**Musa Pest Fact Sheet No. 1**

**THE BURROWING NEMATODE OF BANANAS,**  
**RADOPHOLUS SIMILIS COBB, 1913**

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Burrowing nematode (*Radopholus similis*) is one of the most important root pathogens attacking bananas in the intertropical zone of production. Vegetative propagation using infested corms or suckers has disseminated this pest throughout the world. Although a number of nematode species infect bananas and plantains, *R. similis* is considered to be the main nematode problem of intensive commercial bananas, especially Cavendish types, oriented towards export markets. It is also common on plantain and cooking bananas cultivated in the lowlands of central and eastern Africa, and the Caribbean (Puerto Rico). It is however, generally absent in plantain roots in west Africa and central America. The burrowing nematode is also absent in the highlands of central-eastern Africa and in the subtropical zones of production where a more temperate climate prevails (mediterranean area, Canary islands, Madeira, Cape Province, Taiwan), although it may be present under greenhouse cultivation. The distribution of this nematode species is mainly due to its preference for a temperature-range fluctuating between 24 and 32°C. Optimum reproduction occurs at around 30°C. It does not reproduce below 16-17°C or above 33°C.

*R. similis* is a migratory endoparasitic nematode which completes its life-cycle in 20-25 days in the root and corm tissues (Figure 1). Juveniles and adult females are active mobile forms which may leave the roots in case of adverse conditions. Migratory stages in the soil can easily invade new roots. This species has a pronounced sexual dimorphism in which males present an atrophied stylet and are considered to be non-parasitic. Nematode penetration occurs by preference near the root apex, but *R. similis* can invade any portion of the root length. As the nematode migrates inter and intracellularly, it feeds on the cytoplasm of cortex cells, collapsing cell walls, and although it can penetrate young stelar tissues. (Figure 1). Juveniles and adult females are active mobile forms which may leave the roots in case of adverse conditions. Migratory stages in cultivation. The distribution of this nematode species is mainly due to the soil can easily invade new roots. This species has a pronounced fitness in plant tissues. Some African populations are more pathogenic than populations from the West Indies, Sri Lanka or Queensland (Australia). In the Caribbean-Central America zone, three pathotypes have been characterized, based on their respective pathogenicity, reproduction rate, host preference (ABB-banana types, plantains or others) and caryotype. A pathotype from Puerto Rico is a more severe pathogen on plantains than on other bananas and has 5 chromosome pairs, in contrast to the central American types that prevail on Cavendish bananas, which possess only 4 chromosome pairs. More recently, African populations of *R. similis* have been found to have both 4 and 5 chromosome pairs, although the latter is less common. Enzymatic (PGI) and DNA (RAPD) analyses have revealed two genomic groups which are not related to pathogenicity. The distribution of these genomic groups all over the world appears to be linked to historical contingencies of planting material spread.

Damage depends also on the pathogenicity of the nematode population which varies greatly between production zones. Pathogenicity of populations appears to be linked to their reproductive fitness in plant tissues. Some African populations are more pathogenic than populations from the West Indies, Sri Lanka or Queensland (Australia). In the Caribbean-Central America zone, three pathotypes have been characterized, based on their respective pathogenicity, reproduction rate, host preference (ABB-banana types, plantains or others) and caryotype. A pathotype from Puerto Rico is a more severe pathogen on plantains than on other bananas and has 5 chromosome pairs, in contrast to the central American types that prevail on Cavendish bananas, which possess only 4 chromosome pairs. More recently, African populations of *R. similis* have been found to have both 4 and 5 chromosome pairs, although the latter is less common. Enzymatic (PGI) and DNA (RAPD) analyses have revealed two genomic groups which are not related to pathogenicity. The distribution of these genomic groups all over the world appears to be linked to historical contingencies of planting material spread.

Reducing nematode populations in the soil before planting and the use of cleansed or nematode-free planting material are of primary importance in the control of *R. similis*. Nematode populations may be reduced to an undetectable level by a one-year fallow with non-host plants, such as *Chromolaena odorata* (Asteraceae) which is very effective in Africa. Six-seven weeks of complete flooding can be as effective as 10-12 months of fallow in reducing nematode populations.
replanted rapidly. Paring followed by hot water treatments (52-55°C)

Once introduced, eradication of such as parts of Central America. In the same way, any measure can also be achieved by dipping plant material in a nematicide solution (2 500 ppm) for 30 minutes. The technique known as “pralinage” is a significant improvement over dipping. This involves the use of a nematicidal mud mixture which permits instantaneous coating of the plant. It is recommended to use either bentonite (15 kg in 100 l of water + 400-500 g of active ingredient) or a natural clay (proportion of clay to be mixed with water must be adapted).

The best way to avoid recontamination of nematode-free soil is to use nematode-free plants propagated through in vitro techniques. This is now one of the most common sources of planting material in many producing regions and should be the only method allowed for the introduction of banana plant material into virgin land. Once introduced, eradication of R. similis from the soil is virtually impossible and populations will build-up more or less rapidly after planting. Yield losses may be reduced through propping or guying of pseudostems to avoid toppling. Improved drainage is also an important factor in reducing nematode damage in high rainfall areas, such as parts of Central America. In the same way, any measure which improves fertility and root development may increase plant tolerance to nematodes. Such measures include soil preparation before planting, incorporation of organic matter in the soil, fertilization and irrigation.

Chemical control is currently the most common method of controlling nematode populations. Nematicides are generally non-volatile organophosphates or carbamates, which are applied as granules on the soil surface around the mat. Emulsifiable compounds are applied as liquid sprays or through irrigation systems (e.g. in Canary islands). The optimum application time, dose and frequency are determined by nematicide efficiency, environmental conditions, as well as pathogenicity of local nematode strains and population dynamics. In most production areas, nematicide applications vary between 2 to 3 g of active ingredient per mat and 2-3 applications per year. To avoid problems of enhanced biodegradation induced by repetitive use of the same nematicide, alternation with different compounds is recommended. Although nematicides are generally effective in controlling nematodes and are easy to use, they are expensive, highly toxic and may have a negative impact on the environment.

Several research teams are now collaborating with the breeding programmes of FHIA in Honduras and CIRAD-FLHOR in Guadeloupe as well as with INIBAP in developing cultivar resistance. Pisang Jari Buaya (AA) diploid cultivar types have long been identified as a source of resistance to R. similis. This resistance has been incorporated into the parental lines used in the breeding of improved hybrids and is the source of resistance found in Goldfinger (FHIA-01). Recently, a source of resistance to R. similis has also been detected in several different genome groups, such as AAA - Yangambi Km S and some acuminata and balbisiana wild and cultivated diploids. A method for the early screening of germplasm has been developed. This allows the rapid elimination of the most susceptible genotypes from the screening programme. Only the most interesting germplasm is retained for subsequent field trials, thus reducing the size and expense of the final evaluation. It should be noted that the differences in pathogenicity among populations of R. similis will further complicate efforts in plant breeding and selection against this pest, especially in the ability to obtain broad resistance useful for all production areas. The best approach is to evaluate potentially resistant banana varieties against local pathogenic forms of the nematode in each ecological production zone through coherent regional research networks. Trials have already been established in Uganda and Nigeria (IITA), Cameroon (CRBP), Honduras (FHIA), Martinique and Guadeloupe (CIRAD-FLHOR) and Australia (QDPI).

Your help is needed. INIBAP is encouraging studies on genomic and pathogenic diversity of R. similis to improve integrated control strategies (e.g. crop rotation, fallow, resistance, chemical control) adapted to certain regions. This work will also help to determine the geographic origin of the burrowing nematode and, therefore, additional sources of resistance and possibly natural enemies. You can help by sending root samples infested with R. similis to Jean-Louis Sarah (Laboratoire de nématologie, CIRAD-FLHOR, B.P. 5035, 34032 Montpellier Cedex 01, France - e-mail: sarah@cirad.fr). Root samples must be shaken to remove excess soil but not washed, put into closed plastic bags and send by express mail. Details on collection date, location, cultivar and cultural practices must be included.