

 **O.16 - An agroecological approach to alleviate the impact of plant-parasitic nematodes in banana cropping systems**

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Abstract

For many decades, control of plant-parasitic nematodes and in particular of the worldwide species *Radopholus similis* was mainly based on chemical nematicides not fully safe for the environment and human health. In order to develop more environmentally friendly control strategies, we started to develop in the French West Indies an innovative and modular approach based on integrated crop protection. The two first levels of this approach were conceived to promote prophylaxis in banana agrosystems. They were devoted to soil and plant sanitation. The third and more recent level, which is presented here, also integrates additional prophylactic measures to prevent the spread, in time or space, of parasitic nematodes. It thus includes the assessment of alternative management of nematode-infested crop residues along with use of prophylactic ditches to lessen spatial dissemination of the nematode *R. similis*. However, this third level of modules is above all built to strengthen our strategy through an ecological intensification of the banana agrosystems. It includes the alleviation of biological soil constraints such as plant-parasitic nematodes by the manipulation of the above-ground diversity (vegetal cover). Our current strategy is to introduce in banana agrosystems nematode-resistant cover plants as associated crops, thus achieving multispecific cropping systems that will be further evaluated to understand whether they become more diversified and less prone to parasitic nematodes. We are now testing the association of bananas with the deep-rooting perennial soybean *Neonotonia wightii*. This work is complemented by studies assessing the possibility of also having recourse to nemato-toxic plants such as *Crotalaria* spp. Finally, we assign a module of the third level to the diagnostics of the soil condition, using nematode community structure. This necessary step will help to assess the ecological impact of (current and upcoming) cropping practices. Results from an ongoing study on the structure of nematode communities in banana agrosystems, varying by their level of anthropisation, are introduced.

Banana cropping systems have long been considered as detrimental for the environment because of the high amounts of fertilisers and pesticides they relied on. Among these, chemical nematicides have been used intensively to control communities of endoparasitic nematodes that induce toppling of banana trees, and depreciate water and mineral uptake, thus inducing delayed harvests and small bunches. The worldwide burrowing nematode *Radopholus similis* (Tylenchida, Pratylenchidae) often occupies a key place within these banana root-feeding nematode communities (Gowen and Quénehervé, 1990).

In order to promote cropping strategies allowing a substantial reduction in the use of pesticides, our Research Unit initiated during the last years in the French West Indies, an innovative integrated crop protection strategy for banana cropping systems. This strategy relies on a technological package that is made of three levels of inter-connected modules (Risède et al., 2007). i/ The basal level encompasses existing modules (techniques) designed to promote soil and plant sanitation. It includes the use of healthy vitroplantlets, improved fallows to cleanse the soil from *R. similis*, biotests to monitor the progress of soil *cleansing* towards *R. similis* in commercial banana plots, and the selection of *R. similis* non-host rotational crops. When combined in the framework of restrictive laws for the use of phytosanitary chemicals, these modules proved to be very efficient, thus allowing reaching in the last decade a reduction of sixty per cent in chemical nematicide use in banana farms. ii/ the second level aggregates non-adjusted modules designed to complete the first level by focusing more on the sanitation of the vegetal cover. It includes the identification of *R. similis*-tolerant Cavendish bananas,

the selection of banana hybrids resistant to this nematode species, and the use of predictive models (for Pratylenchidae populations, banana trees populations,). The third and last level we are currently implementing is the one we are going to present here. Also integrating further prophylactic adjustments, it adds an additional dimension to our strategy to reach an ecological intensification of the banana agrosystems.

Three modules constitute this third level. The first one is aimed at further completing prophylaxis by: i/ studying how alternative management of nematode-infested crop residues, i.e. deep burying or removal of these residues, could lessen *R. similis* populations, by the same way reducing the duration of fallowing. ii/Undertaking studies on the survival of *R. similis* in soils and water, in order to gain a better understanding of the spatial dissemination of this nematode, by leaching or runoff waters at the field scale (Chabrier, 2008). This work proved that that this nematode was able to survive several months in the soil without its host plant, and furthermore it was able to survive in water during many weeks. An interesting output of these results is that runoff water can disseminate this nematode thus allowing a quick recontamination of banana plots yet sanitized by fallowing. Consequently, we tested ditches to prevent nematodes from spreading by runoff water. They proved to constitute a simple but powerful means to restrict *R. similis* within banana farms, thus delivering an additional tool to integrate in an overall control strategy of this nematode.

The second module developed at the third level has as the chief objective to alleviate the biological soil constraints by the manipulation of the aboveground diversity (vegetal cover). We are now testing the reintroduction of nematode-resistant cover plants in banana agrosystems, not as rotational crops, but like associated crops. Our final goal is the achievement of multispecific cropping systems, that will be further evaluated to understand whether they are more diversified and less prone to soilborne pathogens, and in particular to endoparasitic nematodes. The model on which we are currently working is the association of bananas with the deep rooting perennial soybean *Neonotonia wightii*, but other ones will also be tested. We are also currently investigating the possibility to benefit from allelopathy effects in these innovative cropping systems. In preliminary in-vitro and in-vivo studies, we evaluated the effects of aqueous extracts of nemato-toxic plants on *R. similis*. *In vitro*, leaf extracts of the legume *Crotalaria* spp. induced a reversible paralysis of the nematode suggesting a true possibility they interact with the biological life cycle of the nematode. In greenhouse studies, *R. similis* inoculum treated by the same aqueous extracts was not able to develop inside banana roots as much than untreated inoculum. These on-going results will be further precised by studying the relationships between doses of aqueous extracts and intensity of the observed biological effects, along with the effects of aqueous extracts obtained from different organs of *Crotalaria* spp, mainly leaves, roots and seeds.

The last module of the third level deals with soil health in banana agrosystems. It is designed to diagnose the soil condition using nematode community structure, thus giving the opportunity to evaluate the ecological impacts of cropping practices and land management. This is a necessary step, seeing that innovative practices should not alter soil ecological processes but, at the contrary, enhance them. An on-going study indicated that in intensified banana cropping systems, length of the soil food web is strongly reduced. In particular, the abundance and frequency of omnivore and predator nematode communities are highly restricted in these situations, while the nematode community is more mature and dominated by omnivore and predator nematodes as well in poorly intensified banana agrosystems as in the ones not using chemical nematicides.

References

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