Appraisal facilities and new practices in banana growing

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I shall present here the results of the first work performed by a CIRAD and IRD pluridisciplinary team working in both Martinique and Guadeloupe.

First, a rapid reminder of the context in which we work. Banana in the West Indies is an intensive crop grown in fragile, densely populated island environments. The population density in Martinique is a little more than 400 persons per km^2, and the figure is a little lower in Guadeloupe, which means that the impact of the crop on the environment must be controlled, especially as tourism is one of the three main resources of the two islands. In addition, as we have seen this morning, the downstream requirements of the industry are changing. Demand for healthy fruits with no pesticide residues is becoming stronger.

Erosion and pollution by pesticides and fertilisers

We first wished to perform an appraisal of the impact of present cultural practices on the environment in terms of erosion (conservation of the environment and the landscape) and water pollution by pesticides and fertilisers. We concentrated above all on nematicides, for two reasons. Firstly, the substances used to control nematodes are particularly toxic (difference in toxicity factor of 1 to 1 000 between nematicides and fungicides) and, secondly, nematicides form slightly less than half of the tonnage of agricultural chemicals used in both Martinique and Guadeloupe.

Making an appraisal is one thing, but then solutions must be proposed. We have been working on this for a very long time within the framework of either the reduction of production costs or the effects on the environment. We have also performed a number of actions to improve cropping systems with a view on the one hand to ensure satisfactory incomes for growers and on the other to limit the effects on the environment.

Our appraisal work has focused on three types of measure corresponding to two scales. The first is the micro-plot. For reasons of a change in dilution or, on the contrary, in concentration, it is absolutely essential to work both on micro-plots to understand the phenomena and on large areas in order to master what happens under real conditions. What tools are used? Runoff test plots adapted to micro-plots are used to measure soil losses (measurement of erosion) and to draw up runoff balances. The runoff test plot principle consists of isolating a 200 m^2 field with steel sheet and collecting water using a sediment trap (a concrete tank fitted with dividers). Percolation water (water going deep into the soil) is tested with wick lisimeters (cones with fibreglass wicks to collect water at a given depth). We worked at a depth of 80 cm. The water crosses a depth of soil and is recovered. It is very similar to drainage water and is collected before it reaches the drains, that is to say before oblique runoff and horizontal transport. We use a tool referred to as gauge threshold for study on a large scale. It is currently used everywhere in France by both the DDASS (*directions des affaires sanitaires et sociales*) and the DIREN (*directions régionales de l'environnement*). It consists of a reservoir used for collecting water samples to establish contamination kinetics and to measure water flow (the outfall is set in such a way that the depth in the reservoir is proportional to flow). Other factors are studied, of course, to explain the results: the measurement of different meteorological conditions, study of surface states and study of the soil parameters affecting water dynamics (density, porosity, etc.). The facilities are completed by perfectly calibrated rainfall simulations on 1-m^2 areas.

The first results concerning erosion are as follows. The rainfall depth required to cause runoff in a perennial banana plantation is extremely high. Several factors can account for this: the substantial layer of leaf litter (covering about 70% of the ground) and the canopy distribution that governs flow. The runoff water contains less than 1% suspended matter and the soils are very stable and rain-resistant. Soil losses are negligible when the soil is covered with leaf litter. To give a figure, during the last six months of

1999 we measured 6 kg of soil losses. This figure should be compared with the tonne lost during the same period from bare earth. However, there is a real risk of erosion while a banana plantation is being established, that is to say during the first year. I remind you that a banana plantation lasts for between four and seven years, depending on local conditions.

Other results concern water contamination by nematicides. We determined each contamination peak in one to three rainfalls depending on product application. This depends on the number of rainfall events in a period of three to five weeks following the spraying of chemicals. It was found that almost all exports of substances took place during these periods. In addition, exports were negligible in comparison with the amounts applied. They were measured in milligrams per hectare whereas we applied kilograms per hectare. In the case of aldicarb, we applied a little less than 4 kg/ha and 6 kg/ha of terbufos and cadusafos respectively. The peaks contain not only the initial active substances but also the immediate breakdown products whose toxicity is high. For aldicarb, we measure not only the aldicarb itself but also the sulphur oxide and sulphone derivatives.

The results for other cases of percolation vary considerably according to the substance studied. We have a cadusafos residue emergence and decrease profile that is fairly comparable in percolation water and runoff water. In contrast, the results for aldicarb are extremely different, with nearly 10 times more in percolation water than in runoff water. These differences are explained on the one hand by the intrinsic characteristics of the products—especially solubility—and also by questions of affinity for clays. The conclusion of this type of study is that the management of water contamination risks should be adapted to the chemicals used. The management of a substance like terbufos or cadusafos is not at all the same as that of carbamates. A number of cultural practices can be used to master and prevent environmental pollution. These practices require knowledge of the environment.

Rational cultural practices

The other way of limiting damage to the environment caused by cropping is the implementation of integrated control of nematodes and banana borers. The rational approach varies considerably according to water and erosion dynamics. It is reminded that soils and topographical conditions vary considerably in Martinique and Guadeloupe. Water, erosion and pesticide dynamics are not the same in a vertisol and an andosol. Possible development proposals vary:

- perimeter canals to channel streams that cross the banana plantation and risk dissolving pollutants;
- grassed strips and protected perimeters are well-known techniques following work on the decontamination of maize soils contaminated by herbicides. This is based on the fact that bananas grown on the banks of watercourses risk causing much greater pollution than plants grown 10 metres away from the water;
- reconversion of risk zones. There are cases in which there is risk of not succeeding in the management of pollution risks. This includes for example low-lying zones close to water courses or springs. In some cases, there is a risk of having to change the use of the zones and stop growing bananas. Other development operations should of course be envisaged case by case.

Nematode control requires the rational use of active substances. CIRAD-FLHOR has progressively developed a cropping system for about ten years. It is based on the use of clean plant material in clean soil. The basis is the organisation of fallow, crop rotation and replanting with tissue culture plants. One of the problems that we have experienced in Martinique in recent years is the extremely variable effectiveness of fallows. A number of studies have been performed to improve the effective fallow ratio. Various research has been performed on the chemical destruction of banana plantations. Using a herbicide to destroy a banana plantation in order to economise nematicide treatments may seem curious. The reason is very simple. When chemical destruction is effective, it saves two or three nematicide treatments in the next banana plantation, and chemical destruction is practically without risk for consumers. The control of nematode populations is much better than with traditional destruction of plantations with machines. The second point on which we are now working is the elimination of nematode reservoir plants. The species *Radopholus similis* does not only attack banana. Many other species can be hosts, and especially a large number of Gramineae and Solanaceae. Possible rotation crops like sugar cane, pineapple, temporary prairie, etc. can be mentioned.

The banana borer is a serious soil pest in the French West Indies and Africa. The search for integrated methods for borer control is based on the search for effective substances that are little or not pollutant, that are not only chemical but also biological (work is being carried out on entomopathogens). Finally, integrated control using pheromone traps has recently been developed by several teams, with CIRAD participation, and mass trapping has been used as the main method in case of weak to medium infestation. This technique has given fairly good results in Costa Rica and in weakly infested zones in Martinique. We are planning in the medium-term to use these traps in biological control. Instead of placing soapy water in traps to kill borers, we are going to use an entomopathogen to cause epidemics in borer populations.

In conclusion, the methods currently used are aimed at gaining knowledge of and appraising the risks in order to allow growers to adjust their production sequence and to use the developments best suited to their situation or, more precisely, developments suited to the individual field since conditions can be very different even between different fields on the same plantation. The final objective is of course that of the greatest possible reduction of the use of agricultural chemicals and especially nematicides. I shall conclude on an optimistic note. In Martinique, we performed 2.1 nematicide treatments per year in 1996 and the nematicide market had decreased by more than a third in 1999 ■

Questions / Answers

Jean-Yves Sommier, French Secretariat of State for Overseas Affairs

It is true that excellent work has been done. We should now see how this can be used in the field. In metropolitan France, a structure—the CORPEN—exists to provide advice as far as the farmer. Are there any contacts with this structure?

Christian Chabrier

It is true that the CORPEN does not intervene directly in Martinique and Guadeloupe. This does not prevent the various stakeholders in the sub-sector (government departments and planters) from operating in synergy in this kind of project. The organisation and the water gauge reservoir system are handled jointly with the DDASS and the DIREN, quite simply because they are extremely expensive. I would like to remind you that an analysis of a nematicide costs around 700 francs. So when you are looking for three or four different substances, the figure very soon reaches 2 000 or 3 000 francs per analysis. If this is multiplied by 365 days, you get an idea of the annual cost of monitoring a small reservoir. It is clear that only team work can put such costly studies to good use. What is done in metropolitan France is not always easily transposed to Martinique. The water pollution problems in the west of France are essentially related to distribution (runoff). It is mainly contaminated runoff that must be managed. In our case, the problem concerns underground water. We are concerned with poorly known mechanisms, such as the distribution of underground water in the West Indies. We also lack much information on the results of the effects of scale. We are beginning to accumulate information on a small scale. A whole series of effects about which we know little for the moment lies between examination of pollution 80 cm from a banana plant and the situation at a spring downstream. The project is young. All this work only started two years ago.

I believe that it was a surprise for the Ministry of the Environment to see that we have a fairly accurate idea of what is happening in the banana profession, because all those involved in the industry—both suppliers of chemicals and banana groups— agreed to work in close co-operation.

Hervé Loir, Banalliance, Martinique

You have mentioned borer traps, fallow and tissue culture plants, which are techniques that are well mastered in the West Indies. However, what is the situation with regard to root analyses, especially for nematodes? Are these techniques part of CTE (*land use contracts)* or rational farming techniques?

Christian Chabrier

This is something that is not new. Planters have used nematological analysis for 15 or 20 years. One cannot therefore really talk in terms of new techniques. This is part of the features that enable the precise monitoring of nematode populations and hence enable the rational use of nematicides.

Jean Harzig, L'Echo

Do you have a preliminary economic approach to the procedure and techniques mentioned

Christian Chabrier

Not for the moment, for a simple reason: the project is too young. We are still testing solutions. It is too soon to know whether the technique is profitable or not. But this is indeed the next phase ■