Epidemiology of a Tobacco Cyst Nematode (*Globodera solanacearum*) in Virginia

DEAN A. KOMM, Assistant Professor, and JOHN J. REILLY, Assistant Professor, Virginia Polytechnic Institute and State University, Southern Piedmont Center, Blackstone 23824, and A. P. ELLIOTT, Assistant Professor, Department of Plant Pathology and Physiology, Virginia Polytechnic Institute and State University, Blacksburg 24061

ABSTRACT

Komm, D. A., Reilly, J. J., and Elliott, A. P. 1983. Epidemiology of a tobacco cyst nematode (*Globodera solanacearum*) in Virginia. Plant Disease 67:1249-1251.

The detection and spread of a tobacco cyst nematode (TCN), *Globodera solanacearum*, was traced from 1961 through 1982. A total of 148 farms (1,230 ha) in a 10-county area of Virginia were verified to have TCN. In 1982, losses reported on 339 ha of infested land amounted to an estimated $700,000 compared with $13,000 in 1980. Yield of tobacco grown on infested land was reduced by an average of 15%. The disease progress curve shows this epidemic in the exponential phase of growth. Continuous tobacco production is the main factor leading to yield reductions caused by TCN. Control practices are discussed.

Globodera solanacearum (Miller & Gray) Behrens was first observed in 1961 parasitizing roots of *Nicotiana tabacum* L. 'Hicks' in Amelia County, VA (6). The original farm consisted of a 1.33-ha field that had been in continuous tobacco production for 7 yr. *G. solanacearum* is closely related to (but differs in pathogenicity from) *G. tabacum*, a tobacco cyst nematode in Connecticut. Miller et al (5) have shown that the tobacco cyst nematode (TCN) in Virginia infects the common weed horsenettle (*Solanum carolinense* L.) and that it is related to the horsenettle cyst nematode (*G. virginiae*).

Since 1961, TCN has been detected in 10 counties in Virginia but nowhere else in the world. In 1979, numerous calls to our disease clinic concerning TCN stirred new interest in this pathogen. Before that year, reports on the spread and/or detection of TCN were sporadic. Occurrence of TCN on farms in Virginia from 1961 through 1982 and the estimated dollar losses caused by this pathogen in flue-cured tobacco are reported in this paper.

MATERIALS AND METHODS

Information concerning the number of farms infested with TCN in 1961 and 1972 was taken from the literature (4,6). The number of farms infested with TCN from 1978 through 1982 was compiled from on-site observations by extension agents and confirmed through the diagnostic assay service of the Virginia Polytechnic Institute and State University. In addition, a predictive nematode assay was used from 1980 through 1982 to detect TCN in fall soil samples before the occurrence of crop injury.

Since 1979, extension agents have estimated the financial losses attributed to TCN. They estimated the number of hectares of tobacco infested with TCN on each farm in their county in 1982 and the probable yield from the infested field. The probable yield was compared with yields of previous tobacco crops grown in the same field or with yields from nearby uninfested tobacco fields. Using the average yield per hectare in a particular county and the state average of $3.98/kg ($/kg is not determined on a county basis), the dollar loss for a field was calculated. Dollar losses for all TCN-infested fields were totaled by county and reported in Table 1.

Extension agents also estimated the total number of hectares infested but not currently planted to tobacco in their county. Additional information generated included production practices and disease control measures used by farmers reporting losses to TCN, as well as practices used by farmers having TCN on their land but with no loss of yield. The determination of yield loss was made by comparing the yield of the current crop with the range of yields from the same field before it became infested.

RESULTS AND DISCUSSION

The distribution of TCN in Virginia by county and date of detection is shown in Figure 1. Of the 17,189 ha available for tobacco production in 1982, 1,230 ha were infested (Table 1). Yield reductions were reported on 339 ha in 1982. On these farms, growers were unaware of the infestation; therefore, losses were severe and averaged 15%. Some farmers in Brunswick County suffered a complete crop failure.

TCN is a concern to a limited number of farmers compared with the number of tobacco farmers in Virginia; however, concern has grown as the number of infested farms has increased (Table 2). A graph of the number of TCN-infested farms is shown in Figure 2. From 1961 to 1978, the spread of TCN was in a lag phase of growth, but by 1979, it had entered the exponential phase of growth. The correlation coefficient for years (x) with the number of infested farms (y) was 0.749, whereas the correlation coefficient of log y on x was 0.965. Therefore, there was a much better fit of data to an exponential growth curve than to a linear growth curve. Figure 2 also shows the regression line for log y on x. The antilog of the regression equation of log y on x is $y = 2.6\ (1.18)^x$, indicating the number of farms infested with TCN was increasing by 18% per year between 1961 and 1982 (8).

We do not know whether TCN is spreading or merely being isolated more frequently because of improved detection aided by the predictive nematode assay program. Nevertheless, considering the ease with which this soilborne pathogen is dispersed by equipment, irrigation water, and infected transplants, some spread seems probable. We do not believe the increase is due to better public awareness because this pathogen has received much attention through the media and area meetings since its discovery. Because the locations of infested farms plotted on county maps show some foci but no discernable overall pattern, it is possible that the organism may be indigenous to the area. Some of the foci are explained by individuals within the same family

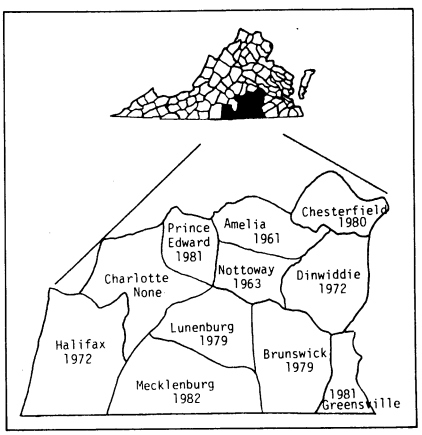

Fig. 1. Distribution of *Globodera solanacearum* in Virginia by county and year of detection.

Accepted for publication 19 May 1983.

The publication costs of this article were defrayed in part by page charge payment. This article must therefore be hereby marked "*advertisement*" in accordance with 18 U.S.C. § 1734 solely to indicate this fact.

Table 1. Production data for Virginia counties known to have farmland infested with *Globodera solanacearum* in 1982

County	Planted (ha)	Average yield (kg/ha)	Average income ($/ha)[a]	Infested planted (ha)	Income loss (Total $)[b]	Income loss ($/ha)	Average income loss (%)[c]	Infested total (ha)
Amelia	231	2,392	9,520	11	19,600	1,782	19	123
Brunswick	1,288	2,224	8,852	142	350,000	2,465	28	408
Chesterfield	78	2,744	10,921	1	0	0	0	4
Dinwiddie	657	2,547	10,137	61	194,250	3,184	31	405
Greensville	184	2,470	9,831	13	1,734	133	1	13
Halifax	3,700	2,140	8,517	...	0	0	0	0
Lunenburg	1,121	2,122	8,446	8	18,000	2,250	27	30
Mecklenburg	2,408	2,271	9,039	2	0	0	0	2
Nottoway	294	2,222	8,844	101	115,600	1,145	13	243
Prince Edward	183	2,252	8,963	0	0	0	0	2
Total or average	10,144	2,338	9,307	339	699,184	1,095	15	1,230

[a] Average income based on the county average kg/ha at the state average of $3.98/kg (county average $/kg is not recorded).
[b] Income loss based on county extension agent estimates.
[c] Percent loss by county = income loss ($/kg) ÷ income ($/ha). Average percent income loss = sum of income losses by county ÷ 8 (8 = number of counties where infested land was planted to tobacco).

Table 2. Number of farms (by county and year) infested with *Globodera solanacearum* for Virginia flue-cured tobacco[a]

County	Number of fields infested by:						
	1961	1972	1978	1979	1980	1981	1982
Amelia	3	12	12	12	13	20	24
Brunswick	0	0	0	7	12	16	21
Chesterfield	0	0	0	0	2	2	2
Dinwiddie	0	1	1	4	9	20	37
Greensville	0	0	0	0	1	1	3
Halifax	0	0	1	1	1	1	1
Lunenburg	0	0	0	4	8	11	15
Mecklenburg	0	0	0	0	0	0	1
Nottoway	0	5	12	22	24	33	43
Prince Edward	0	0	0	0	0	1	1
Total	3	18	26	50	70	105	148

[a] Information compiled from county extension agent reports, diagnostic assays, and predictive assays.

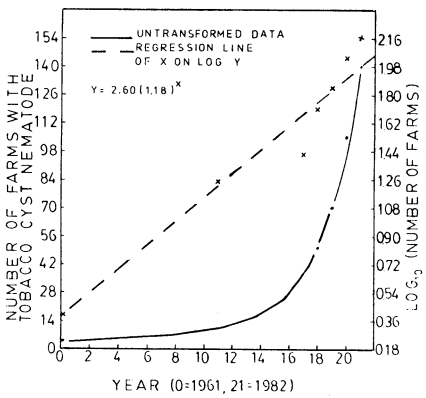

Fig. 2. Cumulative number of farms with tobacco cyst nematode by year since 1961.

sharing equipment and transplants on different farms.

Data from specific counties was alarming in that much of the land available for growing tobacco was infested. For instance, 60, 33, and 25% of the tobacco land in Nottoway, Brunswick, and Dinwiddie counties, respectively, was infested with TCN. Five counties, Pittsylvania, Halifax, Mecklenburg, Brunswick, and Lunenburg, account for 72% of all the flue-cured tobacco grown in Virginia. TCN is established in Brunswick and Lunenburg.

The first infestation of TCN in Mecklenburg was reported by the predictive nematode assay in 1982, but no losses were reported and one farm in Halifax is known to be infested, again with no losses reported. No TCN has been reported in Pittsylvania County. Wyatt Osborne (*personal communication*) stated that several farms in Pittsylvania and Charlotte counties were infested with TCN. However, since 1979, we have had no confirmation of these sites so they were not included in this report. Because 1982 was an ideal year for TCN symptom expression, we are nearly certain that if TCN was more widespread in the counties surrounding the main infestation area, it would have been reported this year. In Greensville County, where little tobacco is grown, TCN was found on three farms, one of them just 6 miles from the North Carolina border. This is the nearest infestation to any neighboring state.

Several factors, the most prominent of which is sandy soils with high moisture content, affect the severity of losses to TCN. County extension agents agreed that the most common cultural practice leading to yield reductions caused by TCN was continuous tobacco culture. This was especially true when either no nematicide was used or ethoprop, carbofuran, or oxamyl was used at the rate recommended for control of root-knot nematodes (*Meloidogyne* spp.). Ethoprop, carbofuran, and oxamyl are not recommended for control of TCN.

Effective management practices are available for TCN. Many farmers follow the recommended control measures and grow tobacco on TCN-infested land without yield reductions. Crop rotation with fescue has been very successful in reducing nematode populations; 1 or 2 yr is satisfactory, but longer is desirable (7). The nematicide phenamiphos and combinations of phenamiphos with either carbofuran or fensulfothion have also proven very effective (3). At least two commercial cultivars, VA 81 and PD 4, are resistant but not tolerant to TCN; that is, nematode reproduction is reduced but the tobacco is stunted and yields are decreased. Sanitation practices such as cleaning of equipment and not using TCN-contaminated irrigation water can help prevent the spread of TCN.

Our records indicate that since 1980, 50% of all known TCN sites were detected by the predictive nematode assay; the other 50% were reported by agents and substantiated by diagnostic assay. Data taken from the predictive nematode assay records show that 39, 21, and 24% of the samples from 1980, 1981, and 1982, respectively, were positive for TCN. The average population densities were 13 and 15 cysts per 500 cm^3 soil for 1981 and 1982, respectively (1,2).

G. solanacearum is a soilborne pathogen and can be spread by contaminated farm equipment, but because effective management practices are available and the pathogen appears to be indigenous, we do not think state or federal regulatory actions are warranted or would serve any useful purpose.

ACKNOWLEDGMENTS

We thank extension agents Wayne Brown, George Board, Bobby Flippen, Don Fowlkes, William Green, Meade Harrison, John Hutcheson, Richard Lacks, Russell Leslie, James Maitland, Larry McPeters, and Richard Nunnally for providing information and Sue Meredith, Charlie Harris, and Robert Wick for technical assistance.

LITERATURE CITED

1. Elliott, A. P. 1981. Report on the Predictive Nematode Assay Program at Virginia Tech, 1980. Ext. Publ. 450-032. 19 pp.
2. Elliott, A. P., Phipps, P. M., Komm, D. A., Babineau, D., Yoder, K., Reilly, J., Harris, C., Meredith, S., Ravlin, R., and Walker, N. 1982. Predictive nematode assay program at Virginia Tech, 1982. Ext. Publ. 450-070. 28 pp.
3. Komm, D. A., and Elliott, A. P. 1983. Evaluation of selected nematicides for control of a tobacco cyst nematode in flue-cured tobacco at three locations. Fungic. Nematic. Tests 38:15-16.
4. Miller, L. I., and Gray, B. J. 1972. *Heterodera solanacearum* n. sp., a parasite of solanaceaus plants. Nematologica 18:404-413.
5. Miller, L. I., Harrison, M. B., and Schindler, A. F. 1962. Horsenettle and Osborne's cyst nematode—two undescribed nematodes occurring in Virginia. (Abstr.) Phytopathology 52:743.
6. Osborne, W. W. 1961. Tobacco attacked by a cyst-forming nematode in Virginia. Plant Dis. Rep. 45:812-813.
7. Osborne, W. W. 1971. The Osborne's cyst nematode—a serious pest in tobacco. Va. Polytechnic Inst. State Univ. Control Ser. 79. 4 pp.
8. Steel, R. G. D., and Torrie, J. H. 1960. Principles and Procedures of Statistics. McGraw-Hill, New York. 481 pp.