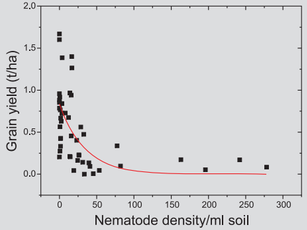
Consequences of nematode attack

- Nematodes can cause significant yield losses through direct pathogenic effects; for instance, by suppressing seedling establishment and growth, and yield.
- Nematodes can interact with other soil biotic and abiotic factors, and influence rice–weed competition.
- Nematode attack can induce symptoms of water stress and intensify symptoms under low water availability, reducing a crop's ability to recover from drought stress.
- Improved weed management can give rise to higher population densities of nematodes in the soil, which may affect subsequent crops.

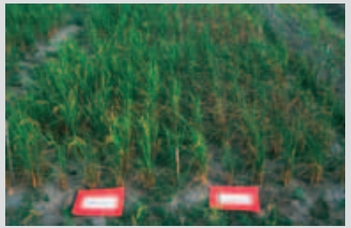
Suppressed seedling growth in West Africa in the presence of high pre-sowing nematode population densities, compared with carbofuran-treated area

Weed management regime	Lowland (no. nematodes†/ 5g root)	Upland (no. nematodes‡/ ml soil)
Clean weeded (high)	477	50
Weeded for first 14 days only (low)	260	29

† *Hirshmanniella oryzae*
‡ *Heterodera sacchari*



Relationship between Heterodera sacchari *population density and upland rice grain yield in West Africa*



Reduced leaf area, drought symptoms, delayed maturity, and premature die-back of plants with high nematode densities (right) compared with those on the left, with low nematode densities

Echinochloa *sp. grows freely, while rice is killed by* Heterodera sacchari

The Africa Rice Center (WARDA)

The Africa Rice Center (WARDA) is an autonomous intergovernmental research association of African member states. WARDA is also one of the 15 international agricultural research Centers supported by the Consultative Group on International Agricultural Research (CGIAR).

WARDA's mission is to contribute to poverty alleviation and food security in Africa, through research, development and partnership activities aimed at increasing the productivity and profitability of the rice sector in ways that ensure the sustainability of the farming environment.

WARDA hosts the African Rice Initiative (ARI), the Regional Rice Research and Development Network for West and Central Africa (ROCARIZ), and the Inland Valley Consortium (IVC).

WARDA has its headquarters in Côte d'Ivoire and regional research stations near St Louis, Senegal, at the International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, and at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) research station at Samanko, near Bamako, Mali.

IRRI

The International Rice Research Institute (IRRI) was established in 1960 by the Ford and Rockefeller Foundations with the help and approval of the Government of the Philippines. Today IRRI is one of the 16 non-profit international research centers supported by the Consultative Group on International Agricultural Research (CGIAR). The CGIAR is sponsored by the Food and Agriculture Organization of the United Nations, the International Bank for Reconstruction and Development (World Bank), the United Nations Development Programme (UNDP), and the United Nations Environment Programme (UNEP). Its membership comprises donor countries, international and regional organizations, and private foundations.

As listed in its most recent Corporate Report, IRRI receives support, through the CGIAR, from donors such as UNDP, the World Bank, the European Union, the Asian Development Bank, the International Fund for Agricultural Development (IFAD), the Rockefeller Foundation, and the international aid agencies of the following governments: Australia, Bangladesh, Belgium, Brazil, Canada, the People's Republic of China, Denmark, France, Germany, India, Indonesia, the Islamic Republic of Iran, Japan, the Republic of Korea, Mexico, The Netherlands, Norway, Peru, The Philippines, Spain, Sweden, Switzerland, Thailand, the United Kingdom, and the United States of America.

DFID

DFID is the UK Government Department responsible for international development policy and managing sustainable development programmes with poorer countries. The Government is committed to halve, by 2015, the proportion of the world's people whose income is less than one dollar a day, the proportion of people who suffer from hunger, and the proportion of people who lack safe drinking water. Other associated targets include basic health care provision and universal access to primary education. DFID works in partnership with the governments of developing countries, international organisations, voluntary bodies, the private sector and the research community.

Crop Protection Programme

One of ten research programmes under DFID's Natural Resources Research Strategy. Managed by Natural Resources International Ltd., the programme commissions projects carried out in partnership with, amongst others, national agricultural research systems (NARS), international research centres or NGOs. Research funded generates knowledge, which supports the sustainable management of crop pests, and offers the poor opportunities to increase sources of income.

This publication is an output from the DFID Crop Protection Programme for the benefit of developing countries. The views expressed are not necessarily those of DFID.

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Nematode parasites of rice

International Rice Research Institute

The Africa Rice Center (WARDA)

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Introduction

Nematode parasites of rice are microscopic organisms invisible to the naked eye. Most nematodes feed and develop in roots, but some feed on aerial parts. Infective stages are worm-like and mobile. The adults may also be mobile, but in some species females become sedentary and swollen.

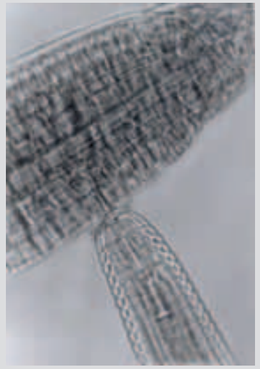
Nematodes are insidious, because the symptoms of damage are often unspecific and easily misdiagnosed. Symptoms include stunting, chlorosis, reduced vigor and symptoms of water stress, which *can be confused with soil physical problems, mineral deficiency and low water availability.* Consequently, the presence of nematodes, and the related damage, is often overlooked both by farmers and in agricultural research.

For rice, production losses of 10% are attributed to nematodes. For all crops, it is estimated that less than 0.2% of the crop value lost to nematodes is invested in nematological research. The relative proportion of funding for nematological research in the tropics is considerably less than that in most temperate countries.

The UK Department for International Development (DFID) has been reducing this disparity through the funding of projects to improve the management of nematodes, reduce yield losses and improve the livelihoods of the world's poorest farmers.

This folder seeks to raise awareness of nematode problems in rice among policy-makers, donors, extension agencies, and national-program and project personnel.

Female cyst and root-knot nematodes swell causing the root cortex to split



Mature nematode feeding on rice root

Nematodes of rice

- Over 150 species of nematodes parasitize rice. Some have a geographically restricted distribution, while others occur throughout the rice-growing regions of the world.
- Nematode parasites on rice may be divided into **foliar parasites** and **root parasites**.
- Injury from foliar parasites produces distinctive symptoms, while above-ground symptoms of root damage can be difficult to diagnose.
- Most nematode species are specific to a particular rice-growing environment; however, some species occur across a range of environments.
- Communities of several potential pest species of nematodes can occur in the same field, which complicates management decisions.
- In the dynamic and hydrologically heterogeneous conditions of small rice farms, nematode communities may be particularly diverse.

Hirschmanniella oryzae *female and eggs in rice root*

Root parasites

Important genera

Heterodera (cyst nematodes)
Hirschmanniella (rice-root nematodes)
Meloidogyne (root-knot nematodes)
Pratylenchus (lesion nematodes)

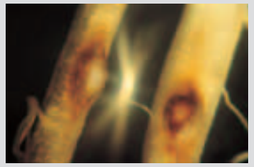
- Damage from root parasites is more important in upland rice and direct-sown lowland rice, where water management is poor.
- Cyst nematodes are important in West Africa, Japan and some states of India.
- Rice-root nematodes are present in lowland rice throughout the world.
- Root-knot nematodes are important in South and Southeast Asia, as well as in parts of Central and South America, and West Africa.

- Females of cyst and root-knot nematodes swell within roots, causing the root cortex to split.
- Mechanical damage of roots by nematodes can make rice plants more susceptible to secondary infections.
- Infection results in stunted, deformed and necrotic root systems, with potentially high yield loss. Infected plants may also be chlorotic.
- Global yield losses due to rice-root nematodes are estimated at 25%, but these nematodes are difficult to control.

Meloidogyne graminicola *root galls on rice seedlings*

Deformed rice roots (right) following infection with Heterodera sacchari

Heterodera oryzicola *cyst and white female emerging from rice root*



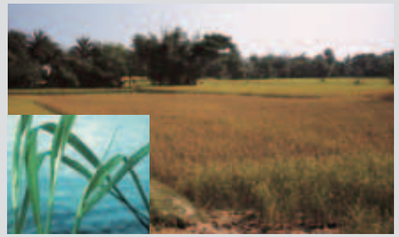
Characteristic hooked tips caused by Meloidogyne graminicola

Rice plants with high (left) and low densities of Heterodera sacchari

Foliar parasites

Important species

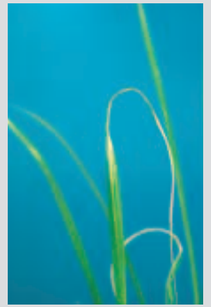
Ditylenchus angustus (Ufra)
Aphelenchoides besseyi (White tip)



Ufra can severely reduce rice yield—inset shows infected plant

Ufra:

- occurs in parts of India and Southeast Asia
- occurs in rainfed and irrigated rice systems in seasonally deep-flooded areas
- can severely reduce yields, particularly where early-season infection occurs



Rice infected with white tip

White tip nematode:

- is globally distributed
- is seed-borne and easily disseminated with grain or seed rice
- is usually restricted to deep water, irrigated and seasonally flooded rice systems
- can cause severe yield losses

Nematode management for resource-poor farmers

Nematodes are likely to become more problematic as cropping systems are intensified through:

- sequential and double cropping
- reduced fallow periods
- improved fallows and weed management
- widespread use of high-yielding, 'improved,' but nematode-susceptible cultivars

Awareness of nematodes as potential pests and constraints to rice production is essential, particularly in view of the current trend towards intensifying rice production.