Sustainable management *of plant-parasitic nematodes* in the Mediterraneanand Sahelian market gardening systems

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In Southern countries, market garden produce is an important food resource and a growing export business. Plant-parasitic nematodes harm the industry and are thought to generate up to 15% of global agricultural losses. Multidisciplinary research on these pests has been conducted in search of an integrated biological protection easily transferable to farmers. Beyond the scientific results the project achieved, its other outstanding success lies in the establishment of the NeMed research network.

Chemical control using methyl bromide was until recently the most common method of controling plant-parasitic nematodes on vegetable crops. However, methyl bromide was banned in 2005 under the Montreal Protocol, which established support measures for developing countries that are to remain in place until 2015. Thus, farmers in the countries of the Maghreb and the Sahel are currently seeking alternate ways of controlling nematodes.

Towards new strategies for *managing plant-parasitic* nematodes

In this overall context, Algeria, Morocco, Tunisia, Senegal and France joined together in the project **"Nematus: an integrated approach to nematode management in Mediterranean and Sahelian vegetable crop systems",** a research partnership that combined research and agricultural technologies. The project's ultimate objective was to promote sustainable production while maintaining the health of humans and the environment.

To help farmers diversify their nematode control techniques, the technical and scientific project sought to develop new pest management strategies that could be easily transferred to end users by:
- exploitation of natural resources (antibiosis, crop management systems, sources of resistance) in vegetable crop systems in the Mediterranean and the Sahel;
- development of sustainable agro-ecological management of nematode communities (taking advantage of interspecific competitions);
- forging a research and development partnership between the private sector (crop production) and the public sector (research and training);
- development of South-South and North-South partnerships taking a multidisciplinary (nematology, mycology) and multi-institutional approach (research institutes, universities, farmers).

NeMed Network: Ecology *and plant nematode* community management *in southern Mediterranean* ecosystems

In view of the real advances in partnership achieved at project mid-term (2007, Agadir, Morocco), the Nematus group decided to open the project review meeting to the nematologist community in North African countries. Accordingly, the first international workshop on "Ecology and management of plant-parasitic nematode communities in southern Mediterranean ecosystems" (NeMed) was organized in Sousse (Tunisia) in March 2008. Some 40 stakeholders attended from the five countries involved as well as Egypt and Libya. The event was attended by representatives from research, higher education and R&D organisations as well as students.

This led to the establishment of a network of the same name (NeMed) to promote an ecosystemic approach to nematode management in the southern Mediterranean through a shift from research into agricultural nematology to research into the ecology of pest communities and their abiotic and biotic interactions

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▲ *The Nematus project explored interactions between species: synergies between nematodes and pathogenic soil flora and antagonisms between nematophagous fungi and plant pathogens.*

(host plants and natural predators mainly). Ultimately, that experience should in turn lead to the emergence of a Sahelian network based on the same goals. The consolidation of such networks is expected to ensure the continuity of linkages forged during the implementation of the Nematus project.

During the workshop, many recommendations were made, some designed to support North-South scientific cooperation aimed at:
- encouraging links with farmers (as experts) while maintaining a high level of internationally competitive basic and applied research;
- periodically renewing the workshop to carry on the discussion on Maghreb nematode problems;
- establishing thematic groups to facilitate the transfer and exchange of scientific information between teams;
- creating a directory of permanent active workers doing research on nematodes (lecturers, researchers, engineers).

Knowledge and technology *transfer to the South*

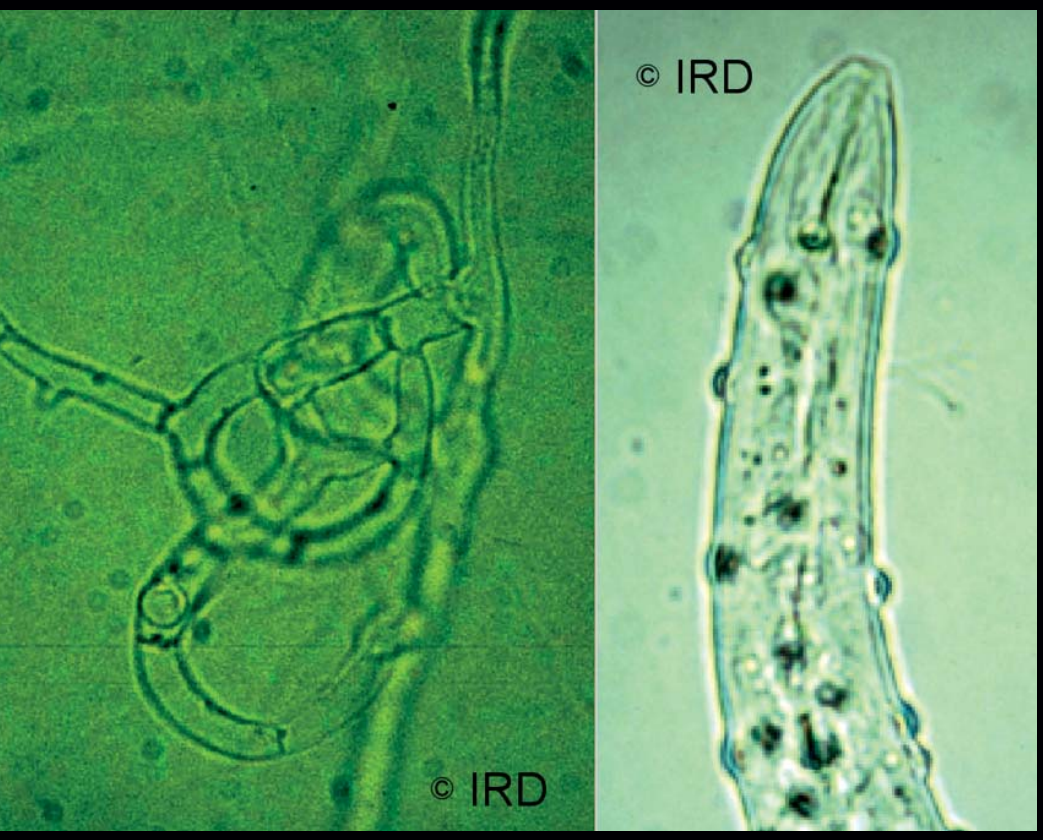
In terms of capacity building, the Nematus project has enabled students to be trained (master's degrees and doctorates in Algeria and Tunisia; engineers in Morocco, Algeria, Tunisia and Senegal). It provided for short stays at *Institut de recherche pour le développement* (IRD, Montpellier and Marseille, France) by permanent staff, to acquire skills in molecular biology and data analysis.

Information was disseminated through publications, degree papers, theses, institutional journals, trade papers, and reports to national and international conferences. Regional workshops and thematic seminars were arranged during review meetings. Finally, a set of protocols was circulated to all partners and a website was put up comprising an online forum and mailing list[1].

The workshop findings were disseminated. Oral presentations of workshop participants were made available in the Nematus website's intranet space. These 20 papers should also be collected in a single document (Proceedings), with abstracts in three languages (French, English, Arabic).

The NeMed workshop participants came up with the following recommendations:
- scientists to develop research areas based on cross-cutting regional themes such as complex cropping systems, ecosystems of agricultural oases, rhizosphere and soil biology (soil microflora, microfauna and macrofauna);
- organization of training workshops in the field (engineers); and
- research teams from the South to submit proposals in international bilateral Calls for Proposals. •••

1. www.montpellier.inra.fr/CBGP/Nematus/index_Nematus.htm



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◀ *The Nematus project explored the diversity of plant-parasitic nematodes and the associated parasitic microflora.*

Turning parasite *biodiversity into an ecology* of management aids

The project has been successful because the countries of the Maghreb are ecologically alike. The nematode problems encountered on vegetable crops are similar in the Maghreb and the Sahel.

The Nematus program explored the diversity of plant-parasitic nematodes and the associated parasitic microflora. By investigating nematodes and how they affect plants within agro-systems, it created a database that will serve as a baseline for future studies.

Numerous taxa were identified. It is interesting to note that the generic diversity of plant-parasitic nematode communities is greater in Senegal and Algeria than in Morocco and Tunisia. In addition, nematode communities are less diverse in the most anthropized market garden systems. Characterization of the most agronomically important species continues, particularly with respect to life history traits (penetration rate, reproduction, fecundity).

The project also explored interactions between species: synergies between nematodes and pathogenic soil flora and antagonisms between nematophagous fungi and plant pathogens. The detection and isolation of strains of nematophagous fungi or fungi that produce toxic substances is under way. These will be further developed at a later date as biological control agents. The project has succeeded in developing experimental strains of native nematophagous fungi suited to the Maghreb's environmental conditions.

Useful results for *sustainable development*

The project has managed to go beyond the population approach to biocontrol (plant-parasite interactions) and to understand the global pathogenesis of plant-parasitic nematode communities: the real issue in the ecologically sustainable management of plant-nematode pathosystems.

The project found out alternative ways of managing plant-parasitic nematodes to enable it to initiate a process that is destined to improve vegetable production, particularly in the Maghreb countries, from the agronomic, environmental and economic standpoint. However, it should now turn to ways of integrating its findings and pursuing the strategy it has adopted, one that combines nematology and mycology.

Further, its research activities should be opened to the whole North African and Sahelian community. It is essential to promote an exchange of experiences between Southern partners in order to develop integrated protection models suited to different cropping systems, but also to transfer the knowledge acquired to market gardening networks supervised by agricultural development NGOs. ■

Partnership

Project leader: *Company MARAISSA Groupe AZURA* (Morocco)

Partners: *Unité de Formation et de Recherche Sciences agronomiques et Développement Rural de l'Université de Thiès* (UFR SADR, Senegal), *Institut Supérieur Agronomique Chott-Mariem* (Tunisia), Institute of Development Research (IRD, France), *Université Saad Dahleb Blida* (Algeria)

Countries involved: Algeria, Morocco, Senegal, Tunisia

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