FINAL REPORT - NEMATODE SURVEY

I. INTRODUCTION

This survey was site oriented. It was intended to sample as wide a range of crops and regions as possible with the time available. No attempt was made to match collections of crops or cropping systems at different sites or on different soils. Results of the survey characterize problems in regions and permit comparisons of problems between regions and crops. They cannot explain species occurrence or populations fluctuations observed in the sampled areas. To do that would require a vastly more complicated survey system.

In the course of this work 205 soil samples were collected from 12 sites in Colombia. Soil and roots included in the samples were processed separately. Nematodes were extracted from soil by centrifugal-flotation. This process does not depend on active nematode movement for extraction, an advantage when samples were transported long distances without refrigeration to preserve specimens in a motile state. Young's technique for extraction of motile endoparasites from roots was employed because it is a standard procedure widely used in nematological research and because equipment suitable for it was available.

Roots containing Meloidogyne females were stained with hot lactophenol containing acid fuchsin. Beans (Phaseolus vulgaris 'Calima') were planted in soil samples containing Meloidogyne larvae from bean crops. Females developing on these host plants will be used for species identifications in those instances when mature females were not collected in the field.

Pratylenchus spp. were relaxed in hot water and preserved in 2.5% formaldehyde. Specimens of Pratylenchus will be dehydrated by Thorne's Slow Process to glycerine before identification.

The major problems discovered in this survey and suggestions for research on them are discussed by crop area. The results of each sample are included in Appendix II. In the List of Activities (Appendix I; Section A) the total range of crops sampled at each site are given. Because of the importance of Palmira to a large number of workers at CIAT, samples collected at Palmira are indexed by plot area (Appendix III).

II. BEANS (Phaseolus vulgaris)

A major part of the total survey was devoted to this crop (132 of 205 samples). Most of these results are included in the CIAT Annual Report for 1978. These data are included in Appendix IV. Farms in the Tenerife area and plots of sugar cane interplanted with beans were sampled subsequent to completion of the Annual Report. Results of these last two surveys are given in Table 1.

Tenerife was similar to previous sample areas in that root knot nematode occurred commonly. Meloidogyne incognita was the predominant species. Tenerife was unusual in the absence of Pratylenchus spp. Scutellonema sp. was extremely common in the Tenerife samples, often at high populations.

Table 1. Genera of plant-parasitic nematodes associated with beans at Tenerife (Valle) and Providencia (Valle).

Genus	Tenerife		Providencia	
	Population/ 500 ml Soil[a]	Population/ g Root	Population/ 500 ml Soil	Population/ g Root
Helicotylenchus	7/8 (3600)	3/8 (40)	4/12 (400)	
Tylenchorhynchus	7/8 (1700)	1/8 (14)	8/12 (300)	
Meloidogyne incognita	4/8 (2800)	3/8 (1520)		
Macroposthonia	1/8 (100)		10/12 (700)	
Trichodorus	4/8 (1700)			
Scutellonema	3/8 (3700)	4/8 (2400)		
Hoplolaimus			11/12 (600)	
Pratylenchus			11/12 (700)	9/12 (186)

[a] Numerator = Number of samples in which genus occurred; Denominator = Number of samples at site; Number in parenthesis = Maximum population of genus.

This nematode constitutes a local problem from bean production in the Tenerife area.

Soil samples from bean plots at Providencia reflected the populations of nematodes developed by the proceeding sugar cane crop. Of the genera found only lesion nematodes pose a check to bean production. While soil populations of this genus were generally low in the bean plots, root samples of beans did contain substantial populations of lesion nematodes. Pratylenchus populations in sugar cane roots were high also. Immediately after harvest when cane roots become unfavorable for nematode feeding, lesion nematodes were migrate from the roots and increase soil populations of this genus. Beans planted at such a time could be severely damaged.

Meloidogyne javanica and Rotylenchulus sp. have been found on sugar cane in Valle (pers. comm. Francia Varón de Agudelo, ICA Palmira). These nematodes could cause substantial losses in bean production. They were not found in this survey, however.

In summary, results of this survey indicate that of the nematodes found Meloidogyne spp. will impose the most important and wide spread limit to bean production in Colombia. At high elevations in cool soils, in areas like Pasto or Popayán, M. hapla will be the predominant species. At warmer temperatures, M. incognita and M. arenaria will predominate. These species were common at La Selva, Río Negro, Restrepo, and Tenerife. Under the very warmest conditions, such as exist in cane fields in Providencia, M. javanica will be most important.

As a basis for ordering research priorities on control of Meloidogyne, economic analysis of root-knot losses should be made first. Natural infestations of M. incognita, M. arenaria, and M. hapla have been identified either on CIAT land or in on-farm trials. There are several contact-systemic nematicides which could be conveniently used to determine bean losses caused by nematodes. I would suggest oxamyl (Vydate 10G or Vydate L; E.I. DuPont) at 2-4 lb ai/A applied at planting and 1 lb ai/A three weeks later applied as a foliar spray. Because this material can act as an insecticide, this research should have internal insecticide controls and the work should be conducted as a joint project of economists, entomologists, and plant pathologists. Meloidogyne may act synergistically with root rot fungi. The effect of nematode control on root rots on bean should be part of this research plan.

Resistant varieties are the only general control procedure for Meloidogyne damage on small farms in Colombia. Sources of resistance to M. incognita and M. javanica have been identified. This breeding work was done before the occurrence of pathogenic races was known. At the present time, 4 races of M. incognita and 2 of M. arenaria have been identified. The reaction of resistant lines to 8 species - race combinations will have to be assessed. In addition, soil temperature alters plant resistance to Meloidogyne attack. This factor must be taken into account by the breeding program.

Weed control with herbicides could be very important in root-knot nematode control and it deserves research effort. Hypersensitivity is the main mechanism of resistance to Meloidogyne. Varieties resistant to Meloidogyne by this means can sustain massive root damage when exposed to high populations of larvae. Common weeds in bean fields, such as Bidens pilosa, are good hosts of root-knot nematodes in all surveyed areas. These weeds maintain high Meloidogyne populations even in the absence of economic host plants. Weed control with herbicides will be important in obtaining maximum performance from resistant varieties.

Where fallow periods exist in the cropping schedule, for example in the Huila area, nematodes could be controlled by this means if good weed control is possible. Herbicides could be very important in strict weed control. More over, weed control with herbicides could lessen damage to root-knot nematodes in most areas of Colombia even on susceptible varieties simply by removing "inter-planted" weeds which are frequently better hosts of Meloidogyne than the beans themselves. This would lower soil populations to less extreme levels.

Systemic and contact nematicides could be useful to small farmers in bean areas such as Río Negro for root-knot control, if economics support their use. Cost of control materials would probably be in the $20 to $40 US/ha range. Since these materials are insecticidal also, cost of materials might be lessened by replacement of single action insecticides in the spray program. These materials can be applied with simple, hand operated equipment.

There are problems with use of these chemicals in Colombia. They are extremely toxic to humans and difficult for farmers to handle safely. They present special problems when farm families are closely associated with treated areas. In many areas beans are interplanted with an array of crops with different harvest times. It would be impossible to treat bean crops without also treating non-target crops under these conditions.

Because of the complexity of cropping systems and the intensive use of land on small farms, crop rotation, although effective in control of root-knot nematodes in other areas, is not feasible in Colombia.

Second in importance to Meloidogyne on bean are species of Pratylenchus, lesion nematodes. Colombian soils are infested widely with a number of different species of Pratylenchus including P. penetrans, P. crenatus, P. vulnus, P. zeae, and P. brachyurus. In general research programs for control of Meloidogyne should be applicable to Pratylenchus also. Because lesion nematodes do not require specialized host reactions to establish a successful host-parasite relationship, as in the case of Meloidogyne, resistance to lesions nematodes may be more difficult to find.

Within much more restricted areas, Helicotylenchus, Xiphinema, Longidorus, Cacopaurus, and Scutellonema may cause damage to beans. Nothing is known about the pathogenicity of these genera to beans. The greatest need for research in this case is to link high populations with economic damage. This can be done best with field trials utilizing chemicals for nematode control.

III. DESMODIUM OVALIFOLIUM/ MELOIDOGYNE JAVANICA

A report to the Beef Production Team on this subject has been made (Appendix V). Since this report was made the identification of M. javanica has been authenicated. Infestations of this species have been found in D. ovalifolium at El Limonar and Quilichao. At both El Limonar and Quilichao, M. javanica reproduces on numerous solanaceous and composite weeds. Most probably, D. ovalifolium initially became infested by contact with native populations of M. javanica in these areas. Occurrence of M. javanica on these weeds in Valle increase the likelihood of its occurrence on similar weeds in the Colombian Llanos.

Surveys of other Desmodium species at El Limonar and D. barbatum at Palmira did not reveal infestations of M. javanica on them. Brachiaria, Paspalum, and Andropogon at Quilichao were not found to be hosts of M. javanica. These grasses supported only low populations of Pratylenchus and Macroposthonia.

IV. MISCELLANEOUS

At Palmira nematodes populations were generally low reflecting the effects of crop rotation and heavy soils. Two interesting observations may indicate potential nematode problems for crops at Palmira, however.

Extremely high populations of Helicotylenchus sp. occurred in plot H3 following rice. Populations were approximately 13,000 specimens/500 ml soil. This type of population development may indicate loss to rice or to crops planted following rice.

The area of sandy soil in plot P1 immediately next to the bamboo planting contained high populations of Cacopaurus and, in addition, low populations of Meloidogyne sp., the only area of occurrence for this genus at Palmira. Cassava planted in this area may be damaged by these genera. There is no research on damage caused by Cacopaurus. Because of the Meloidogyne this area should not be monocropped with susceptib le host crops.

APPENDIX I

List of Activities

A. Collection of soil and roots (samples each) (Total samples).

1. Carimagua; Desmodium ovalifolium (8), Zornia (1), Pueraria (1), Desmodium barbatum (2), weed (Labiatae) (1), Cassava (5), (18).
2. El Limonar; Desmodium sp. (1), D. carne (1), D. heterophyllum (1), D. heterocarpa (1), D. ovalifolium (2), weed (Compositae) (1), weed (Solanaceae) (1), (8).
3. La Selva; Bean (6) (6).
4. Palmira; Bean (27), Bean/Maize (7), Bean/Cassava (4), Bean/Sorghum (3), Sorghum (6), Cassava (6), Rice (2), Andropogum (1), Fallow (5), Bamboo (2), Weeds (8), peanut grass (1), (72).
5. Pasto; Bean (3), Bean/Maize (4), (7).
6. Popayán; Bean (23), Bean/Maize (1), (24).
7. Potosí; Bean (2), (2).
8. Restrepo; Bean (11), Coffee (1), Plantain (1), Aracacia xanthorhiza (1), (14).
9. Río Negro; Bean/Maize (20), (20).
10. Santander; Bean (1), Zornia sp. (1), D. ovalifolium (6), Guinea grass (3), Paspalum (2), Brachiaria (2), Andropogon (3), (18).
11. Tenerife: Beans (5), Bean/Maize (1), Bean/Maize/Plantain (1), Bean/Strawberry (1), (8).
12. Providencia; Bean (3), Bean/Sugar Cane (9), Sugar Cane (3), (15).

List of Activities (Cont.)

B. Submission of _Meloidogyne_ spp. from bean and _Desmodium ovalifolium_ to International _Meloidogyne_ Project at North Carolina State University.

C. Report to Beef Production Team on _Desmodium ovalifolium/Meloidogyne javanica_ problem.

D. Preparation of data for CIAT Annual Report, 1978.

E. Preparation of English script and photographs for Audiotutorial program, "Nematodes which attack beans and their control".

APPENDIX II

RESULTS OF NEMATODE SURVEY SEPTEMBER 7 TO DECEMBER 12, 1978

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
1. Palmira O_1 North	Bean	Helicotylenchus	100	NS
2. Palmira S_2 North	Corn/ Bean	Helicotylenchus	100	NS
3. Popayán Phytopathology	Bean	Helicotylenchus	600	NS
		Meloidogyne	900	NS
4. Popayán Plant Breeding	Bean	Helicotylenchus	1100	NS
		Meloidogyne	900	NS
		Trichodorus	200	NS
5. Popayán Agronomy North	Bean/ Corn	Meloidogyne	100	NS
6. Popayán Agronomy/Physiol-ogy	Bean	Meloidogyne	1000	NS
7. Santander	Bean	Helicotylenchus	400	NS
8. Palmira K_2 South		No Plant Parasites	-	NS
9. Palmira E_1 North	Bean	Pratylenchus	100	NS
10. Palmira S_1 South West	-	No Plant Parasites	-	NS
11. Palmira L_1 North	-	Pratylenchus	2200	NS
		Helicotylenchus	800	NS
12. Palmira I_2 East	Bean/ Sorghum	Tylenchorhynchus	100	NS
13. Palmira I_2 Central	Bean/ Sorghum	Tylenchorhnchus	100	NS
14. Palmira I_2 West	Bean/ Sorghum	Helicotylenchus	100	NS
		Tylenchorhynchus	100	NS
15. Palmira N_1A South	Bean	No Plant Parasites	-	NS
16. Palmira N_1B South	Bean	No Plant Parasites	-	NS

Survey Result

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
17. Palmira				
N_1C South	Bean	No Plant Parasites	-	NS
18. Palmira				
N_1D South	Bean	Helicotylenchus	200	NS
19. Palmira				
N_1E South	Bean	No Plant Parasites	-	NS
20. Palmira				
N_1F South	Bean	Paratylenchus	100	NS
		Tylenchorhynchus	100	NS
21. Palmira				
O_1 South	Bean	Helicotylenchus	100	NS
22. Palmira				
M_1 South	-	No Plant Parasites	-	NS
23. Rio Negro	Bean/	Criconema	2800	-
Anibal Valencia	Corn	Helicotylenchus	1300	-
		Pratylenchus	800	52
		Trichodorus	200	-
24. Rio Negro	Bean/	Criconema	400	-
Anibal Valencia	Corn	Helicotylenchus	800	-
		Trichodorus	300	-
		Xiphinema	100	-
		Pratylenchus	-	30
25. Lost				
26. Rio Negro	Bean/	Criconema	400	-
Ignacio Soto	Corn	Helicotylenchus	2600	14
		Pratylenchus	200	21
		Meloidogyne	300	-
		Trichodorus	700	-
27. Rio Negro		Lost	-	0
Ignacio Soto				

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
28. Rio Negro	Bean/	Criconema	200	-
Octavio Franco	Corn	Helicotylenchus	600	
		Trichodorus	200	-
		Pratylenchus	0	20
29. Rio Negro				
Octavio Franco	Bean/	Helicotylenchus	900	5
	Corn	Meloidogyne	900	20
		Trichodorus	400	-
30. Rio Negro				
Luis Giraldo	Bean/	Criconema	1400	-
	Corn	Helicotylenchus	900	-
		Meloidogyne	700	-
		Pratylenchus	200	20
		Trichodorus	200	-
31. Rio Negro				
Luis Giraldo	Bean/	Helicotylenchus	700	-
	Corn	Criconema	300	-
		Meloidogyne	3200	40
32. Rio Negro				
Francisco Jarami	Bean/	Helicotylenchus	1500	-
llo	Corn	Macroposthonia	100	-
		Meloidogyne	900	-
		Pratylenchus	300	6
		Trichodorus	100	-
33. Rio Negro				
F. Jaramillo	Bean/	Helicotylenchus	400	-
	Corn	Meloidogyne	4300	40
		Pratylenchus	300	-
34. Rio Negro				
Jaime Alzate	Bean/	Helicotylenchus	2900	-
	Corn	Meloidogyne	3800	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
35. Rio Negro				
J. Alzate	Bean/	Helicotylenchus	4300	10
	Corn	Macroposthonia	100	-
		Meloidogyne	3000	45
		Pratylenchus	500	15
36. Rio Negro				
Pedro Gómez	Bean/	Helicotylenchus	4800	-
	Corn	Criconema	2000	-
		Meloidogyne	1000	-
		Trichodorus	500	-
37. Rio Negro				
Pedro Gómez	Bean/	Criconema	1500	-
	Corn	Helicotylenchus	2700	-
		Meloidogyne	1600	137
		Trichodorus	500	130
38. Rio Negro				
Antonio Gómez	Bean/	Criconema	1700	-
	Corn	Helicotylenchus	4200	-
		Meloidogyne	5100	-
		Pratylenchus	300	-
		Trichodorus	200	-
39. Rio Negro				
A. Gómez	Bean/	Criconema	800	-
	Corn	Meloidogyne	2600	366
		Helicotylenchus	2600	33
		Pratylenchus	200	600
		Trichodorus	600	-
40. Rio Negro				
Ramón Arboleda	Bean/	Criconema	600	-
	Corn	Helicotylenchus	400	-
		Macroposthonia	200	-
		Meloidogyne	600	-
		Pratylenchus	400	600
		Trichodorus	100	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
41. Rio Negro				
R.Arboleda	Bean/	Criconema	800	-
	Corn	Helicotylenchus	300	-
		Meloidogyne	800	533
		Pratylenchus	700	2833
42. Rio Negro				
Octavio Her-	Bean/	Helicotylenchus	1300	-
nández	Corn	Meloidogyne	800	-
		Pratylenchus	1600	4633
		Trichodorus	100	-
43. Rio Negro				
O.Hernández	Bean/	Helicotylenchus	1400	-
	Corn	Meloidogyne	200	-
		Pratylenchus	2100	10660
		Trichodorus	600	-
44. Palmira				
I_1 North	Bean	Helicotylenchus	100	-
		Tylenchorhynchus	700	-
45. Palmira				
J_1 South	Bean	Pratylenchus	300	-
		Tylenchorhynchus	300	-
46. Palmira				
I_1 West	Sorghum	Helicotylenchus	500	3
		Pratylenchus	700	8
		Tylenchorhynchus	700	-
47. Palmira				
L_1 North	Fallow	Pratylenchus	100	NS
		Tylenchorhynchus	100	NS
48. Palmira				
H_2 North East	Bean	No Plant Parasites	-	-
49. Palmira				
I_1 W	Bean	Helicotylenchus	200	-
		Pratylenchus	500	100
		Tylenchorhynchus	200	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
50. Palmira E_2 South	Bean	No Plant Parasites	-	-
51. Palmira H_2 North Central	Bean	Helicotylenchus	200	-
52. Popayán VEF78 Lote Iz.	Bean	Helicotylenchus	1200	NS
		Meloidogyne	300	NS
		Trichodorus	400	NS
53. Popayán Lote Izquierdo	Bean	Helicotylenchus	900	NS
		Meloidogyne	200	NS
54. Popayán Bl.Cruzamiento	Bean	Helicotylenchus	200	NS
		Meloidogyne	4800	NS
		Trichodorus	200	NS
55. Popayán Derecha surco 1400-3000	Bean	Helicotylenchus	900	NS
		Meloidogyne	300	NS
		Trichodorus	200	NS
56. Popayán VEF78 Derecha Surco 1-1400	Bean	Helicotylenchus	100	NS
		Meloidogyne	500	NS
		Trichodorus	100	NS
57. Popayán Pudriciones Radiculares	Bean	Meloidogyne	100	NS
58. Popayán VEF Volubles	Bean	Helicotylenchus	600	NS
		Meloidogyne	1600	NS
59. Popayán Comercial Diacol-Calima	Bean	Helicotylenchus	1000	NS
		Meloidogyne	1000	NS
		Trichodorus	100	NS

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g root
60. Popayán				
Mejoramiento	Bean	Helicotylenchus	1200	NS
(Bodega)		Trichodorus	100	NS
61. Popayán				
Mejoramiento	Bean	Meloídogyne	1200	NS
(Casa)		Trichodorus	100	NS
62. Potosí				
Thung	Bean	Helicotylenchus	9700	NS
63. Potosí				
Thung	Bean	Helicotylenchus	6100	NS
64. El Limonar				
Lote 388	Desmo-	Macroposthonia	800	-
	dium sp.	Pratylenchus	400	53
65. El Limonar	Desmo-			
	dium sp.	No Plant Parasites	-	-
66. El Limonar	Desm.			
	Carne	No Plant Parasites	-	-
67. El Limonar	Desm.			
	heterop.	Pratylenchus	700	-
	Carpa	Helicotylenchus	100	-
68. Quilichao	Zornia			
	sp.	No Plant Parasites	-	-
69. El Limonar	D.hetero			
	phyllum	No Plant Parasites	-	-
70. Palmira	Bean	Helicotylenchus	2100	-
01 South		Telotylenchoides	900	-
71. Palmira				
O_2North East	Bean/	Helicotylenchus	2400	-
	Corn	Gracilicus	1200	-
		Pratylenchus	200	6
72. Palmira				
O_2North Central	Bean/	Helicotylenchus	400	-
	Corn	Pratylenchus	-	4

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g root
73. Palmira				
O_2North Central	Bean/	Helicotylenchus	300	-
	Corn	Pratylenchus	0	20
74. Palmira				
O_2North Central	Bean/	Helicotylenchus	700	-
	Corn	Pratylenchus	200	40
75. Palmira				
O_2North Central	Bean/	Helicotylenchus	300	-
	Corn	Pratylenchus	0	40
76. Palmira				
O2North Central	Bean/	Helicotylenchus	200	-
	Corn	Pratylenchus	0	11
77. Palmira				
F3South	Bean	Pratylenchus	200	63
78. Palmira				
F3North	Bean	Pratylenchus	0	40
		Tetylenchus	200	-
		Tylenchorhynchus	100	-
79. Palmira				
P1	Sorghum	Helicotylenchus	2200	-
80. Palmira				
P1	Bean/	Helicotylenchus	2700	35
	Cassava	Cacopaurus	3000	-
		Pratylenchus	0	8
81. Palmira				
P1	Bean/	Helicotylenchus	2900	20
	Cassava	Cacopaurus	3200	-
		Pratylenchus	0	20
82. Palmira				
P1	Cassava	Helicotylenchus	3100	26
83. Palmira				
P1	Bean	Helicotylenchus	3000	20
		Cacopaurus	700	-

Survey Results

Sample#/Location	Crop	Genera	population/500mlSoil	Populat./g root
84. Popayán	Bean	Meloidogyne	NS	80
		Helicotylenchus	NS	80
85. La Selva	Bean	Helicotylenchus	1000	NS
		Pratylenchus	100	NS
		Meloidogyne	800	NS
		Trichodorus	100	NS
		Diphtherophora	100	NS
86. La Selva	Bean	Helicotylenchus	600	NS
		Meloidogyne	600	NS
		Longidorus	100	NS
		Xiphinema	100	NS
87. La Selva	Bean	Criconema	100	NS
		Diphtherophora	100	NS
		Helicotylenchus	700	NS
		Meloidogyne	400	NS
		Pratylenchus	400	NS
88. La Selva	Bean	Helicotylenchus	500	NS
		Pratylenchus	200	NS
		Meloidogyne	500	NS
		Diphtherophora	200	NS
		Xiphinema	100	NS
89. La Selva E	Bean	Helicotylenchus	1000	NS
		Meloidogyne	300	NS
		Xiphinema	600	NS
		Diphtherophora	200	NS
		Trichodorus	100	NS
		Pratylenchus	900	NS
		Longidorus	200	NS
90. La Selva	Bean	Helicotylenchus	600	NS
		Pratylenchus	300	NS
		Meloidogyne	800	NS
		Trichodorus	100	NS
		Xiphinema	100	NS

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Populat./g root
91. Palmira				
P3	Bean	Helicotylenchus	100	-
92. Palmira				
P3	Bean	Pratylenchus	300	6
		Tylenchorhynchus	100	-
93. Palmira				
P3	Bean	Pratylenchus	100	-
94. Palmira				
P3	Bean	No Plant Parasites	-	-
95. Palmira				
S4	Cassava	No Plant Parasites	-	-
96. Palmira				
S4	Cassava	No Plant Parasites	-	-
97. Palmira				
P1	Bean/ Cassava	Helicotylenchus	3000	-
98. Palmira				
P1 Ent.	Cassava	No Plant Parasites	-	-
99. Palmira				
01 South	Bean	Helicotylenchus	500	-
		Tylenchorhynchus	100	-
100. Palmira				
H3	Rice	Helicotylenchus	12800	-
		Tylenchorhynchus	200	-
101. Palmira				
H4	Rice	No Plant Parasites	-	-
102. Quilichao				
Grof II	Desmodium ovalifolium	Pratylenchus	700	1860
103. Quilichao				
Paladines	D.ovalifolium	Pratylenchus	700	153
		Helicotylenchus	300	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g root
104. Quilichao Ferguson, Sep.77	D.ovali folium	Pratylenchus	300	20
		Macroposthonia	100	-
105. Quilichao Ferguson, My	D.ovali folium	No Plant Parasites	-	-
106. El Liminar Jensen	D.ovali folium	Pratylenchus	200	80
		Tylodorus	300	-
107. Quilichao Ferguson; Seed	D.ovali folium	Helicotylenchus	100	-
108. Quilichao Ferguson; Seed	D.ovali folium	Macroposthonia	100	-
109. Popayán Microbio.	Bean	Xiphinema	200	NS
		Macroposthonia	300	NS
		Paratrichodorus	200	NS
		Meloidogyne	100	NS
110. Popayán Microbio.	Bean	Helicotylenchus	100	NS
		Paratrichodorus	200	NS
		Macroposthonia	100	NS
111. Popayán Microbio.	Bean	Macroposthonia	300	NS
		Paratrichodorus	100	NS
		Meloidogyne	100	NS
112. Popayán Microbio	Bean	Macroposthonia	400	NS
113. Popayán Agronomy	Bean	Pratylenchus	100	NS
		Meloidogyne	100	NS
		Macroposthonia	100	NS

Survey Results

Sample#/Location	Crop	General	Population/500ml Soil	Population/g root
114. Popayán				
Agronomy	Bean	Macroposthonia	300	NS
		Paratrichodorus	300	NS
115. Popayán				
Agronomy	Bean	Helicotylenchus	500	NS
		Pratylenchus	200	NS
		Macroposthonia	100	NS
		Paratrichodorus	200	NS
		Meloidogyne	400	NS
116. Popayán				
Agronomy	Bean	Helicotylenchus	100	NS
		Macroposthonia	400	NS
		Xiphinema	100	NS
117. Palmira				
P1	Bean/ Cassava	Helicotylenchus	2200	-
118. Popayán	Bean	Helicotylenchus	800	-
		Trichodorus	500	-
		Meloidogyne	900	-
		Heterodera	100	-
119. Palmira	Andro-			
T3	pagon	No Plant Parasites	-	-
120. Palmira				
R1	Cassava	No Plant Parasites	-	-
121. Popayán				
ICA	Potato	Helicotylenchus	100	-
122. Palmira				
T2	Bean	No Plant Parasites	-	-
123. Palmira				
T2	Bean	No Plant Parasites	-	-
124. Palmira				
T2South	Sorghum	No Plant Parasites	-	-
125. Palmira				
R3	Sorghum	Pratylenchus	200	31

Survey Results

Sample#/Location	Crop	Genera	Population/500mlSoil	Population/g root
126. Palmira N1	Sorghum	No Plant Parasites	-	-
127. Palmira R3	Sorghum	Tylenchorhynchus	200	-
128. Popayán Roots only	Bean	Meloidogyne	NS	Females
129. Restrepo Roots only	Bean	Meloidogyne	NS	100
130. Pasto Lote 3	Bean/ Maize	No Plant Parasites	-	-
131. Pasto Lote 3	Bean/ Maize	Pratylenchus	100	165
132. Pasto Lote 3	Bean	Tylenchorhynchus	2500	-
		Meloidogyne	600	-
		Pratylenchus	1000	182
		Diphtherophora	500	-
133. Pasto Lote #3	Bean	Tylenchorhynchus	900	-
		Pratylenchus	300	96
		Meloidogyne	200	-
		Heterodera	100	-
134. Pasto Lote 9	Bean/ Maize	Tylenchorhynchus	100	-
		Helicotylenchus	100	-
		Heterodera	700	-
		Meloidogyne	400	-
		Pratylenchus	-	5
135. Pasto Lote 9	Bean/ Maize	Tylenchorhynchus	300	-
		Trichodorus	100	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Populat./g root
136. Pasto				
7S Lago	Bean	Macroposthonia	100	-
		Tylenchorhynchus	800	-
137. Restrepo				
FARM[5] Bean Plot P. Mendoza	Bean	Meloidogyne	300	-
138. Restrepo				
FARM[5] Farmer P.Mendoza	Bean	Meloidogyne	500	-
139. Restrepo				
Plot Beans	Bean	Trichodorus	200	-
A.Gómez		Hoplolaimus	100	-
		Helicotylenchus	-	11
140. Restrepo				
Farm Beans	Bean	Meloidogyne	200	-
A.Gómez		Hoplolaimus	300	-
		Helicotylenchus	200	-
		Diphtherophora	200	-
		Pratylenchus	0	20
141. Restrepo				
Bean Plots	Bean	Helicotylenchus	3800	70
G.Galindo		Trichodorus	700	-
		Pratylenchus	200	-
142. Restrepo				
Farm Beans	Bean	Helicotylenchus	1000	70
G.Galindo		Meloidogyne	600	120
		Trichodorus	200	-
		Pratylenchus	0	30
143. Restrepo				
Plot Beans	Bean	Helicotylenchus	600	4
P.Guerrero		Trichodorus	100	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Populat./g root
144. Restrepo				
Aracacia	Aracacia	Helicotylenchus	400	NS
P. Guerrero		Meloidogyne	10100	NS
145. Restrepo				
Farm Beans	Bean	Helicotylenchus	100	-
M. Rojas		Meloidogyne	800	-
		Macroposthonia	600	-
		Trichodorus	200	-
		Pratylenchus	0	6
146. Restrepo				
Plot Beans	Bean	Helicotylenchus	200	-
M. Rojas		Meloidogyne	400	4
147. Restrepo				
P. Mendoza	Coffee	Meloidogyne	300	9
148. Restrepo				
Plot Beans	Bean	Helicotylenchus	1000	15
J. Martínez		Diphtherophora	100	-
		Trichodorus	100	-
		Pratylenchus	0	5
		Meloidogyne	0	5
149. Palmira	Bamboo	Paratylenchus	34100	48
		Helicotylenchus	100	-
150. Palmira	Bamboo	Paratylenchus	4100	210
		Meloidogyne	200	-
		Gracilacus	200	60
		Criconema	200	-
151. Palmira				
Pl ENT	Cassava	Paratylenchus	5900	48
		Pratylenchus	100	-
		Gracilacus	3200	-
		Meloidogyne	200	24
		Cacopaurus	500	8

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
152. Carimagua				
Rep IV	Cassava	Pratylenchus	500	NS
		Tylenchorhynchus	200	NS
153. Carimagua				
UnMarked	Cassava	Pratylenchus	500	NS
		Trichodorus	600	NS
154. Carimagua				
Rep II	Cassava	Paratylenchus	100	NS
		Macroposthonia	300	NS
155. Carimagua				
Rep III	Cassava	Helicotylenchus	100	NS
		Macroposthonia	100	NS
156. Carimagua				
Rep I	Cassava	Pratylenchus	20	NS
157. El Limonar				
Roots only	Solana-ceous Weed	_Meloidogyne_ _javanica_	-	-
158. El Limonar				
Roots only	Composite Weed	_Meloidogyne_ _javanica_	-	-
159. Tenerife				
Farm 1	Bean/	Tylenchorhynchus	1500	14
	Corn/	Meloidogyne	200	-
	Plantain	Helicotylenchus	200	26
160. Tenerife				
Farm 2	Bean	Tylenchorhynchus	1700	-
Sample 1		Helicotylenchus	100	-
		Macroposthonia	100	-
161. Tenerife				
Farm 2	Bean/	Tylenchorhynchus	700	-
Sample 2	Strawberry	Helicotylenchus	100	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
162. Tenerife				
Farm 3	Bean	Tylenchorhynchus	900	-
		Helicotylenchus	1000	40
		Meloidogyne	200	-
		Scutellonema	200	120
		Trichodorus	200	-
163. Tenerife				
Farm 4	Beans	No Plant Parasites	-	-
164. Tenerife				
Farm 5	Beans	Scutellonema	1200	660
Sample 1		Tylenchorhynchus	100	-
		Helicotylenchus	900	40
		Meloidogyne	500	580
		Trichodorus	200	-
165. Tenerife				
Farm 5	Beans	Meloidogyne	2800	1520
Sample 2		Scutellonema	3700	2400
		Trichodorus	1700	-
		Helicotylenchus	3600	-
		Tylenchorhynchus	500	-
166. Tenerife				
Farm 6	Beans	Meloidogyne	300	240
		Tylenchorhynchus	300	-
		Helicotylenchus	600	-
		Trichodorus	100	-
		Scutellonema	0	20
167. (#8)				
Santander	Guinea Grass	Macroposthonia	2000	-
168. (#10)				
Santander	Guinea Grass	Pratylenchus	300	6
		Macroposthonia	200	-
169. (#9)				
Santander	Guinea Grass	Macroposthonia	900	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
170. (#2)				
Santander	Paspalum	Pratylenchus	400	-
		Macroposthonia	500	-
171. (#3)				
Santander	Paspalum	Helicotylenchus	1200	2
		Pratylenchus	1200	16
		Macroposthonia	4700	-
172. (#7)	Bracharia	Macroposthonia	300	-
173. (#1)				
Santander	Bracharia	Pratylenchus	1600	2
		Macroposthonia	800	-
174. (#11)				
Santander	Andropo-gon	Pratylenchus	200	4
		Macroposthonia	200	-
175. (#4)				
Santander	Andropo-gon	Pratylenchus	100	-
		Macroposthonia	2000	-
176. (#6)				
Santander	Andropo-gon	Pratylenchus	100	2
177. Providencia	Bean	Tylenchorhynchus	300	-
		Pratylenchus	200	7
		Hoplolaimus	600	-
178. Providencia	Bean/Cane	Hoplolaimus	600	-
		Macroposthonia	700	-
		Pratylenchus	500	98
		Helicotylenchus	300	-
		Tylenchorhynchus	100	-
179. Providencia	Bean/Cane	Hoplolaimus	600	-
		Pratylenchus	100	40
		Macroposthonia	600	-

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
180. Providencia	Bean/ Cane	Hoplolaimus	300	-
		Pratylenchus	700	26
		Macroposthonia	200	-
		Helicotylenchus	100	-
181. Providencia	Bean/ Cane	Tylenchorhynchus	100	-
		Pratylenchus	400	11
		Macroposthonia	300	-
		Hoplolaimus	300	-
182. Providencia	Bean/ Cane	Tylenchorhynchus	200	-
		Pratylenchus	400	2
		Macroposthonia	600	-
		Hoplolaimus	300	-
183. ENT Providencia	Bean/ Cane	Hoplolaimus	300	-
		Pratylenchus	200	-
		Macroposthonia	300	-
		Tylenchorhynchus	100	-
184. ENT Providencia	Cane	Tylenchorhynchus	500	-
		Pratylenchus	100	108
		Macroposthonia	200	-
		Hoplolaimus	300	-
185. ENT Providencia	Bean/ Cane	Tylenchrhynchus	100	-
		Pratylenchus	400	-
		Macroposthonia	400	-
		Hoplolaimus	300	-
186. ENT Providencia	Bean	Tylenchorhynchus	100	-
		Hoplolaimus	400	-
		Pratylenchus	200	186
		Macroposthonia	100	-
187. ENT Providencia	Bean/ Cane	Pratylenchus	-	40

Survey Results

Sample#/Location	Crop	Genera	Population/500ml Soil	Population/g Root
188. ENT				
Providencia	Bean/ Cane	Hoplolaimus	100	-
		Pratylenchus	100	80
		Macroposthonia	200	-
		Helicotylenchus	400	-
189. ENT				
Providencia	Bean/ Cane	Hoplolaimus	200	-
		Pratylenchus	100	-
		Macroposthonia	200	-
		Helicotylenchus	100	-
		Tylenchorhynchus	100	-
190.				
Providencia	Cane	Tylenchorhynchus	100	-
		Pratylenchus	1900	150
		Macroposthonia	100	-
		Hoplolaimus	300	-
191.				
Providencia	Cane	Pratylenchus	200	273
		Tylenchorhynchus	300	-
		Macroposthonia	300	-
192.				
Palmira	Peanut Grass	Pratylenchus	100	125

APPENDIX III

Palmira Collections Sites

Plot	Sample Numbers
E2	50
F3	77, 78
H2	48, 51
H3	100
H4	101
I1	44, 46, 49
I2	12, 13, 14
J1	45
K2	8
LI	11, 47
MI	22
NI	15, 16, 17, 18, 19, 20, 126
O1	1, 21, 70, 99
O2	71, 72, 73, 74, 75, 76
PI	79, 80, 81, 82, 83, 97, 98, 117, 151
P3	91, 92, 93, 94
RI	120
R3	125, 127

Plot	Sample Numbers
SI	10
S2	2
S4	95, 96
T2	122, 123, 124
T3	119
Bamboo	149, 150
Peanut grass	192

APPENDIX IV

ANNUAL REPORT

NEMATOLOGY

R. M. Riedel

During my tenure at CIAT as Visiting Scientist a major portion of my time was spent working with the Bean Production Program. Between September 27 and November 27, 1978, 112 soil and 66 root samples were collected in 8 bean production areas. These sites included research plots on CIAT Stations at Palmira, Popayán and Santander de Quilichao; ICA Stations at La Selva and Pasto; and on farm trials in the Potosí (Huila), Restrepo (Valle), and Río Negro (Antioquia) regions. Nematodes were extracted from soil by centrifugal-flotation in sugar solution. Washed roots were incubated 24 hr at 24 C in shaken water to extract endoparasites. Collections of Pratylenchus and Meloidogyne were identified to species. Aphelenchus, Aphelenchoides, Ditylenchus, Tylenchus, and Psilenchus were not included in the survey.

Eighteen genera of plant parasites were collected from bean soil (Table 1) and 3 from bean roots (Table 2). Three genera occurred generally in soil and root samples. Helicotylenchus, Pratylenchus, and Meloidogyne occurred in 66% and 18%, 37% and 62%, and 36% and 41% of soil and root samples, respectively. Since Helicotylenchus is primarily ectoparasitic relatively low recovery from roots would be expected. Populations of Meloidogyne from root samples represent egg hatch during 24 hr incubation. These populations are not necessarily indicative of relative degrees of root infestation.

Helicotylenchus spp. while quite generally occurring in bean soils were usually present in small population less than 1000/500 ml soil. There is no literature concerning the pathogenicity of Helicotylenchus to beans. However, unusual population development at Palmira (3000/500 ml), Restrepo (3800/500 ml) and Río Negro (4800/500 ml) may indicate some damage to beans at these sites. Damage to beans at Potosí could be expected because of the very large population of spiral nematode (9700/500 ml).

Damage to beans by root-knot nematodes has been repeatedly documented. Meloidogyne javanica causes up to 90% loss of beans in Colombia. Meloidogyne found in this survey undoubtedly cause reductions in bean yields.

Meloidogyne occurred on 9 of 10 farms sampled at Río Negro. M. arenaria was the predominant species. M. hapla was collected once. Soil samples frequently contained large numbers of larvae (5100/500 ml). In this limited sample variety 706 produced larger galls than variety Cargamanto. Root rotting was more pronounced with 706 although this may have been caused by the early maturation of this variety. Occurrence of Meloidogyne spp. was favored by the coarse soil textures and long history of mono cultured beans at Río Negro.

Five of 6 farms visited at Restrepo were infested with root-knot nematodes, probably M. incognita. Cropping practices at Restrepo favor maintenance of

Meloidogyne in bean soils. *Aracacia xanthorhiza*, an excellent host of *Meloidogyne* (10, 100/500 ml), is frequently interplanted with a first crop of beans. Tomato, another good host, may be rotated with beans. Plantain and coffee are heavily infested with root-knot nematodes at Restrepo and these crops are often planted to beans. *Bidens pilosa* (Compositae), a common weed in bean fields is another good host of *Meloidogyne*.

Meloidogyne hapla occurred in all soil samples from Popayán. *M. hapla* is generally not as destructive as southern species. However, at Popayán seedlings are subjected to high populations (4800/500 ml) which would increase the affect of nematodes on beans. Root rot was common at Popayán. Since *M. hapla* can increase root rot incidence, this species could be causing losses in this way in addition to direct pathogenicity. *Bidens pilosa* is important at Popayán in maintaining high populations throughout the plot area. Lack of crop rotation also contributes to population increase.

Soil from La Selva was infested with *Meloidogyne*. Since root samples with females were not included in these samples identification cannot be certain, yet larval measurements indicate *M. incognita* is the predominant species. *M. incognita* commonly occurs on vegetables and weeds at La Selva.

Meloidogyne occurred in soil samples from Pasto but galled bean roots were not collected. Nematodes could have been reproducing on weeds. The species has not been identified but the cool soil environment at Pasto would favor *M. hapla*.

Pratylenchus spp. are important pathogens of beans in the United States. Research in Brazil associated P. brachyurus with unthrifty beans.

Pratylenchus penetrans and P. crenatus were collected at Río Negro and La Selva. P. penetrans was extracted from Cargamanto and 706 varieties in high numbers (10,660/9 root, fresh weight) at Río Negro. This species in growth chamber work has stunted potted beans at populations of one per plant. Lower yields must result from these extreme populations in the field also. Associative cropping of beans and maize should favor maximum population development of P. penetrans. Soil populations of Pratylenchus at La Selva were equal to those at Río Negro. P. penetrans could be expected to cause yield losses at La Selva also. P. crenatus is probably not an important pathogen of bean.

At Pasto high soil and root populations of a species similar to Pratylenchus andinus occurred in beans following potato. P. andinus has been collected once previously from potatoes in Bolivia. Its pathogenicity to bean is unknown. Since potatoes are a known host, this crop should not be rotated with beans. P. penetrans, P. crenatus, and P. andinus are cool soil species.

Pratylenchus brachyurus, P. vulnus, and P. zeae were extracted from beans at Palmira. Populations were highest when beans followed sorghum. Most root populations were very low. These species probably do not cause damage to beans at Palmira.

Frequent rotations and heavy soil help to keep populations of most nematodes low at Palmira. There were exceptions, however. Cacopaurus sp. occurred in substantial numbers (3200/500 ml) on beans or beans interplanted with cassava. Entomology cassava plots near the bamboo thicket also supported substantial numbers of Cacopaurus. Gracilacus and Telotylenchoides also occurred in substantial populations at Palmira. Nothing is known concerning the pathogenicity of these genera to beans. They may represent production problems of a localized nature.

At La Selva Xiphinema and Longidorus populations were high and they may be important problems in that area.

Table 1. Genera of plant parasitic nematodes extracted from 200 ml soil by centrifugal-flotation.

Genus	Genera in Bean Soil							
	CIAT						Farms	
	La Selva	Palmira	Pasto	Popayán	Potosí	Santander	Restrepo	Río Negro
Cacopaurus		4/44 (3200)						
Criconema	1/6[a] (100)[b]							12/19 (2800)
Diptherophora	4/6 (200)		1/7 (500)				2/90 (200)	
Gracilacus		2/44 (1200)						
Helicotylenchus	6/6 (100)	24/44 (3000)	1/7 (100)	14/23 (1200)	2/2 (9700)	1/1 (400)	7/10 (3800)	19/19 (4800)
Heterodera			2/7 (700)	1/23 (100)				
Hoplolaimus							2/10 (300)	
Longidorus	2/6 (200)							
Macroposthonia			1/7 (100)	7/23 (400)			1/10 (600)	3/9 (200)
Meloidogyne	6/6 (800)		3/7 (600)	19/23 (4800)			6/10 (800)	16/19 (5100)
Paratrichodorus				5/23 (300)				
Paratylenchus		1/44 (100)						
Pratylenchus	5/6 (900)	17/44 (500)	4/7 (1000)	2/23 (200)			1/10 (200)	12/19 (800)
Telotylenchoides		2/44 (2200)						
Tetylenchus		1/44 (200)						
Trichodorus	3/6 (100)			8/23 (400)			6/10 (700)	14/19 (700)
Tylenchorhynchus		4/44 (700)	5/7 (2500)					
Xiphinema	6/6 (600)			2/23 ([illegible]00)				1/19 (100)

a) Numerator = number of samples in which genus occurred. Denominator = total number of samples collected at site.
b) Maximum population/500 ml soil.

Table 2. Genera of plant parasitic nematodes extracted from bean roots by Young's Method.

Genus	CIAT						Farms	
	La Selva	Palmira	Pasto	Popayán	Potosí	Santander	Restrepo	Río Negro
Helicotylenchus[a]	%[b]	3/28 (52)[d]	0/7	1/1 (80)	%	%	4/11 (70)	4/19 (14)
Meloidogyne[a]	%	0/28	0/7	1/1 (80)	%	%	3/11 (120)	17/19 (533)
arenaria								x
hapla				x				x
incognita								
Pratylenchus[a]	%	12/28 (100)	4/7 (182)	0/1	%	%	3/11 (30)	12/19 (10,660)
brachyurus		x[c]						
crenatus								x
penetrans								x
vulnus		x						
zeae		x						
andinus ?			x					

a) Combined species count
b) Numerator = number of samples in which genus occurred. Denominator = Total number of samples collected at site.
c) x = occurrence; not all samples yet identified.
d) Population/g fresh weight of root.

APPENDIX V

Nematode Damage to *Desmodium ovalifolium* at

Carimagua (October 2-4, 1978)

Root-Knot Nematode (tentatively identified as *Meloidogyne javanica*) was found in the following areas at Carimagua:

1) *D. ovalifolium* planted west of the airstrip.
2) *D. ovalifolium* planted as cover in a cassava planting west of the station buildings (the cassava has since been harvested and grass planted in the former cassava rows).
3) *D. ovalifolium* in the grazing plots across the lake from the station buildings.
4) *D. ovalifolium* in the agronomy introduction plot west of the station buildings.
5) *Desmodium* sp. indigenous to the savanna west of the airstrip next to the wire fence (approx. 100 m west of infested *D. ovalifolium* plots).
6) An unidentified mint (Labiatae) plant from infested *D. ovalifolium* plots.

All of the plantings in 1 through 4 above were started with vegetative propagules. Sites 2, 3, and 4 were started with cuttings from the agronomy introduction plot. The original planting of *D. ovalifolium*, that in the agronomy introduction plot (#4 above), was started with cuttings from CIAT (Palmira) reputedly stuck in unsterilized soil.

Root-Knot nematodes were not found in any D. ovalifolium plantings started from seed, nor were they found in Zornia or Peureria plantings contiguous to the infected D. ovalifolium west of the airstrip (site #1). Grasses growing in infested Desmodium plots were also free of galls. Soil samples collected from all seeded Desmodium sites, Zornia and Peureria plantings, and samples of savanna soils (except those taken around the infested native Desmodium, were free of root-knot larvae.

Zornia plantings at site #1 were hosts to large populations of spiral nematode (Helicotylenchus sp.; 39,600/500 ml soil). Soil from around infected native Desmodium contained Pratylenchus sp., Macroposthonia sp., and Meloidogyne larvae at populations of 100, 200, and 100/500 ml soil, respectively. Soil from infested D. ovalifolium plots contained approximately 1400 Meloidogyne larvae/500 ml soil.

Meloidogyne javanica causes severe damage to Desmodium ovalifolium. The plant reacts to nematode attack by forming extremely large, confluent galls. Root development is converted entirely to gall formation by the nematodes. Infected plants are chlorotic and stunted. Eventually plants defoliate and die. On a field basis, infected plants tend to appear along lines of surface draniage.

Galled roots contain numerous females located along the stele. As galls become large females become embedded in and completely surrounded by root tissue. Egg-sacs are large. They are found both on gall surfaces and within gall tissue.

B. Conclusions and Recommendations:

The pattern of nematode distribution indicates that infected propagules from the agronomy plot are responsible for spread of nematodes in the Carimagua plantings. The source of initial introduction of the namatodes is most probably the cuttings from CIAT used to establish the initial plot.

The occurrence of root-knot nematodes in the native Desmodium is troublesome, however. Since the patch of infected native Desmodium was down slope from infected D. ovalifolium, spread of the nematodes from D. ovalifolium plots to the native plants is possible, although native Desmodium and native legumes upslope from the infected area and between infected native and infected D. ovalifolium were not found to be infected. Occurrence in native flora could indicate natural occurrence of root-knot in savannas around Carimagua.

Assuming that M. javanica is not native to Carimagua, the nematodes could be eradicated by starvation. To this end, infected D. ovalifolium plantings should be destroyed as soon as possible. D. ovalifolium and weeds within infested areas could be killed with a wide spectrum herbicide such as glyphosphate. One to two weeks after destruction of the plots, or after sufficient time for the thickest galls to rot, a grass cover should be established in the plots and the land should not be returned to plot work.

The use of soil fumigants (dichloropropene, dichloro propenes + chloropicrin, dichloropropenes + methylisothiocyanate, methylbromide) to reduce nematode populations cannot be recommended. In successful soil fumigation the soil must be plowed, disced after desintegration of plant parts, and finally injected with chemicals. All of these operations result in contaminated machinery which would have to be disinfested to prevent spread of the nematodes to uninfested areas by subsequent use of the machinery. Since the present infested areas are small, the operations involved in herbicide application and grass establishment could be accomplished with hand tools.

Although hand tools and workers foot wear would have to be disinfested, this could be done easily with NaOCl solution, formalin or 75% alcohol. Disinfestation of farm machinery would require steam cleaning, space fumigation with methyl-bromide, or thorough washing. In the latter case, wash water must be contained in and isolated area to prevent distribution of the nematode in the run-off.

Destruction of Desmodium in the former cassava area is important since this plot is located across the road from a large peanut planting. Peanuts can be hosts of M. javanica.

Reproduction of the Carimagua root-knot population on crops grown at Carimagua and a range of savanna flora, particularly the Leguminosae, should be determined at CIAT as a first research priority. Much the same information could be obtained by a more through examination of the native flora for root-knot infestation. This type of survey could also pin-point native root-knot populations which could pose a threat to Desmodium ovalifolium in wide-spread use.

Another very high research priority should be screening of D. ovalifolium germ-plasm for resistance to M. javanica. Some resistance to Florida populations has been reported in D. ovalifolium (pers. comm. Dr. J. Lenné) and the probability for success for this line of work is high.

Finally, in the absence of wide spread occurrence of M. javanica native root-knot nematodes in the grazing areas of the Llanos Orientales, the use of D. ovalifolium, even susceptible types, is not necessarily discouraged. Nematodes cause "simple interest" type of diseases because of their low reproductive potential, compared to bacteria or fungi, and their relatively low rate of dispersal. Nematode distribution is also severely limited by physical soil characteristics. Indeed one of the characteristics of nematode infestations is the unevendistribution of symptoms, mirroring the uneven distribution of nematodes themselves, in fields of very limited extent. Root-knot nematodes are not likely, therefore, to cause rapidly developing epiphytotics in D. ovalifolium. The best strategy for Desmodium use, if resistant lines cannot be found, would be deployment of the crop with research designed to control the limited areas of infested Desmodium likely to occur.