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**TEN-MONTH REPORT OF THE CROP NEMATODE RESEARCH & CONTROL PROJECT
(CMRCP)**

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**Department of Plant Pathology
North Carolina State University
Raleigh, N.C. 27695-7616**

September 15, 1984 - July 31, 1985

Submitted by: J. N. Sasser, Principal Investigator

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The activities of the Crop Nematode Research & Control Project for the past ten months have been summarized with emphasis on the three major goals of the project: screening for resistance, cropping systems research, and technology transfer.

SCREENING FOR RESISTANCE - Mr. Kerrick Hartman, Leader

Summary of Breeding Line Resistance Evaluations. Several International Agriculture Research Centers (IARC's) have sent crop germ plasm for evaluation of resistance to the major species and races of the root-knot nematode, Meloidogyne species. These include the International Center of Tropical Agriculture (CIAT) in Colombia, the International Center for Maize and Wheat Improvement (CIMMYT) in Mexico, and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India (Table 1). In addition, the Inter-Regional Potato Introduction Project (IR-1) at the University of Wisconsin, Madison, has contracted with us for the screening of several hundred lines of potatoes (see also Table 1). Since screening for resistance is an activity started by the International Meloidogyne Project (IMP), a portion of the evaluations listed in Table 1 was initiated by the IMP and completed by the CNRCP. In addition to CIAT, CIMMYT, and ICRISAT, we also have cooperative agreements with the International Institute of Tropical Agriculture (IITA) in Nigeria, the

Table 1. Summary of Crop Breeding Lines Screened for Meloidogyne Resistance by the CNRCP.

Source	Crop Type	No. Lines Screened	Nematode Population Screened Against	Work Status
CIAT	<u>Desmodium</u> *	56	Major Species ²	Complete, Report Issued 9/27/84
	Bean*	70	Major Species ¹	Complete, Report Issued 11/19/84
	Bean	90	Major Species ¹	In Progress
CIMMYT	Triticale*	272	Major Species ¹	Complete, Report Issued 3/13/85
	Barley*	213	Major Species ¹	Complete, Report Issued 3/13/85
ICRISAT	Chickpea*	56	Major Species ³	Complete, Report Issued 9/27/84
	Peanut	80	<u>M. hapla</u> <u>M. arenaria</u> (R-1)	Complete, Report Issued 1/3/85
	Peanut	25	<u>M. hapla</u> <u>M. arenaria</u> (R-1)	In Progress
IR-1	Potato	324	<u>M. hapla</u> <u>M. chitwoodi</u>	Progress Report Issued 1/2/85, Final Report in progress
	Potato	644	<u>M. hapla</u> <u>M. chitwoodi</u>	Work scheduled to begin 7/10/85

* Resistance evaluations initiated by the IMP.

¹M. incognita (races 1,2,3, and 4), M. arenaria (races 1 and 2), M. javanica, and M. hapla.

²Same as 1) except omitted races 2 and 4 of M. incognita and race 2 of M. arenaria.

³Same as 1) except omitted race 4 of M. incognita and race 1 of M. arenaria.

Asian Vegetable Research & Development Center (AVRDC) in Taiwan, the International Potato Center (CIP) in Peru, and the International Rice Research Institute (IRRI) in the Philippines.

Status of the Transfer of Screening-for-resistance Technology.

Currently, screening for resistance to root-knot nematodes is done primarily at the project center in Raleigh. However, transfer of this technology has now been initiated by means of discussion and demonstrations of techniques for visiting scientists by Mr. Kerrick Hartman, who supervises all screening at the project center. Scientists who have received or are scheduled to receive training include the following:

- 1) Eng. Agr. Rubens Lordello (Brazil), Jan. 14-18, 1985;
- 2) Mr. M. U. Ahmad (Bangladesh), Jan. 14-25, 1985;
- 3) Dr. D. R. Viglierchio (California), June 18, 1985;
- 4) Mr. Dennis Lawn (U.S.A.), July 15-26, 1985 (graduate student from the University of Illinois who plans to spend 9 months in Zambia).
- 5) Dr. V. W. Saka (Malawi), July-Oct., 1985; and
- 6) Dr. D. S. Bhatti (India), Aug. 7-11, 1985.

For descriptions of some of these visits, see the section on technology transfer.

In addition to actual training and visits, project personnel have published a booklet entitled Standardization of Host Suitability Studies and Reporting of Resistance to Root-knot Nematodes which provides our cooperators with a step-by-step accounting of the screening procedure followed at the project center. This publication should be valuable to anyone wishing to initiate a screening-for-resistance program (see section on technology transfer).

Use of Computer. The mainframe computer at Triangle Universities Computing Center (TUCC) has been used for compilation, manipulation and statistical analysis of data obtained from screening evaluations for several years. All reports issued to the IARC's contain computer-generated summaries of evaluations by cultivar or breeding line for each nematode population used. The summaries include information on the average gall and eggmass indices and an estimate of the reproductive capabilities of the nematode population for each line. These estimated parameters are used to classify cultivars into resistance categories. Current use of the IBM-PC is limited to the word-processing capabilities. However, we are in the process of using data-management capabilities to catalog our live collection of Meloidogyne species which is used as a source for nematode populations in screening-for-resistance evaluations.

Personnel Changes. Mr. Kerrick Hartman has been temporarily assigned on a half-time basis to a grant by Carolina Power & Light Company to work on various aspects of the nematode-related forest decline problem in the southern Appalachian Mountains. Mr. Hartman will continue to supervise the root-knot screening program as before. However, released salary funds will allow us to hire an additional technician. Mrs. Lydia White, currently a Research Technician II, will be promoted to an Agricultural Research Technician I and will assume additional responsibilities in the screening program. Mr. J. Edward Morgan, who has worked with us for several years on a part-time basis, has been hired into a full-time position as a Research Technician II.

CROPPING SYSTEMS RESEARCH - Dr. James P. Noe, Leader

International cooperative research. CNRCP cropping systems research goals include the implementation of research sites in several developing country locations. Potential collaborators have been identified in USAID priority countries with nematology research facilities considered adequate to implement a program in cropping systems research. On-site visits have been made to Costa Rica, Jamaica, Jordan, Mexico, Pakistan, the Philippines, and Taiwan to determine the feasibility of collaborative research. Seminars and discussions were held involving cooperating scientists, local university administrators, local government agriculture officials, and USAID mission agricultural officers in each of the countries. Details of the proposed research were presented formally in the seminars, and subsequent discussions centered on adaptation of the methodology to local conditions. Further discussions with administrators and government officials were concerned with possible local sources of funding for cropping systems research. Several of the selected sites expressed interest in the cropping systems research.

After the project was presented by Drs. Noe and Sasser and a proposal was submitted through our local cooperators, funding was allocated by the USAID mission in Jordan for nematode cropping systems research in the Jordan Valley. Funding was also granted by the Farming System and Soil Resources Institute (FSSRI) through the Philippine Council of Agricultural Research and Rural Development (PCARRD) for cropping systems research in Batangas, Cavite, and Laguna, Philippines. On-site cropping systems research proposals have been submitted to local agencies in Jamaica, Costa Rica, and Pakistan. A proposal has also been submitted to the Korean Science Foundation

(KSF) for support of nematode cropping systems research in collaboration with the CNRCP. This joint project was initiated by Dr. Y. E. Choi, our cooperator in Korea. It was anticipated that three to four primary international sites would be established in this phase of the project.

On-farm tests in North Carolina. Cropping systems research methodologies are being implemented at several sites on a variety of crops in North Carolina. The purpose of this research is to refine and improve techniques for implementation at international sites, while at the same time collecting valuable information on nematode-host relationships for important crops in North Carolina. Test sites have been established in growers' fields to monitor the relationships among various nematodes and host crops. A total of 576 preplant soil samples have been assayed for plant-parasitic nematodes, and physical and chemical soil variables have been analyzed in each of the plots. This research is being done in collaboration with the Agronomic Division of the North Carolina Department of Agriculture, the agency responsible for advising and making recommendations to farmers based on nematode assays.

Discussion Session on Nematode Cropping Systems Research Methodology. The annual meeting of the Organization of Tropical American Nematologists was held at the University of the West Indies - St. Augustine, Trinidad, July 28 to August 2, 1985. Since many of our cooperating scientists from the Caribbean and Central and South America had plans to attend this meeting, a formal discussion session was arranged on nematode cropping systems research methodology.

Participating in the session were Dr. J. N. Sasser as moderator, and Drs. Rodriguez-Kabana R., H. L. Rhoades, and James P. Noe as discussion speakers.

Guide to Cropping Systems Research Methodology. Dr. Noe is preparing a detailed guide to implementation of cropping systems research for the management of losses due to plant-parasitic nematodes.

TECHNOLOGY TRANSFER - Mrs. Cathy C. Carter, Leader

Expansion of Nematology Network. At least 24 additional developing country scientists have requested to become cooperators in the CNRCP over the last year. The total number of cooperators in the network is now 175.

Visits from Developing Country Cooperators. Eng. Agr. Rubens R. A. Lordello from Brazil visited the CNRCP center at Raleigh on January 14-18, 1985. His time was devoted to learning the screening-for-resistance procedures and becoming familiar with the cytological techniques useful in the differentiation of Meloidogyne species.

Mr. M. U. Ahmad from Bangladesh visited the CNRCP center at Raleigh January 14-25, 1985. He received training in the screening-for-resistance procedures, was assisted in conducting a computerized literature search, was coached in the morphological aspects of Meloidogyne identification, and received instruction in various nematode extraction techniques.

Dr. Parviz Jatala, Head of the Department of Nematology and Entomology at the International Potato Center (CIP) in Lima, Peru, visited the CNRCP center on May 23-24, 1985. He and Dr. Sasser discussed the possibility of continuing collaborative research between

CIP and the CNRCP. This work will involve the screening of sweet potato (a new mandate crop for CIP) lines for resistance to root-knot nematodes.

Dr. Samia Massoud from Cairo, Egypt, visited the CNRCP center July 5, 1985. She received general publications on root-knot nematode biology and taxonomy as well as a demonstration of nematode extraction techniques and an overview of project activities.

Mr. Dennis Lawn, graduate student from the University of Illinois, visited the CNRCP center July 15-26, 1985. He received general publications on root-knot nematodes as well as training in the techniques of species identification using perineal patterns, the differential host test, and male head morphology. He also received an overview of the screening-for-resistance program and an introduction to nematode cytogenetics and biochemistry. Mr. Lawn received this training to prepare himself for work on a 9-month nematology research project in Zambia.

Dr. V. W. Saka from Malawi will be visiting the CNRCP center from July through October. His time will be spent primarily on learning screening-for-resistance procedures by screening chickpea cultivars from Malawi. In this length of time, he will be able to receive hands-on training in all aspects of resistance screening. The techniques he learns will be applied to a screening-for-resistance program in Malawi.

Short-term Nematology Training Services. Fifteen faculty/staff personnel in the Department of Plant Pathology, Genetics, and Botany at NCSU have agreed to participate in short-term, nematology training for scientists from developing countries. Within this program, visitors may choose to spend time with experts in the subject

areas in which they are most interested. A brochure describing the available training services has been printed and sent to each of our cooperators. In this way, even visitors who can stay only a few days can plan ahead and ensure that their time here will be organized and productive.

Mexican Workshop on Meloidogyne. Dr. Carlos Sosa Moss, nematologist, Centro de Fitopatologia, Colegio de Postgraduados, Chapingo, Mexico, requested that we assist him in a workshop on Meloidogyne during the week of July 8-12, 1985. Forty scientists from various parts of Mexico attended. The following faculty of the departments of Plant Pathology and Genetics at North Carolina State University participated in giving 12 lectures as indicated and conducting laboratory exercises. Titles of lectures and lecturers are as follows:

- 1) An overview of the International Meloidogyne Project and its relationship to the Mexican National Meloidogyne Project.
- J. N. Sasser
- 2) Identification of Meloidogyne species on the basis of differential host test and perineal pattern morphology. - J. N. Sasser
- 3) The classification of the family Meloidogynidae. - H. H. Triantaphyllou
- 4) The genus Meloidogyne and morphological characters differentiating its species. - H. H. Triantaphyllou
- 5) Detailed morphology and anatomy of the genus Meloidogyne.
- J. D. Eisenback
- 6) Diagnostic characters useful in the identification of the four most common species of root-knot nematodes. - J. D. Eisenback

- 7) Methods*for interaction studies. - J. D. Eisenback
- 8) Embryogenesis and post-embryogenesis. - A. C. Triantaphyllou
- 9) Gametogenesis and mode of reproduction. - A. C. Triantaphyllou
- 10) Biochemistry—enzymes in identification of root-knot nematodes.
- A. C. Triantaphyllou
- 11) Spatial pattern analysis of plant-parasitic nematodes.
- J. P. Noe
- 12) Research methodology for optimization of cropping systems to
minimize losses due to plant-parasitic nematodes. - J. P. Noe

In addition to lecturing and conducting laboratory sessions, the Crop Nematode Research & Control Project (CNRCP) provided 40 copies of each of the following publications:

1. An Advanced Treatise on Meloidogyne, Vol. I, Biology & Control.
2. An Advanced Treatise on Meloidogyne, Vol. II, Methodology.
3. Biology, identification & control of root-knot nematodes (Meloidogyne species). (Spanish version)
4. A guide to the four most common species of root-knot nematodes (Meloidogyne species) with a pictorial key. (Spanish version)

While participating in the workshop, Drs. Noe and Sasser also held informal discussions with scientists from Mexico and Peru who were interested in cropping systems research and other components of the Crop Nematode Research & Control Project.

Questionnaire to Assess Interest Among Cooperators for an International Course in Plant Nematology. A brochure has been prepared and sent to our cooperators to assess their interest in an intensive three-week, international course in plant nematology to be held in the summer of 1986. The proposed, three-week course is scheduled to be taught by Dr. J. D. Eisenback. Tentative plans call

for 15 hours of formal lectures supplemented by 30-45 hours of laboratory instruction for a maximum of 20 students. Lecture topics are to include morphology and taxonomy of nematodes, adaptations to parasitism, nematodes as parasites and pathogens, disease complexes, virus transmission, ecology and population dynamics of nematodes, breeding for resistance, control strategies and tactics, nematode management, and nematicide usage. Laboratories will emphasize nematode morphology, sampling for nematodes, methods for extracting and staining nematodes, cultivation of plant-parasitic nematodes, pathology and life cycles of various groups of nematodes, evaluation of resistance, design of experiments, and evaluation of nematode management systems. Special lectures will be given by various project personnel.

Publications. Below is a list of recently published IMP and CNRCP publications.

1. Anonymous. 1984. Crop nematode research & control project. Coop. Publ. of the Dept. Plant Pathol., North Carolina State Univ., and U.S. Agency for Int. Dev., Raleigh, N.C. 4 pp.

This brochure describing the CNRCP was designed and printed in October/November 1984. It covers the goals, rationale, and research emphasis of the new project as well as a description of available for-hire services. It was mailed to our cooperators in conjunction with the first issue of the International Nematology Network Newsletter in January 1985.

2. Sasser, J. N., C. C. Carter, and K. M. Hartman. 1984. Standardization of host suitability studies and reporting of resistance of root-knot nematodes. Coop. Publ. of the Dept. Plant Pathol., North Carolina State Univ., and U.S. Agency for Int. Dev., Raleigh, N.C. 7 pp.

This pamphlet has been sent to all of our developing country cooperators with the hope that the screening procedure will be carried out more uniformly. In this way, a basis for comparison of plant resistance will be established.

3. Carter, C. C. (ed.). 1984-5. International Nematology Network Newsletter. Quarterly Publ. of the Dept. Plant Pathol., N.C. State Univ., and U.S. Agency for Int. Dev., Raleigh, N.C.

Three issues of this quarterly publication have now been sent to our cooperators: December 1984, March 1985 and June 1985. The response has been encouraging. Scientists from six of the eight project regions have sent us research notes to be published in the newsletter. Requests from additional developing country scientists who would like to receive this publication are received regularly.

4. Sasser, J. N. and C. C. Carter (eds.). 1985. An advanced treatise on Meloidogyne, Vol. I: Biology and control. Coop. Publ. of the Dept. Plant Pathol., North Carolina State Univ., and U.S. Agency for Int. Dev., Raleigh, N.C. 422 pp.

Barker, K. R., C. C. Carter, and J. N. Sasser (eds.).
1985. An advanced treatise on Meloidogyne, Vol. II:
Methodology. Coop Publ. of the Dept. Plant Pathol.,
North Carolina State Univ., and U.S. Agency for Int.
Dev., Raleigh, N.C. 223 pp.

This long-awaited, hard-bound, two-volume set based on the 1983 International Workshop on Root-knot Nematodes was published in July 1985. Copies are being sent free to our cooperators, other scientists and libraries in developing countries. Anyone requesting the two volumes from developed countries will be charged \$65. Hundreds of requests have already been received from libraries, students, scientists, and developing country cooperators. Individual chapters in these two volumes that were written by personnel at the project center are listed below.

Volume I

- Chapter 3 Overview of the International Meloidogyne Project 1975-1984.....J. N. Sasser & C. C. Carter
- Chapter 4 Some taxonomic principles.....H. Hirschmann
- Chapter 5 The classification of the family Meloidogynidae.....H. Hirschmann
- Chapter 6 Detailed morphology and anatomy of second-stage juveniles, males, and females of the genus Meloidogyne (root-knot nematodes).....J. D. Eisenback
- Chapter 7 The genus Meloidogyne and morphological characters differentiating its species.....H. Hirschmann
- Chapter 8 Diagnostic characters useful in the identification of the four most common species of root-knot nematodes (Meloidogyne spp.).....J. D. Eisenback

- Chapter 9 Cytogenetics, cytotaxonomy and phylogeny of root-knot nematodes.....A. C. Triantaphyllou
- Chapter 11 Identification of major Meloidogyne species employing enzyme phenotypes as differentiating characters.....P. R. Esbenshade & A. C. Triantaphyllou
- Chapter 17 Interactions among concomitant populations of nematodes.....J. D. Eisenback
- Chapter 36 Transfer of agricultural technology.....C. C. Carter

Volume II

- Chapter 5 Identification of Meloidogyne species on the basis of differential host test and perineal pattern morphology.....K. M. Hartman & J. N. Sasser
- Chapter 6 Techniques for preparing nematodes for scanning electron microscopy.....J. D. Eisenback
- Chapter 7 Cytological methods for the study of oogenesis and reproduction of root-knot nematodes.....A. C. Triantaphyllou
- Chapter 8 Electrophoretic methods for the study of root-knot nematode enzymes.....P. R. Esbenshade & A. C. Triantaphyllou
- Chapter 14 Analysis and interpretation of data from nematological experiments.....J. P. Noe

5. Refereed Journal Publications Authored or Co-authored by Project Personnel

Eisenback, J. D., B. Yang, and K. M. Hartman. 1985. Description of Meloidogyne pini n. sp., a root-knot nematode parasitic on sand pine (Pinus clausa), with

additional notes on the morphology of M. megatyla. J. Nematol. 17:206-219.

Eisenback, J. D. and K. M. Hartman. 1985. Sphaeronema sasseri n. sp. (Tylenchulidae), a nematode parasitic on Fraser fir and red spruce. J. Nematol. 17:346-354.

Noe, J. P. and C. L. Campbell. 1985. Spatial pattern analysis of plant-parasitic nematodes. J. Nematol. 17:86-93.

Noe, J. P. and K. R. Barker. 1985a. Overestimation of yield loss of tobacco caused by aggregated spatial pattern of Meloidogyne incognita. J. Nematol. 17:245-251.

Noe, J. P. and K. R. Barker. 1985b. Relation of within-field spatial variation of plant-parasitic nematode population densities and edaphic factors. Ecol. & Epidemiology 75:247-252.

Survey of Extension-type Information Desired by Cooperators.

Questionnaires were mailed to all developing country cooperators to elicit their assessment of 15 proposed topics for extension publications in their countries. Based on the responses, the topics have been ranked in order of priority, and work has begun on the compilation of information concerning the two most requested topics: 1) Nematode management through crop rotation and 2) Guidelines for use of nematicides. In addition to the 15 originally proposed topics, at least that many more have been suggested by various cooperators.

Acquisition of Publications on Technology Transfer. Letters were sent to all the major International Agriculture Research Centers with a request for representative publications on technology transfer.

Practically all of the centers responded, and the collection of publications that we subsequently acquired should be very useful in the development of our own technology transfer publications. Some pointers can be followed concerning the layout and content of extension brochures.

CNRCP Microcomputing Facility. The IBM PC/AT microcomputer for the project was delivered in May 1985. The hardware has been set up, and software has been installed for database management, basic mathematics and graphics, and word processing. Databases are in the design phase for information on root-knot resistance, cropping systems research, and general nematological references.

LIST OF PROPOSED ACTIVITIES FOR UPCOMING YEAR

1. Prepare sample extension bulletins for overseas cooperators.
2. Enter all nematode culture information into the IBM PC/AT microcomputer.
3. Train visitors from developing countries.
4. Compile bibliographies on various nematodes and enter them onto the word processor.
5. Plan and conduct intensive 3-week international course in plant nematology for next summer. This activity will depend on the response received from our network nematologists.
6. Develop memoranda of agreement with additional International Agriculture Research Centers for the screening of food crop lines and/or cultivars for resistance to root-knot nematodes.
7. Plan small workshops in key project regions based on need, demand, and available resources.

8. Visit countries that are cooperating on cropping systems research so progress can be assessed.
9. Continue local on-farm tests in North Carolina for development of improved cropping system research methodologies.
10. Continue transfer of screening-for-resistance technology to various cooperators and IARC's.
11. Continue publication of the quarterly International Nematology Network Newsletter.
12. Complete and publish guide to cropping systems research methodology.