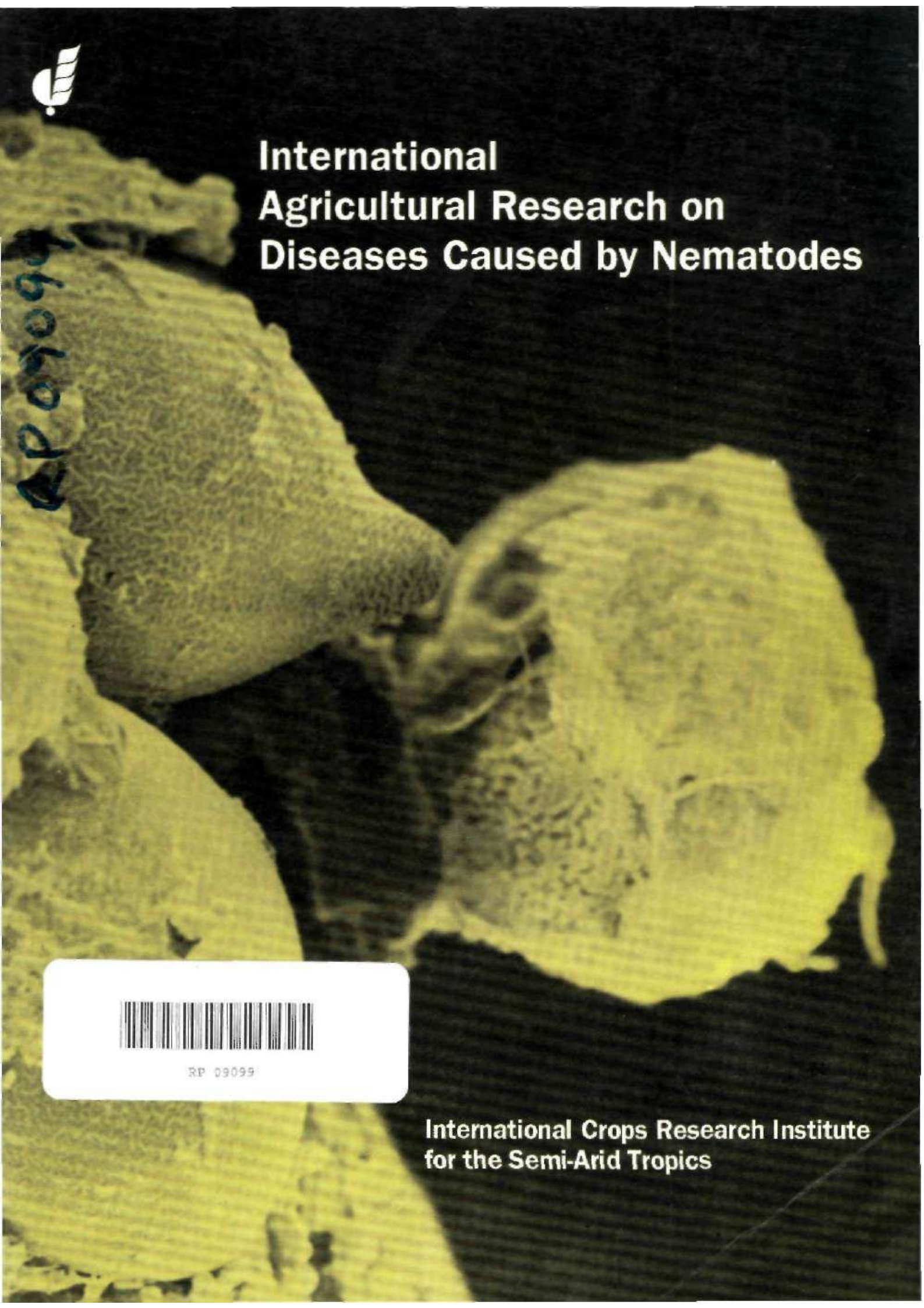

International Agricultural Research on Diseases Caused by Nematodes

International Crops Research Institute for the Semi-Arid Tropics

Abstract

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In conjunction with the International Congress of Plant Pathology (Montreal, 28 Jul-6 Aug 1993), a satellite meeting was organized by ICRISAT to discuss research on plant-parasitic nematodes and the role of international agricultural research centers (IARCs) in alleviating the constraints nematode diseases impose on production of food crops, especially in the developing countries. Twenty scientists from ten countries and two IARCs participated in the meeting. This publication provides a background to the meeting, a record of discussions on research strategies, priorities, and collaborative activities, and recommendations for future research.

Résumé

La recherche agricole internationale sur les maladies causées par les nématodes—besoins et contraintes: compte rendu et recommandations d'une réunion satellite du Congrès international de la pathologie végétale, le 6 août 1993, Montréal, Canada. Conjointement avec le Congrès international de la pathologie végétale, tenu du 28 juillet au 6 août 1993 à Montréal, une réunion satellite a été organisée par l'ICRISAT dans le but d'examiner la recherche sur les nématodes parasites des plantes et le rôle des centres de recherche agricole internationale dans l'allègement des contraintes imposées par les maladies dues aux nématodes sur la production des cultures vivrières, particulièrement dans les pays en développement. Vingt chercheurs provenant de dix pays et deux centres internationaux ont participé à cette réunion. Ce document fournit les informations de base sur la réunion ainsi qu'un compte rendu des discussions sur les stratégies de recherche, les priorités et les activités coopératives. Sont également présentées, des recommandations pour les travaux de recherche à entreprendre dans l'avenir.

Resumen

Investigación agrícola internacional sobre enfermedades causadas por nematodos—exigencias y constreñimientos: resumen y recomendaciones de una reunión satélite del Congreso Internacional de Patología Vegetal, El 6 de Agosto de 1993, Montreal, Canadá. ICRISAT, en conjunción con el Congreso Internacional de Patología Vegetal, organizó una reunión satélite con el fin de examinar, por un lado, investigación sobre nematodos parasíticos de plantas y, por otro, el papel de los centros internacionales de investigación agrícola en aliviar los constreñimientos impuestos por las enfermedades de nematodos sobre la producción de cosechas, particularmente en lo que concierne a los países en vía de desarrollo. Veinte científicos de diez países y de dos centros internacionales participaron en esta reunión. Esta publicación provee el contexto de la dicha reunión, las actas de las discusiones sobre estrategias de investigación, prioridades, actividades colaborativas así como recomendaciones para la investigación futura.

Cover: *Heterodera cajani* cysts with egg sacs on a pigeonpea root.

International Agricultural Research on Diseases Caused by Nematodes

Needs and Constraints

Summary and Recommendations
of a Satellite Meeting of the
International Congress of Plant Pathology

6 Aug 1993
Montreal, Canada

Edited by
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ICRISAT

International Crops Research Institute for the Semi-Arid Tropics
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1994

Acknowledgments

Special thanks to Dr Michele Heath, Chairperson, Program Committee, International Congress of Plant Pathology, Canada for scheduling this meeting at the Palais des Congres, Montreal and to Dr B R Kerry for chairing the meeting. Thanks are due to Dr P Jatala, Nematologist, Centro Internacional de la Papa (CIP), Peru and to Dr M Luc, Institut francais de recherche scientifique pour le developpement en cooperation (ORSTOM) for their cooperation. Professor J M Webster, Center for Pest Management, Department of Biological Sciences, Simon Fraser University, Burnaby, Canada, and Professor D J Patel, Department of Nematology, Gujarat Agricultural University, Anand, Gujarat, India were unfortunately unable to participate; nevertheless, their help is gratefully acknowledged. Dr Renu Sharma, Nematologist, Central Plant Protection Training Institute, Hyderabad, India helped in reviewing the proceedings.

Contents

Foreword

It is well known that plant-parasitic nematodes reduce crop yields, either directly through parasitic action or indirectly as vectors of other plant pathogens. While research on plant-parasitic nematodes has dramatically intensified in the past four decades, it is not surprising to note that research on nematodes in many developing countries is still inadequate.

Any factor that brings about a change in the crop environment can potentially disturb the equilibrium between the crop landraces and the population of parasitic nematodes. Increasing human population in developing countries and the consequent increase in intensity of crop cultivation have led to a sudden surge of importance accorded to nematodes in new cropping systems.

The Consultative Group on International Agricultural Research (CG1AR) sponsors 18 international agricultural research centers (IARCs) with specific crop mandates. These IARCs focus their research mainly on problems of food crops widely grown in developing countries. Thus IARCs, such as Centro Internacional de Agricultura Tropical (CIAT), Centro Internacional de Majoramiento de Maiz y Trigo (CIMMYT), Centro Internacional de la Papa (CIP), International Center for Agricultural Research in the Dry Areas (ICARDA), International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), International Rice Research Institute (IRRI), and the West Africa Rice Development Association (WARDA), have an opportunity to investigate real and potential nematode problems of the main food crops in developing countries.

Drs S B Sharma and D McDonald should be commended for their initiative in organizing a meeting of interested nematologists in conjunction with the International Congress of Plant Pathology held in Montreal, Canada, from 28 July to 6 August 1993. The summary and recommendations presented in this publication will, I am sure, stimulate further interest in research on nematode-related problems in food crops. The Group that met in Montreal could perhaps be considered as a Working Group to ensure information exchange in future.

Y L None
Deputy Director General
ICRISAT

Introduction and objectives

B R Kerry

I thank the participants, many with considerable international research experience, for staying on after attending the International Congress of Plant Pathology to discuss the important topic of nematode constraints to crop production and the role of international agricultural research centers (IARCs) in constraint alleviation. I also express my gratitude to Dr S B Sharma, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) Asia Center, who has organized the program.

The Consultative Group on International Agricultural Research (CGIAR) was established in 1971 by 20 donor countries with a budget of approximately 20 million dollars. There are now about 40 donors, providing a budget of 300 million dollars, but despite such an expansion in activities over the past 20 years, resources allocated to nematological research in the IARCs continue to be less than those allocated to other disciplines.

Only three IARCs have resident nematologists, and three others rely on scientific consultants. Too often, therefore, an IARC nematologist has a wide responsibility for tackling nematode problems of the mandate crops but is usually alone and under-resourced and must rely on colleagues in national agricultural research systems (NARS).

Several review papers highlighting new developments in nematological research were presented during the International Congress of Plant Pathology. Much of this research has been done in well-equipped laboratories in developed countries, and it is important to assess how relevant this work is to the needs of farming community in developing countries. In general, research in developed countries is now targeted at low-input systems using sustainable methods of pest management. This could mean that chances of successful transfer of technologies from developed to developing countries are better than ever before. However, such transfers need expert inputs and a regular exchange of personnel and information to ensure their success. Research centers in Australia, Europe, and the USA provide international training courses and opportunities for research in nematology. At Rothamsted, a new initiative—Rothamsted International—has been launched to provide fellowships for postgraduate scientists to visit the station for specialist training.

During this meeting, S B Sharma from the ICRISAT Asia Center and J C Prot from the International Rice Research Institute (IRRI) will talk about their work in IARCs, and K S Varaprasad from India and F Lamberti from Italy, who have wide experience in international nematology, will discuss nematode constraints to crops in their regions. From these keynote addresses, a general discussion is

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planned to (a) identify research needs and help coordinate the research between colleagues in developed and developing nations; (b) improve nematological resources through training and taxonomic support; and (c) highlight the significance of nematode constraints to many crops worldwide. Constraints to nematological research in all countries mean that collaborative research and the careful targeting of resources are essential to ensure progress. To this end, it is hoped that this type of meeting, initiated by Dr Sharma, can be held regularly to help improve contacts between nematologists in the IARCs and the NARS.

Nematode constraints to crop production and the role of international agricultural research centers in constraint alleviation: role of the International Crops Research Institute for the Semi-Arid Tropics

S B Sharma and D McDonald

The international agricultural research centers (IARCs), supported by the Consultative Group on International Agricultural Research (CGIAR), form a global network for research on over 20 crops that together provide some 80% of the food energy and protein requirements of developing countries. The mandate crops of the IARCs suffer serious losses in yield due to plant-parasitic nematodes (Table 1), and it has been found that these losses are much greater in the developing than in the developed countries. Reasons for this are many and diverse, but it is clear that diseases caused by nematodes are among the least understood pest problems in developing countries, and that the government departments responsible for agricultural research do not appear to be sufficiently aware of plant-parasitic nematodes and the crop losses they cause.

Table 1. Estimated annual yield losses in the mandate crops of the international agricultural research centers due to plant-parasitic nematodes.

Crop	Latin name	Loss (%)
Banana	*Musa* spp	19.7
Cassava	*Manihot esculenta*	8.4
Chickpea	*Cicer arietinum*	13.7
Cowpea	*Vigna unguiculata*	15.1
Field beans	*Phaseolus* spp	10.9
Groundnut	*Arachis hypogaea*	12.0
Pearl millet	*Pennisetum glaucum*	11.8
Pigeonpea	*Cajanus cajan*	13.2
Maize	*Zea mays*	10.2
Rice	*Oryza sativa*	10.0
Sorghum	*Sorghum bicolor*	6.9
Sweet potato	*Ipomoea batatas*	10.2

Source: Sasser and Freckman (1987).

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The damage caused by nematodes is often less dramatic and more subtle than that caused by other pathogens/pests; losses can only be revealed by extensive research and field trials. To conduct these trials, trained staff are essential but may not be available in many developing countries. Plant nematologists are scarce in the developing countries of Africa and Asia and, with the possible exception of India, most nematologists have to spread their efforts over many crops. Some countries do not have even a single trained plant nematologist. It is for this reason that the involvement of IARCs in the management of nematode pests of life-sustaining crops is important, and facilities for nematological work have been established in some of them.

Role of ICRISAT in alleviation of nematode constraints

Regular work on diseases of ICRISAT's mandate crops caused by nematodes, particularly of grain legumes, began in 1986. Earlier, nematological research was conducted ad hoc by short-term consultants and visiting scientists. One of the most important primary objectives was to assess the relative importance of nematodes associated with the mandate crops. From field surveys, questionnaire surveys, and contacts with crop protection scientists, it became clear that these crops host many species of plant-parasitic nematodes and that species of cyst, lesion, reniform, and root-knot nematodes are the most important (Table 2).

Table 2. Plant-parasitic nematodes associated with ICRISAT'S mandate crops.

Crop	Number of species	Important species
Sorghum *(Sorghum bicolor)*	114	*Pratylenchus* spp
Pearl millet *(Pennisetum glaucum)*	52	*Pratylenchus* spp
Chickpea *(Cicer arietinum)*	51	*Meloidogyne incognita, M. javanica, M. artiellia*
Pigeonpea *(Cajanus cajan)*	65	*Heterodera cajani, Rotylenchulus reniformis, M. javanica*
Groundnut *(Arachis hypogaea)*	101	*M. arenaria, M. javanica, Pratylenchus brachyurus, Scutellonema* spp

Constraint identification

Methodical and extensive plant disease surveys are rare in the developing countries. A questionnaire survey revealed that not even 10% of the total world area under sorghum, pearl millet, chickpea, pigeonpea, and groundnut has been adequately surveyed for plant-parasitic nematodes. Joint surveys involving scientists from the host country and ICRISAT have unearthed problems of possible economic importance, and have recorded the presence of several crop-damaging nematode species (Table 3). This work has gradually led to increased awareness of and interest in nematode problems. More can be done by non-nematologists in reporting diseases suspected to be caused by nematodes. The association of scientists from the national agricultural research systems (NARS) in these surveys has helped them to understand and appreciate that nematode-induced damage is important and deserves attention.

Table 3. Nematode constraints identified by joint surveys.

Country	Constraints identified
China	Widespread distribution of root-knot nematodes (*M. arenaria* and *M. javanica)* in major groundnut-growing regions.
India	Widespread distribution of pigeonpea cyst nematode *(Heterodera cajani)* in parts of western and southern India.
	Presence of lesion nematode (*Pratylenchus brachyurus)* on groundnut in southern India.
Kenya	Potential seriousness of *Rotylenchulus parvus, Scutellonema unum,* and *M. javanica* in pigeonpea.
Nepal	Identification of root-knot nematodes *(Meloidogyne javanica* and M. *incognita)* as possible constraints to chickpea production.
Niger	Potential seriousness of *Scutellonema clathricaudatum, Xiphinema parasetariae, Paralongidorus bullatus,* and *Telotylenchus indicus* in groundnut and pearl millet.
	Presence of *Heterodera gambiensis* on pearl millet.
	Presence of many species of important plant-parasitic nematodes *(Scutellonema, Pratylenchus, Helicotylenchus,* and *Aphelenchoides)* in the groundnut-growing regions (including those of Benin and Burkina Faso).
Vietnam	Potential seriousness of ring, root-knot, and lesion nematodes in traditional cropping systems (rice-groundnut-sweet potato).

Field diagnosis of damage caused by nematodes

As a first step to assist NARS scientists, we have developed simple techniques to recognize and diagnose nematode-caused damage. Infection by cyst nematodes causes 'pearly root' symptoms on pigeonpea, easily seen 30-35 days after sowing. The roots of affected seedlings bear many pearly white females of the cyst nematode. Similarly, infection by reniform nematodes causes 'dirty roots' because the nematodes produce mucilaginous egg sacs on the roots to which soil particles become attached and are not easily dislodged even when roots are shaken. If these roots are dipped in a 0.25% trypan blue stain for 3 minutes and then rinsed in water, the egg sacs are selectively colored blue while the roots are not stained. This simple technique permits easy identification of reniform nematode infection without a microscope.

Techniques for identification of host-plant resistance

At ICRISAT Asia Center (IAC), simple and reliable greenhouse procedures have been developed to screen chickpea, pigeonpea, and groundnut genotypes for resistance to important plant-parasitic nematodes. Early work has shown that most released cultivars of these crops are susceptible to nematodes.

Development of human resources in nematology

To capitalize on the technology and improved plant materials emanating from nematology research at IAC, we consider it vital that strong national research programs be developed. In our Training and Fellowships Program, about 500 trainees from 40 countries have been given lectures on plant nematology, while a smaller number have received more advanced lectures on and practical training in nematological problems. Most of the participants had no previous formal or informal training in nematology. In addition, research fellows, research scholars, in-service fellows, and future research scientists in our mandate area are being regularly trained in nematology at IAC.

Nematology network

At IAC, we insist that any option in managing nematode diseases recommended to the farmers must be compatible with low-input crop production strategies. Identification and utilization of host-plant resistance is therefore a very desirable component of any integrated nematode management program. The IARCs have contributed substantially to this area through the collection, maintenance, evaluation, and utilization of plant genetic resources and their distribution to scientists worldwide. The use of nematode-resistant cultivars is a practical, low-cost, and

environmentally safe technology. We are evaluating the world germplasm of chickpea, pigeonpea, and groundnut for resistance to important plant-parasitic nematodes. Scientists from NARS come to IAC to learn resistance-screening techniques, and may collaborate with us later in screening germplasm for resistance to the nematode populations prevalent in their regions and countries. We are developing a network of scientists from different agro-ecological regions who can assist in the multilocational evaluation of resistant germplasm, and in testing cropping systems developed to manage plant-parasitic nematodes. Currently, we are considering cooperative research on plant-parasitic nematodes with other international institutions on an ecoregional basis. In the past, collaboration among nematologists in the different IARCs was limited. Inter-center cooperation in plant nematology could be of great value in surveys, regional training programs on crop loss assessments, and cropping system based management. For example, collaboration between the nematologists at the International Rice Research Institute (IRRI) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) could be useful in managing important nematodes species in the rice-based cropping systems of Vietnam. We also collaborate with such mentor institutions as the International Institute of Parasitology in the United Kingdom for confirmation of nematode identifications, and are gradually extending our collaboration to other institutions to include basic work on transfer of resistance from wild relatives of our mandate crops to adapted cultivars, and on identification of potentially important biocontrol agents. Research on nematode constraints to crop production is gradually but steadily gaining momentum at ICRISAT, and the future progress will be limited only by the lack of resources devoted to it (Table 4). The present levels of financial and human resources devoted to nematology are certainly well below the critical level required for us to contribute substantially to the mission of CGIAR—to ensure adequate food supplies in the developing world.

Table 4. Allocation of funds at ICRISAT for work on constraints to legume production (based on the 1994-98 Medium-Term Plan).

Biotic stress factors	Allocation (%)
Insect pests	20.3
Diseases caused by fungi	22.9
Aflatoxin/mycotoxins	6.5
Nematodes	4.4
Viruses	14.7

Reference

Sasser, J N, and Freckman, D W. 1987. A world perspective on nematology: the role of the society. Pages 7-14 *in* Vistas on nematology: a commemoration of the twenty-fifth anniversary of the Society of Nematologists (Veech, J A, and Dickson, D W, eds.). Hyattsville, Maryland, USA: Society of Nematologists, Inc.

Nematode constraints to crop production and the role of international agricultural research centers in constraint alleviation: role of the International Rice Research Institute

J C Prot

Rice *(Oryza sativa)* is the staple food for half of the world's people, particularly those with low income. It is the second most important food crop after wheat *(Triticum* spp) and is grown on 150 million ha. Asia produces 90% of the world's rice. Rice is grown in four major types of ecosystems, which contribute to the world production: irrigated (72%), rainfed lowland (19%), upland (5%), and deepwater/ tidal wetland (4%). It is estimated that a 65% increase in the world rice production will be needed by 2020 to meet the projected population growth. For South and Southeast Asia, the increase needed is estimated at about 100% (Anonymous 1989).

Nematode constraints to rice production

Rice is a low-value crop. Usually, nematode problems in low-value crops are not fully recognized by farmers and policymakers. However, losses due to plant-parasitic nematodes are estimated at 10% of the world's rice production; in monetary terms, the losses in rice production caused by nematodes were estimated at 16 billion dollars and ranked second to those in sugarcane *(Saccharum officinarum)* (Sasser and Freckman 1987). The four major genera of plant-parasitic nematodes of potential economic importance found associated with rice in South and Southeast Asia are *Ditylenchus* in deep water rice, *Hirschmanniella* in permanently or intermittently flooded ecosystems, *Meloidogyne* in all the rice ecosystems, and *Pratylenchus* in upland rice. Because of the greater contribution to the total rice production of the rice ecosystems in which they occur, *Hirschmanniella* and *Meloidogyne* are potentially more serious than the other two genera (Prot 1993). However, when equity and environmental issues are considered, *Ditylenchus angustus* in deepwater rice and *Pratylenchus* spp in upland rice are also important rice parasites.

Nematology program at IRRI

IRRI's main objectives are to generate and disseminate rice-related knowledge and technology, and to help enhance national agricultural research systems

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(NARS). In 1988, a Nematology Unit was created within IRRI's Plant Pathology Division. In 1993, it had nine persons working mostly on nematode problems of irrigated and upland rice. To understand the role of nematodes in rice production and to increase the productivity of rice and rice-based system by controlling those of economic importance while protecting the sustainability of these ecosystems are tremendous challenges. IRRI cannot do this alone. The resources of its traditional partners—NARS, sister CGIAR centers, advanced research laboratories and institutions—and new partners—nongovernmental and private organizations in both rice-growing and industrialized countries—also must be catalyzed' (Anonymous 1992).

Collaboration with NARS and other institutions

The Nematology Unit has established collaborative research programs with NARS in Indonesia, the Philippines, and Vietnam. In strengthening NARS, one of the roles of IRRI is to facilitate the linkage between research done in both less developed and industrialized countries. Because of the scarcity of available information, the variability of rice ecosystems, the changes occurring in the rice ecosystems, the variety of rice cropping systems, and the possibility of rice becoming a high-value crop when farmers will have to produce 9-10 t ha^{-1}, there are most certainly many opportunities for nematologists working in industrialized countries to join the NARS and IRRI to work on rice nematodes. Some areas for such collaborative research are (1) understanding of the effects of nematodes on the productivity and sustainability of the different rice ecosystems, (2) evaluation of variability of rice-parasitic nematodes, and (3) evaluation of the possibility to control them by using antagonistic organisms.

References

Anonymous. 1989. IRRI toward 2000 and beyond. Manila, Philippines: International Rice Research Institute. 71 pp.

Anonymous. 1992. Rice research in a time of change. IRRI's medium-term plan for 1994-98. Manila, Philippines: International Rice Research Institute. 79 pp.

Prot, J C. 1993. Monetary value estimates of nematode problems, research proposal and priorities: the rice example in South and Southeast Asia. Fundamental and Applied Nematology 16: 213-216.

Sasser, J N, and Freckman, D W. 1987. A world perspective on nematology: the role of the society. Pages 7-14 *in* Vistas on nematology: a commemoration of the twenty-fifth anniversary of the Society of Nematologists (Veech, J A, and Dickson, D W, eds.). Hyattsville, Maryland, USA: Society of Nematologists, Inc.

Nematode constraints to crop production in South Asian countries and the role of international agricultural research centers in constraint alleviation

K S Varaprasad

The science of nematology is in a developing phase in South Asia. Diseases caused by nematodes are gradually being recognized as important biotic stresses in crop production. The discovery of the golden nematode of potato in 1961 in southern India stimulated interest in nematology among plant protection scientists in India. Currently more than 300 persons are engaged in teaching, extension, and research on nematology in India. However, the development of agricultural nematology in other South Asian countries has been slow.

Nematode constraints to crop production in South Asia

Rice and wheat are the principal cereal crops grown in Bangladesh, Bhutan, India, Myanmar, Nepal, Pakistan, and Sri Lanka. The potentially important nematode constraints to rice production in South Asia are rice root nematodes *(Hirschmanniella* spp), white tip nematode (*Aphelenchoides besseyi),* ufra nematode *(Ditylenchus angustus),* root-knot nematode *(Meloidogyne graminicola),* cyst nematodes *(Heterodera* spp), and lesion nematodes *(Pratylenchus* spp). Rice root nematodes are widespread and occur in all rice-growing tracts of the world. Ufra, white tip, and root-knot nematodes are important constraints to rice production in India, Bangladesh, and Myanmar. Yield losses due to rice root nematode range from 20 to 50%, depending on the nematode inoculum levels, the age of the crop, and the weather conditions at the time of infection. White tip nematode infection at the level of 650 nematodes for every 100 seeds reduced panicle weight by 60% in Bangladesh (Rahman and Taylor 1983). Improperly filled kernels, sterility, and discoloration of grains are responsible for economic losses in India. Annual yield losses due to the ufra nematode range from 4 to 30% in Bangladesh and northeastern India. Annual yield losses due to the root-knot, cyst, and lesion nematodes range from 10 to 42% in India.

'Molya' disease, caused by the cereal cyst nematode *(Heterodera avenae),* and ear-cockle nematode *(Anguina tritici)* are the major nematode problems of wheat on the Indian subcontinent. Molya disease is an important constraint to wheat production in northern India. In addition to producing seed galls, ear-cockle

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nematode, in association with a bacterium, causes 'tundu' disease, which results in severe losses in infested crops. Very limited information is available on nematode constraints to sorghum, pearl millet, and maize in the South Asia region, but it is known that lesion nematodes, stunt nematodes *(Tylenchorhynchus* spp), and cyst nematodes are important parasites of these crops in India.

Chickpea, pigeonpea, soybean *(Glycine max),* black gram *(Vigna mungo),* mung bean (V. *radiata),* cowpea *(V. unguiculata),* french bean *(Phaseolus vulgaris),* pea *(Pisum sativum),* and moth bean *(V. aconitifolia)* are important legume crops grown in South Asia. *Meloidogyne javanica* and *M. incognita* are the most important nematodes in all the chickpea-growing regions. In Pakistan, lesion nematodes are also considered to be important pathogens. Pigeonpea cyst *(Heterodera cajani),* root-knot *(Meloidogyne* spp), and reniform *(Rotylenchulus reniformis)* nematodes cause important problems in this region. Root-knot nematodes cause serious problems on soybean, black gram, cowpea, pea, and mung bean. Overall, 10-12% of pulse production is lost because of root-knot nematodes in India.

Groundnut, sunflower *(Helianthus annuus),* castor *(Ricinus communis),* mustard *(Brassica juncea),* sesame *(Sesamum indicum),* and coconut *(Cocos nucifera)* are important oil-yielding crops grown in the region. Root-knot nematodes (*M. arenaria* and *M. javanica)* cause problems in groundnut in India and Myanmar, which are the major groundnut-producing countries in South Asia. Sunflower, a recently introduced crop in the region, is highly susceptible to root-knot and reniform nematodes. The burrowing nematode, *Radopholus similis,* causes major problems on coconut in India and Sri Lanka; its control increased the yields of coconut up to 30% in India.

Potato *(Solanum tuberosum),* tomato *(Lycopersicon esculentum),* eggplant *(Solatium melongena),* okra *(Hibiscus esculentus),* cucumber *(Cucumis sativus),* sponge gourd *(Luffa cylindrica),* ridge gourd *(L. acutangula),* bitter gourd *(Momordica charantia),* beans *(Phaseolus* spp), onion *(Allium* spp), chillies *(Capsicum* spp), and garlic *(Allium sativum)* are important vegetable crops in South Asia. Carrot *(Daucus carota),* beetroot *(Beta vulgaris),* cabbage *(Brassica oleracea* var *capitata),* and cauliflower *(B. oleracea* var *botrytis)* are also grown to a limited extent. Almost all these vegetable crops are highly susceptible to root-knot nematodes *(M. incognita, M. javanica, M. arenaria,* and *M. hapla).* Reniform nematode also causes extensive damage to a large number of vegetable crops in the region. Burrowing nematodes attack several vegetables and cause serious damage to garlic and ginger *(Zingiber officinale).* The root-knot nematode, *M. incognita,* is the most widespread and important problem on potato, followed by *M. javanica* and *M hapla.* Potato cyst nematodes *(Globodera rostochiensis* and *G. pallida)* have been reported from small pockets in India and Pakistan, and have recently been reported from Sri Lanka. Yield losses up to 80% are common in areas infested with potato cyst nematode (Jatala and Bridge 1990). Nematode control trials in India indicated that potato yields doubled following soil fumigation with nematicides. Stunt and spiral nematodes have caused 9 to 29% loss in tuber yield in the potato-growing tracts in the hills of northern India.

Role of the international agricultural research centers (IARCS)

Among the 18 IARCs, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) is the only institute located in South Asia with a mandate to work on sorghum, pearl millet, finger millet *(Eleusine coracana),* chickpea, pigeonpea, and groundnut. ICRISAT has taken a good lead in identifying nematodes as important constraints to production of its mandate crops, and has established an independent nematology laboratory. The progress achieved at ICRISAT Asia Center (IAC) in the field of nematology has been highlighted by Dr S B Sharma at this meeting. Some of the nematology laboratories of the Indian Council of Agricultural Research (ICAR) already have successful interactions with IARCs either directly or indirectly, e.g. the Central Rice Research Institute, Cuttack and Directorate of Rice Research, Hyderabad with the International Rice Research Institute (IRRI), Philippines; the Central Potato Research Institute, Simla with the Centro Internacional de la Papa (CIP), Peru; and the Project Directorate of Wheat, Karnal and the All India Co-ordinated Maize Improvement Project, New Delhi with the Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT), Mexico. The Nematology Unit of IAC has strong links with various nematology laboratories of ICAR and several agricultural universities in India and Nepal. There is great scope for the expansion of linkages and networking with other South Asian countries.

Conclusions

India (Rao et al. 1986) and Pakistan (Saeed 1990), to a large extent, have identified the major nematode constraints to their principal crops. However, there is a need to identify NARS scientists in other countries who need training in nematology and could possibly collaborate with the IARCs. Priority should be given to joint crop surveys in Myanmar and Bhutan because little information is available about nematode problems in these two countries. The nematological experience gained in India during the last three decades and the techniques of successful management of important nematode problems could be shared with neighboring countries to achieve rapid results on a field scale. ICRISAT Asia Center should take a lead in developing low-input options for the management of important nematode diseases; in providing training in the field of nematology in the region; in developing a network of nematologists working on ICRISAT's mandate crops; and in establishing an independent nematode identification center for South Asia, which would greatly benefit the region in identification and alleviation of nematode problems.

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References

Jatala, P, and Bridge, J. 1990. Nematode parasites of root and tuber crops. Pages 137-180 *in* Parasitic nematodes in subtropical and tropical agriculture (Lal, M, Sokora, R A, and Bridge, J, eds.). Oxford, UK: C. A. B. International.

Rahman, M L, and Taylor, B. 1983. Nematode pests associated with deep water rice in Bangladesh. International Rice Research Newsletter 7(5): 15.

Rao, Y S, Prasad, J S, and Panwar, M S. 1986. Nematode problems in rice: crop losses, symptomatology and management. Pages 279-299 *in* Plant parasitic nematodes of India—problems and progress (Das Gupta, D R, and Swarup, G, eds.). New Delhi, India: Indian Agricultural Research Institute.

Saeed, M. 1990. Development of phytonematology in Pakistan. Pages 515-525 *in* Progress in plant nematology (Saxena, S K, Khan, M W, Rashid, A, and Khan, R M, eds.). New Delhi, India: CBS Publishers and Distributors Pvt. Ltd.

Nematode constraints to crop production in the Mediterranean region and the role of international agricultural research centers in constraint alleviation

F Lamberti

The Mediterranean region comprises the following 23 countries (listed clockwise from north to southwest): Portugal, Spain, France, Italy, Malta, Slovenia, Croatia, Serbia, Albania, Greece, Bulgaria, Romania, Turkey, Cyprus, Syria, Lebanon, Jordan, Israel, Egypt, Libya, Tunisia, Algeria, and Morocco.

Nematode constraints

The most important and widespread nematode pests in the region are *Meloidogyne* species. *Meloidogyne arenaria, M. hapla, M. incognita,* and *M. javanica* occur throughout the region; however, the most frequent and economically important species is M. *incognita,* highly polyphagous and pathogenic to various vegetable, industrial, and fruit crops (Lamberti 1992). Heavy attacks of this nematode can suppress yields completely; however, crop losses are usually in the range of 60-80%. *Meloidogyne naasi* is also present, but its economic importance is not well established. *Meloidogyne artiellia* is a major parasite of leguminous and cereal crops in various countries, causing economically significant yield losses especially in chickpea and wheat. Of the potato cyst nematodes, *Globodera rostochiensis* seems to be more widespread in the region than *G. pallida;* however, pathogenicity thresholds of both the species range between 1.4 and 2.1 eggs or juveniles g^{-1} of soil. Initial population densities of 60 eggs or juveniles g^{-1} of soil can completely suppress marketable yields. Among the species of *Heterodera,* economically significant losses are caused by *H. avenae, H. carotae, H. ciceri, H. goettingiana,* and *H. schachtii.* Also reported in the region, although their economic importance is not known, are *H. cacti, H. cruciferae, H. latipons,* and *H. trifolii.*

The bulb and stem nematode, *Ditylenchus dipsaci,* is a major pest of several crops, such as onion *(Allium* spp), strawberry *(Fragaria* spp), and various legumes. Other plant-parasitic nematodes in the Mediterranean region are *Aphelenchoides besseyi, A. fragariae, A. ritzemabosi, Gracilacus peratica, Helicotylenchus dihystera, H. multicinctus, H. oleae, H. vulgaris, Longidorus africanus, L. cohni, Mesocriconema xenoplax, Paratylenchus dianthus,* P. *neoamblycephalus, Pratylenchus brachyurus,* P. *mediterranean, P. penetrans, P. thornei,* P. *vulnus, Rotylenchulus macrodoratus, R. reniformis, Trichodorus tunisiensis, T. viruliferus, Tylenchulus semipenetrans, Xiphinema elongatum, X. index, X. italiae,* and *Zygotylenchus guevarai.*

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The broad range of problems and the diversity of agricultural production systems require trained scientists to diagnose and manage the damage caused by plant-parasitic nematodes by accurate identification of the nematode populations, proper evaluation of economic thresholds, and a choice of feasible, safe, and economical measures of control. Such persons are not always available in Mediterranean countries, but what is particularly lacking in the region is not competence and dedication of a few scientists and teachers, but facilities to conduct applied research under field conditions and the extension services to disseminate the results and to advise farmers.

Role of the international agricultural research centers (IARCS)

The international agricultural research centers (IARCs) and other international agencies already play an important role in alleviating production constraints in the Mediterranean region. In fact, the International Center for Agricultural Research in the Dry Areas (ICARDA) in Syria undertakes various projects to improve productivity of cereal and legume crops in the region. Centro Internacional de la Papa (CIP) in Peru carries out field experiments in many North African and Middle Eastern countries. The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in India conducts research on several legumes such as chickpea, which is of primary importance in the Mediterranean region. Centro Internacional de Mejoramiento de Maiz y Trigo (CIMMYT) in Mexico grants contracts to several Mediterranean research institutions. The International Rice Research Institute (IRRI) in Philippines and the West Africa Rice Development Association (WARDA) in Cote d' Ivoire, with research units in various western African countries, undertake research on crops of fundamental importance to the Mediterranean diet. The International Institute of Tropical Agriculture (IITA) in Nigeria exchanges plant material, documentation, and scientists with many Mediterranean institutions. Finally, the Food and Agriculture Organization of the United Nations (FAO), with its headquarters in Italy, funds various projects in many Mediterranean countries.

Can the international centers improve their role in contributing to the development of the agricultural systems in the Mediterranean region?

Certainly they can, particularly at a time when, due to economic exigencies, human and financial resources of national research institutions have been severely curtailed, and when such constraints have become more acute in developing countries where increased efforts and resources are needed the most. Probably, modest increases in the contributions by donors, and careful selection of research programs, would strengthen the activity and the presence of such centers in key areas and develop and enhance a network of regional officers who would either confirm or adapt the information gathered at the main locations. Applied

research must remain the main objective of the IARCs, and dissemination of the results of their applied research must be extensive.

Reference

Lamberti, F. 1992. Nematology in the Mediterranean region. Nematologica 38: 449-454.

General discussion and recommendations

The general discussion was about the necessity of strengthening nematology research at the international agricultural research centers (IARCs). The participants believed that the fact that the mandate crops of the IARCs are hosts of many damaging nematode species, and available crop loss estimates, signify the importance of nematode pests as constraints to the production of these mandate crops. Many participants voiced a need to initiate an international project to assess losses caused by nematodes to the mandate crops in developing countries, and to highlight the need for increased nematological research at the IARCs. The group was concerned that so few trained nematologists were employed in programs at the IARCs, particularly in comparison with the number of scientists in allied disciplines. Nematologists at IARCs are often alone and usually under-funded. The group felt that to make faster progress in providing low-input management options to resource-poor farmers in the regions, it is imperative that nematology programs are expanded at the IARCs. Some participants expressed their conviction that nematode diseases are essential components of root health problems, and wondered why active nematology programs have been started only at ICRISAT, IRRI, and CIP and not at other crop-based IARCs.

The national programs in developing countries (except India) do not have adequate expertise and facilities in nematology to identify and manage the nematode constraints. The participants felt that active and meaningful collaboration between nematology centers in the developed nations and the IARCs could lead to effective and need-based nematology training courses for plant protection workers and extension workers in the mandate regions of the IARCs. The low-input management technologies developed in advanced nations could be transferred to the developing nations through these training courses.

The participants felt that this type of meeting should be held regularly to develop and improve contacts between plant nematologists working in IARCs and other international and regional institutions and NARS scientists in developing and developed countries with interest in crops of international importance.

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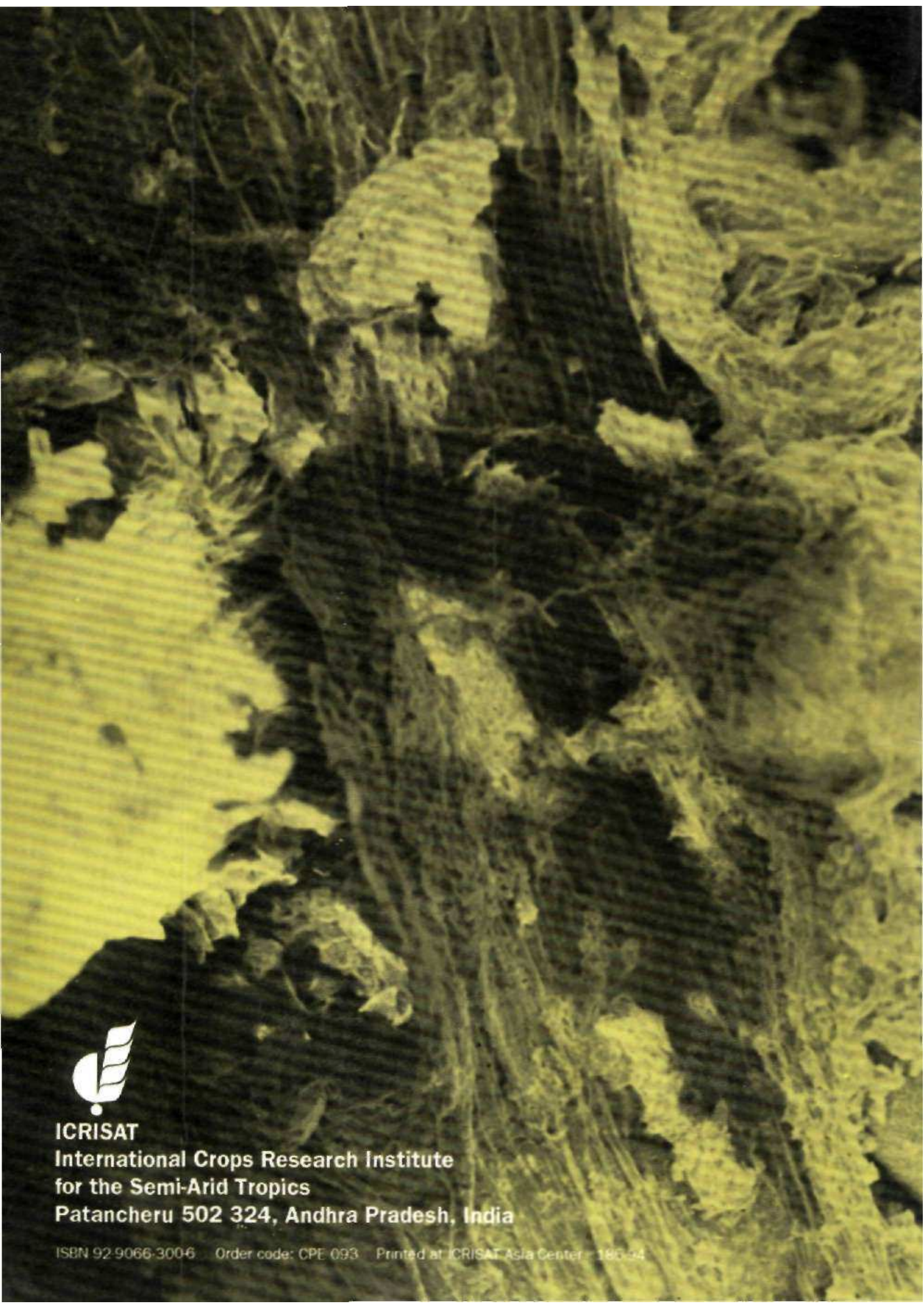
About ICRISAT

The semi-arid tropics (SAT) encompasses parts of 48 developing countries including most of India, parts of southeast Asia, a swathe across sub-Saharan Africa, much of southern and eastern Africa, and parts of Latin America. Many of these countries are among the poorest in the world. Approximately one-sixth of the world's population lives in the SAT, which is typified by unpredictable weather, limited and erratic rainfall, and nutrient-poor soils.

ICRISAT's mandate crops are sorghum, pearl millet, finger millet, chickpea, pigeonpea, and groundnut; these six crops are vital to life for the ever-increasing populations of the semi-arid tropics. ICRISAT's mission is to conduct research which can lead to enhanced sustainable production of these crops and to improved management of the limited natural resources of the SAT. ICRISAT communicates information on technologies as they are developed through workshops, networks, training, library services, and publishing.

ICRISAT was established in 1972. It is one of 18 nonprofit, research and training centers funded through the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is an informal association of approximately 50 public and private sector donors; it is co-sponsored by the Food and Agriculture Organization of the United Nations (FAO), the World Bank, and the United Nations Development Programme (UNDP).



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