the symptoms (Jones 1994). For this reason, it is recommended that plants should be kept in quarantine for 9 to 12 months. Diagnosis of BSV is also difficult because a number of strains are heterogeneous from the serological and genetic point of view.

It is important to continue research on the distribution of this new disease, to identify the BSV races in Colombia and also to determine the pathogenicity of the different isolates or races, the *Musa* germplasm that possesses resistance or tolerance to the disease, the effect of the virus on plantain and sugar cane production and finally the other host plant species and the vectors involved in the spread of the disease.

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Latin America

Strategies for the improvement of banana growing in Cuba

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Bananas and plantains are grown in approximately 120 countries, with total production of approximately 75 x 10^6 tonnes of fruits, most of which are grown by 56 of these countries. Nine-tenths of production is an important food resource for more than 400 million inhabitants of tropical countries and the rest is exported to industrialised countries. Approximately a third of the fruits are plantains and the rest are dessert bananas. Some 50 percent of the world plantain crop is grown in Africa, 25 percent in South America, 15 percent in Asia and 10 percent in Central America (Swennen 1995). Bananas are rich in carbohydrate, vitamins C, B and A and minerals such as potassium and calcium.

In the past two decades, banana and plantain production has been seriously threatened on the one hand by pathogens and on the other by population growth preventing long fallow periods and thus causing decreased soil fertility (Rodríguez 1994).

Black Sigatoka (*Mycosphaerella fijiensis* Morelet) is generally considered to be the major cause of falling yields of both plantain and dessert banana (Ortíz *et al.* 1995, Mobambo *et al.* 1993, Craemer & Ortíz 1995). The variability of the reaction observed in tetraploid progeny of plantain suggests that black Sigatoka could be controlled by the use of recessive genes.

The banana borer *Cosmopolites sordidus* Germar is of Indo-Malaysian origin and widespread in the tropics. The pest affects both plantain and banana crops by weakening the corms and causing toppling. The borer, combined with nematodes that also cause serious damage to roots, reduces nutrient absorption and transport, causing decreased plant growth that in particular affects fruit filling.

The causes of the decrease in yields are thus complex. In addition to those listed above, it should be mentioned that banana plants may topple fairly easily under certain field conditions, for example when growth of the root system is hindered or when bunch weight increases. Although the latter feature enhances productivity, it also increases the risk of stem breakage, not to speak of the tendency for the corm to develop closer to the surface of the ground in certain economically important clones.

When the positive and negative points of banana and plantain growing are examined, it seems essential for Cuba to set up a genetic improvement programme which, combined with ecologically sustainable and appropriate technology would make it possible to seek solutions to these problems in the various existing cropping systems.

Plantain and banana in Cuba

Plantains and dessert bananas traditionally form a large part of the Cuban diet and were an important feature in exports to the United States in the last decades of the nineteenth century (Balmaseda 1886). This commercial activity began to decrease with the appearance of banana wilt (*Fusarium oxysporum* f. sp. *cubense*) and then exports stopped in 1950 when the foreign companies abandoned the banana plantations. The companies transferred their capital to Central America where soil and climate are much more favourable than in Cuba (Alvarez 1993).

Banana and plantain growing was extensive until the 1960s; minimum inputs were used and the crop suffered from inadequate irrigation systems and techniques. The situation began to improve in 1971 with the introduction of new intensive cropping concepts that made it possible to attain a yield of 100 tonnes per hectare of Cavendish group clones in some irrigated areas with advanced techniques and micro-nozzles.

Plantains (AAB group) were not in the same situation as dessert bananas and although satisfactory yields were achieved (up to 17 to 20 tonnes per ha) in some years in the 1970s and until the mid-1980s, black Sigatoka, nematodes and borers among other factors caused a marked decrease in yields to the extent that this type of fruit practically disappeared from the market, remaining only in very limited small production zones. The introduction by *Instituto de Investigaciones en Viandas Tropicales* (INIVIT) of cultivars of the Bluggoe type (ABB group) made it possible to compensate to a certain degree for the absence of plantains. However, because of Cuban eating habits, solutions should be sought to re-launch production. INIVIT has developed several lines of research for this:

1. the setting up of agrotechnical measures to achieve economically profitable yields, in spite of certain limiting factors for production;
2. control of limiting factors such as black Sigatoka, banana borer and nematodes. INIVIT has developed a technological procedure giving yields of up to 17 tonnes per ha with the clone 'CEMSA 3/4' (plantain) without the need to apply fungicide to control black Sigatoka;
3. the establishment of a genetic improvement programme using traditional methods (hybridization, selection, etc.) and associated techniques to obtain as rapidly as possible banana and plantain clones that possess the characteristics sought by growers.

Objectives of the *Musa* improvement programme

The targets of the Cuban programme for improving *Musa* are as follows:

1. to characterise the *Musa* germplasm available in Cuba using INIBAP/IPGRI descriptors, i.e. 300 accessions today;
2. to continue research at national and international level;
3. to ensure the field and *in vitro* gene bank conservation;
4. to increase genetic variability, giving priority to advanced diploids and AAB clones;
5. to give priority to obtaining more productive plantain clones with useful characters of resistance to black Sigatoka and Moko disease (*Pseudomonas solanacearum*) and also resistance or tolerance to banana borer and nematodes;
6. to obtain more productive banana clones with export characteristics and resistance or tolerance to the main pests and diseases (black and yellow Sigatoka, borers, wilt, nematodes and Moko disease);
7. to develop banana and plantain clones that are tolerant to stress conditions (drought, soil salinity, etc.);
8. to work on existing hybrids and clones and on new plant material to obtain new, small plants with a straight habit and a cylindrical pseudostem to make them wind-resistant and, in the case of plantain, an alternative for rotation with potato in a single cycle using existing irrigation systems (Fregat, Kubam, etc.);
9. to continue research on the biological control of diseases and pests (nematodes and borers);
10. to continue research on the Cavendish group using genetic engineering techniques and/or obtaining mutants with the aim of producing new plants with resistance to black Sigatoka while conserving their export qualities.

Strategies to be used to attain the objectives set

1. Characterization of germplasm using morphological data, biochemical methods and new biotechnology techniques.
2. Definition of the productivity potential, fruit quality and resistance to pests and diseases of the clones in the national gene bank.
3. Establishment of a hybridization programme using the clones in the national gene bank and the germ-plasm introduced through the INIBAP Transit Centre (ITC) at Catholic University of Leuven (KUL) in Belgium.
4. Evaluation of improved hybrids and those of commercial interest made available within the framework of international tests (International *Musa* Testing Programme, IMTP).
5. Introduction of IITA improved hybrids and EMBRAPA germplasm through ITC.
6. Induction of mutations using physical and chemical methods on explants from various sources.
7. Breeding tetraploid material.
8. Performing studies on genotype/environment interactions with a view to the regionalization of clones.

General considerations

The overall programme strategy is designed in the light of the objectives chosen and the complexity of the characters to be improved. For this reason, the results are planned for the short, medium and long term. Developing mass micropropagation techniques and the close links between researchers and growers are favourable for the rapid multiplication of new clones and their use in production. This will facilitate the relocation of production zones in a relatively short time. These techniques are a definite advantage when they are used well, but can be dangerous when this is not the case. Although it is certain that improvement considered as positive can be spread rapidly, it is also true that an unsuitable change can follow the same path. The procedures must therefore be accurate and reliable. ■

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