

Report of Site Visit to the International Meloidogyne Project
March 21-23, 1983: Raleigh, NC

Introduction

Members of the review team were impressed by the accomplishments of the International Meloidogyne Project (IMP). The communication network established among agricultural scientists throughout the world is noteworthy. The interaction between scientists at North Carolina State University (NCSU) headquarters and cooperators has given many of the scientists in LDC's a much needed, enhanced image with governmental officials in their countries.

During the period of this project much relevant information has accumulated about root-knot nematodes and their importance in crop production. The scientists at NCSU have characterized the four most important species of Meloidogyne by assembling over 1000 populations of root-knot nematodes from all over the world. The morphology is now well understood as a result of the detailed studies by light and scanning electron microscopy of several life stages. The existence of a limited number of races within species is now well established through the use of a standard host differential test. The chromosome numbers of the species have been thoroughly examined. Practical guides for identification now in use in LDC's are now available for use by general biologists, as well as by nematologists.

We consider the accomplishments of the IMP to date to be:

- a. Thorough taxonomic review of the genus Meloidogyne and proof that 95% of the populations collected represent only four species. The most common one is M. incognita which has four recognizable subspecific divisions (races). This will simplify the task of plant breeders.
- b. The existence of races demonstrated the necessity of directing breeding for resistance toward the most prevalent populations in each of the regions of the world.
- c. The finding that a particularly virulent isolate of a fungus, originally discovered in Peru, has potential for use elsewhere as an agent that destroys nematode eggs.
- d. The demonstration that attack by one nematode species can break the resistance of a plant to another species to which the cultivar possesses genetic resistance.
- e. The start of a program to locate sources of genetic resistance to root-knot nematodes by screening germplasm collections and breeding lines submitted by International Agricultural Research Centers.
- f. Possibly the most important contribution is that work on practical control of damage to crops by root-knot nematodes is now underway in many LDC's. This work should continue after IMP terminates.

Review of Contract (cf. Scope of Work Document, p. 3)

2-d-1. Very well done. The scientists at NCSU have characterized 95% of the populations collected around the world. Further major effort is not warranted.

2-d-2. Ecological studies. These were not well designed. The publication produced appears to result from survey of data from questionnaires. Little information of value has resulted.

2-d-3. In progress—see elsewhere in report for details.

2-d-4. Cropping systems—no concerted effort until now. Cooperators have been alerted to evaluate their crop rotations.

2-d-5. The information network is an outstanding accomplishment.

2-d-6. Interaction with International Agricultural Research Centers has improved, especially in connection with the search for resistance.

2-d-7. Training. The internal evidence of effective training is that the reports from cooperators are improving, as shown in the proceedings of the workshops. Further training beyond the current workshop is no longer required. The provision for a travelling specialist in cropping systems analysis will accomplish a training function.

2-d-8. Technology transfer. Ms. C. Carter has proved to be effective and the visits by Drs. Sasser and Triantaphyllou were of great importance.

2-d-9. Publications. The publications produced by IMP are outstanding, both in content and format. The utility of the proposed text to be based on proceedings of the April 1983 workshop is questionable in the opinion of the Review Team. Existing publications could be revised as new information warrants.

With these accomplishments in mind, the Review Team examined the objectives listed in the continuation proposal. We conclude:

1. The work planned for the next three years should be designed to bring about an orderly termination of the IMP. To this end, we respectfully recommend certain alterations in the approach to several of the proposed objectives in order to focus research efforts more sharply and critically on achieving goals of lasting, beneficial impact on root-knot control in LDC's.

The Team agreed that three areas should be stressed: (a) screening for resistance; (b) an evaluation of cropping sequences practiced in selected LDC's with respect to their effects on nematode populations and crop yields; and (c) the provision of support for efforts of cooperators to produce materials for use in nematode extension work in their countries. Each of these is discussed in detail in this report.

2. We also suggest that the work on systematics, morphology, ecology, and species interactions no longer falls within the scope of IMP.
3. We further recommend that the budget be revised to reach a total expenditure of \$900,000 for the three years of continuation and that the project close by September 1986.
4. The extensive collection of populations of Meloidogyne from around the world will be lost at the conclusion of IMP, unless provision is made for its maintenance (see Science 220:163). We urge that NCSU seriously consider ways of maintaining representative populations at Raleigh.

Evaluation of Screening for Sources of Resistance to Meloidogyne

Screening of germplasm from several International Agricultural Research Centers is underway. We detected the lack of clear goals of the screening program and the lack of sufficient attention to the techniques employed. Some of the candidate plants represent breeding lines already produced for other purposes, while others are simply accessions from germplasm collections. Still others are already known to be resistant to Meloidogyne. We recommend:

- a. The initial search for genetic resistance to Meloidogyne should be done at NCSU. This should examine responses to the four races of M. incognita, the two of M. arenaria, and to each of the other two important species.
- b. A search should be made for techniques to simplify the procedures to permit rapid rejection of nonresistant accessions after one life cycle of the nematode.
- c. Screening should proceed in three stages: (1) initial rejection of accessions susceptible to all populations tested; (2) retest of promising accessions on five populations of each kind representing different geographical origins; (3) retest of selected resistant accessions by some cooperators using several populations from their own localities under their conditions.
- d. The screening program should place major emphasis on examination of the available germplasm of important food crops of the world.

Evaluation of Cropping Sequences and Nematode Control in LDC Crops

The objective of establishing economic thresholds for the wide variety of crops in the many cooperating countries is overambitious and clearly beyond the scope of this project. Nevertheless, the methodology outlined could provide some general relationships between nematode numbers and crop response, as well as information on nematode population increase on the crops involved. Development of cropping systems for management of root-knot nematodes has been mentioned repeatedly as a goal of the IMP in the past, but little has been accomplished toward this goal beyond the independent contributions of the cooperators. This objective is a concrete attempt to address those components which would make up the cropping system.

The proposed methodology to establish small plots in fields having Meloidogyne population gradients is considered efficient, since it involves minimal effort on the part of cooperating growers and provides two separate data sets from the same series of plots (i.e., crop response data and nematode population response). Judicious selection of cooperators is essential for optimum choice of test sites and for minimizing failures. Detailed studies on one crop, such as sampling studies, are not recommended; instead, we recommend that research focus on fewer plots on a wide variety of crops so that data are obtained for more components of potential cropping systems. Test crops should include those commonly grown in rotations in the regions, as well as intercropping systems and fallow, if prevalent. We doubt that parameters of Seinhorst's equations could be obtained. Economic thresholds are not a feasible goal—not only are such data difficult to obtain, but no economic analysis is proposed.

The provision of a cropping system specialist to visit selected cooperators is useful, since he could stimulate this type of research among cooperators and could impart some unity of methodology to different cooperators. We anticipate that the IMP will be a stimulus to establish long-term studies of this type around the world. The IMP should produce a

summary of these new studies, as well as of previous related work, together with standardized procedures for conducting such projects.

Evaluation of Technology Transfer

As a fitting conclusion to the entire IMP, support to cooperators should be offered to assist them in the production of materials for extension of knowledge to growers. A cooperator must provide his own ideas of information prepared in suitable form for the culture of his own region. Support from NCSU should be limited to help with graphics, check of accuracy, sample copies of printed matter, etc. The IARC's have much experience in technology transfer and the cooperators should be encouraged to take advantage of this experience.

Two research projects were proposed which we agree are biologically sound, but need to be approached with caution or be considered outside of IMP.

Biological Control

As proposed, this consists of a test of a single strain of a common soil fungus found by Dr. Jatala at CIP in Peru. It shows some promise because it feeds on young eggs of Meloidogyne. Before undertaking large-scale testing of the potential agent of biological control, the IMP should test this fungus in several ways in the U.S. to describe its biology and assess its efficacy. If it lives up to Dr. Jatala's expectations, it should then be distributed to cooperators for further evaluation. Caution should be exercised in recommending this biological control system until testing is done carefully.

Species Interaction

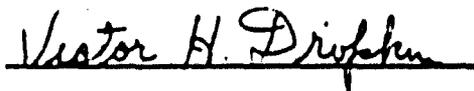
The finding of a specific interaction between certain populations of M. incognita and of M. arenaria that leads to breaking of resistance is of great significance. But we conclude that investigation of this phenomenon falls outside the scope of the IMP. We, therefore, recommend that separate funding be sought for this aspect of the subject.

Summary

Our overall assessment of IMP is that it has accomplished very much, given the time allotted and the state of knowledge in existence when the work began. The project will leave a legacy of trained, interested scientists around the world who will continue to find practical ways of increasing food production as a result of their experience in IMP. We have attempted to outline a program for concluding IMP in an orderly fashion and, at the same time, adding useful knowledge. We suggest continuation of the effort to find resistant germplasm, the accumulation of knowledge of effective cropping systems for controlling root-knot losses, and a program of production of materials for extension to growers in LDC's. We believe the existing personnel can accomplish these in the next three years with the suggested budget.

Respectfully submitted,

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