Pp. 103–127 *in* F. Lamberti, C. E. Taylor, and J. Seinhorst, eds. Nematode vectors of plant viruses. New York: Plenum Press.

8. McGuire, J. M. 1964. Efficiency of *Xiphinema americanum* as a vector of tobacco ringspot virus. Phytopathology 54:799–801.

9. McGuire, J. M., and S. L. Wickizer, 1980. Occurrence of necrotic ringspot of blueberry in Arkansas. Arkansas Farm Research 24:(4)6.

10. Siddiqi, M. R. 1973. Systematics of the genus *Trichodorus* Cobb. 1913 (Dorylaimida:Nematoda) with descriptions of three new species. Nematologica 19: 259–278.

11. Zuckerman, B. M. 1962. Parasitism and pathogenesis of the cultivated highbush blueberry by the stubby root nematode. Phytopathology 52:1017–1019.

12. Zuckerman, B. M., and J. W. Coughlin. 1960. Nematodes associated with some crop plants in Massachusetts. Massachusetts Agricultural Experiment Station Bulletin 521.