XVI REUNIÓN INTERNACIONAL ACORBAT 2004

OAXACA, MÉXICO

26 de Septiembre al 1 de Octubre del 2004

September 26 to October 1, 2004

EDITORES

Mario Orozco-Santos

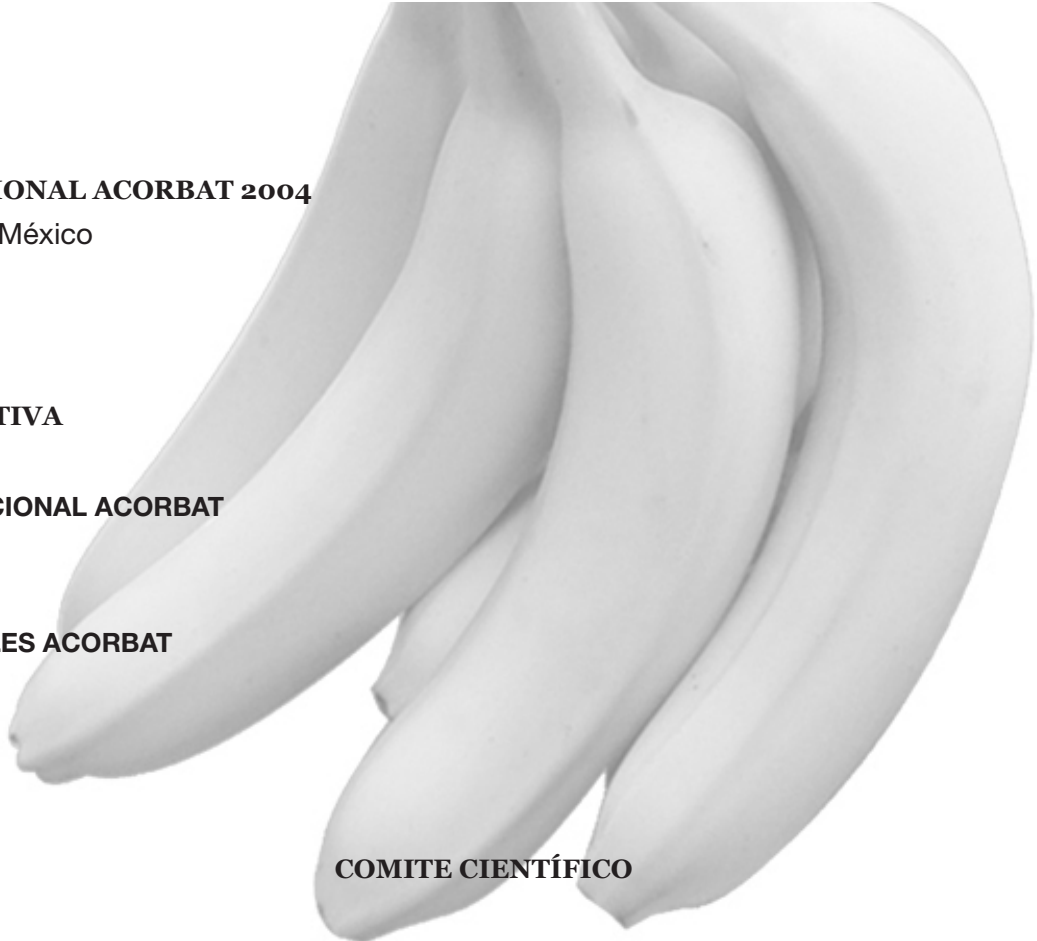
José Orozco-Romero

Manuel Robles-González

Joaquín Velázquez-Monreal

Victor Medina-Urrutia

Jesús Alberto Hernández Bautista



XVI REUNION INTERNACIONAL ACORBAT 2004
Oaxaca de Juárez, Oaxaca; México

ESTRUCTURA ORGANIZATIVA

REPRESENTANTE INTERNACIONAL ACORBAT
Ing. Guzmán Carroz Chacín

ASESORES INTERNACIONALES ACORBAT
Dr. Ramiro Jaramillo Celis
Dr. Franklin Rosales E.

COMITÉ ORGANIZADOR

Humberto Pérez Morales
Presidente

Rafael Lara Villar
Vicepresidente

Gabriel Cue Sacre
Coordinación de Logística

Ing. Roberto Moreno Sada
Coordinación Financiera

C.P. Mario García Rodríguez
Coordinación Operativa

M.C. José Orozco Romero
M.C. Mario Orozco Santos
Coordinación Académica

Seferino Santos Pérez
Ignacio Gutiérrez Moreno
Coordinación actividades sociales

Roberto López Molina
Coordinador de Promocion y Divulgación

COMITE CIENTÍFICO

M.C. José Orozco Romero
Presidente

M.C. Mario Orozco Santos
Dr. Silvio Belalcazar Carvajal
M.C. Ulises Díaz Zorrilla
Ing. Jesús Alberto Hernández Bautista
M.C. Luis Carrasco Rey
M.C. Manuel Robles González
Dr. Joaquín Velásquez Monreal
M.C. Víctor Medina Urrutia
M.C. Ricardo José Zapata Altamirano
M.C. Arturo Vizcaíno Guardado
Dr. Octavio Pérez Zamora
M.C. Aarón Morfin Valencia

IMPACT AND MANAGEMENT OF BLACK SIGATOKA IN BRAZIL

Zilton José Maciel Cordeiro[11]; Aristoteles Pires De Matos[1]; Sebastião De Oliveira E Silva[1]; Luadir Gasparotto[2]; Maria De Jesus Barbosa Cavalcante[3]

ABSTRACT

The black Sigatoka disease of the banana crop, caused by *Mycosphaerella fijiensis* Morelet, anamorph *Paracercospora fijiensis* (Morelet) Deighton, was first reported in Brazil in 1998, in the State of Amazonas. Currently that disease is widespread all over the North Region of Brazil (except in the State of Tocantins), as well as in the states of Mato Grosso (Center West Region) and São Paulo (South East Region). The presence of black Sigatoka in Brazil resulted in serious problems to the commercialization of fruit and plants of the *Musaceae* botanical family, due to restrictions to movement of those products from affected regions to areas still free of the pathogen, aiming at preventing its spread. In areas where the disease is already present yield losses may be as high as 100%. Such a situation requested the replacement of the banana varieties under cultivation by black Sigatoka resistant varieties. On this regard, the State of Amazonas played a very important role replacing the susceptible cultivars for Caipira, Thap Maeo, FHIA-18 e Pacovan Ken, all of them resistant to the pathogen. Data on spore survival under several conditions, epidemiological studies, chemical and cultural control strategies of the disease, and genetic resistance, were also generated by researchers. All this knowledge made possible to recommend six black Sigatoka resistant varieties. The recent detection of black Sigatoka in banana growing areas of the State of São Paulo will probably determine a new phase on its banana industry, since it is the State number one on banana production and consumption, as well as the main importer from other banana growing areas of Brazil.

RESUMEN

La Sigatoka-negra, enfermedad de las bananas, causada por el hongo *Mycosphaerella fijiensis* Morelet/*Paracercospora fijiensis* (Morelet) Deighton, ha sido detectada en Brasil, en 1998 en la provincia de Amazonia. Hoy, la enfermedad, se encuentra presente en todos las provincias de la región Nordeste (a excepción del Tocantins), en el Mato Grosso y en la provincia de São Paulo. La presencia de esta enfermedad en el territorio Brasileño tiene provocado cambios en la comercialización de la fruta. Entre estos cambios, están la prohibición de transferencia del producto para provincias que no han sido afectados por la enfermedad y la reglamentación en el transito de frutos e plantas de la familia de las musaceas, con el objetivo de no diseminar el patógeno. Donde está presente la enfermedad, las pérdidas de productividad llegan hasta el 100%. Esta situación ha igualmente causado cambios en las variedades cultivadas, donde, la provincia do de Amazonas tiene actuado de manera más efectiva, de manera que los nuevos campos de siembra son en su mayoría de las variedades Caipira, Thap Maeo, Fhia 18 y Pacovan Ken, todas resistentes a la Sigatoka negra. En la investigación también se han desarrollados estudios, generando informaciones a cerca de la supervivencia de las esporas del hongo en diversas superficies, de la epidemiología y control químico de la enfermedad, el manejo técnico y principalmente sobre variedades resistentes, llegando a la recomendación de seis variedades resistentes a dicha enfermedad. La presencia de la enfermedad en São Paulo, debe determinar una nueva etapa, donde será necesario convivir de manera racional con la enfermedad, visto que es una provinvia de gran importancia, tanto como productor y, consumidor, así como es un gran importador de esta fruta de distintas provincias de la Federación.

INTRODUCTION

The banana is a crop grown all over Brazil. The States of São Paulo, Bahia, Pará, Santa Catarina, Minas Gerais, Pernambuco and Ceará are the most important banana producers in that country (IBGE, 2004). In 2002 those States were responsible for 62% of the banana harvested area and for 71% of total production. Besides showing the highest banana production area in Brazil, the State of São Paulo also shows the highest yield. Being cultivated all over Brazil, the banana crop is responsible for the generation of jobs and income for thousands of brazilian people, thus playing an important role on keeping the banana growers activities. Another characteristics of the banana crop is its ability to be harvested all over the year assuring food and income for those who are engaged on its production. In Brazil there are about 600,000 rural properties devoted to the

[1]Embrapa Cassava & Fruits, Caixa Postal 007, CEP 44380-000 – Cruz das Almas, Bahia, Brasil, zilton@cnpmf.embrapa.br
[2]Embrapa Western Amazon, Rodovia AM-010, Km 25 Estrada Manaus/Itacoatira, CEP 69011-970 – Manaus, Amazonas, Brasil
[3]Embrapa Acre, Rodovia BR 364, Km 14, CEP 69901-180 – Rio Branco, Acre, Brasil

banana production, 60% of them with an area corresponding to 2 to 50 hectares (IBGE, 2004a). Considering the current banana growing area in Brazil, that is about 520,000 ha and the estimated number of orchards (600.000), it is possible to assume that the average banana growing area per grower in that country is less than one hectare. Although these are estimated data, they do show the importance of the small grower on the brazilian banana production.

Among the several diseases that affect the banana crop all over the world, the black Sigatoka is considered the most important, being highly aggressive on susceptible varieties, specially under conducive environmental conditions, such as the combination of high relative humidity with and favorable temperature. Under such conditions, yield losses of susceptible cultivars can be as high as 100%. Black Sigatoka was first reported on bananas in the Fiji Island, in 1963, under the denomination of black leaf streak. In 1972 this disease was reported in Honduras being named black Sigatoka. This disease was first detected in Brazil in 1998 (Cordeiro et al., 1998) following its spread throughout the Latin America.

The objective of this study is to describe the impacts resulting from the incidence of black Sigatoka in Brazil, to report its spread in the country, and the actions developed towards its control.

MATERIAL AND METHODS

Since the first detection of black Sigatoka in Brazil, works related to control strategies have been performed for several research institutes at both nation and state levels. Regulatory actions include legal measures performed by the Secretariat of Sanitary Defense, Brazilian Ministry of Agriculture, and Sanitary Defense Agencies of each state, aiming at ruling the commercialization of fruits from affected areas and the movement of planting material as well. Other actions include training of human resources, diffusion of information related to the disease and implementation of several research activities in order to give technical support to the legal restriction measures.

RESULTS AND DISCUSSION

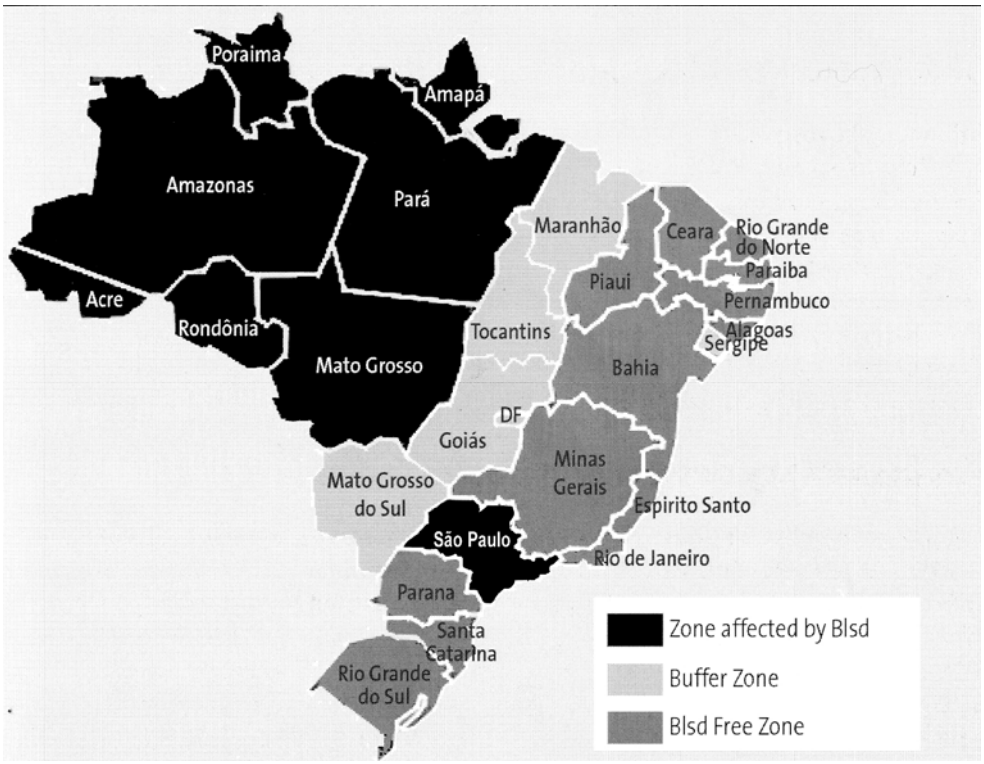
Spread of black Sigatoka in Brazil

As mentioned elsewhere, the black Sigatoka disease was first detected in Brazil in 1998 in the Municipalities of Tabatinga and Benjamim Constant, State of Amazonas, brazilian border with Colombia and Peru (Pereira et al., 1998; Cordeiro et al., 1998). It is thought that the source of inoculum was transported through the Solimões river, the main way of transport in that region, making also possible its dissemination very rapidly during the year 1998, reaching banana growing areas close to Manaus, the capital of the State of Amazonas, located about 1,500 km way from the place were the disease was first detected. By the end of 1998, the disease was found in the State of Acre, probably coming from Bolivia. In 1999, black Sigatoka was detected in the States of Rondônia and Mato Grosso. Following its spread in the North Region of Brazil the disease reached the States of Pará, Roraima and Amapá, where it was detected in the year 2000. The fast movement of black Sigatoka from the North Region to the Center West Region of Brazil (State of Mato Grosso) suggested that in short period of time that disease would probably affect all the other banana growing states but that did not happen. In the State of Mato Grosso its was possible to establish pathogen free areas based on diagnostic surveys and disease monitoring. The apparent control on the dissemination of the black Sigatoka was probably due to both the implementation of legal actions by the sanitary defense agencies not allowing the transportation of banana fruits from affected areas to disease free regions, and the occurrence of natural barriers such as long dryness periods unfavorable to the disease development, the geographic isolation of the banana orchards, and the prevalence of extensive areas planted with soybeans, corn and cotton in regions affected by the disease. Despite that period of apparent control of the pathogen dissemination, in July 2004 black Sigatoka was detected in the main banana growing region of São Paulo, the State number one in banana production in Brazil. The occurrence of that disease in São Paulo, open up perspectives to expect a more rapid dissemination of the pathogen, due to the intense traffic from and to that state, and the prevalence of a more intensive banana industry, thus constituting a very important concern to sanitary officials, specialists and banana growers from regions still free of that disease.

Figure 1 shows the current situation of black Sigatoka in Brazil: the black area corresponds to the states already affected by the disease. The states in light gray color are considered as a “buffer zone” established by the Secretariat of Sanitary Defense, Brazilian Ministry of Agriculture, where priority actions have been implemented

in order to retard, as much as possible, the dissemination of black Sigatoka in Brazil. The banana growing states still free of that disease are represented by the dark gray color.

Figure 1. Brazilian map showing the states affected by the black Sigatoka disease (black), the proposed buffer zone (light gray) the disease free states (dark gray). Cruz das Almas, Bahia, Brazil, 2004



ACTIONS TO CONTROL BLACK SIGATOKA IN BRAZIL

Quarantine restriction measures

Black Sigatoka is a disease under quarantine restrictions in Brazil, where it is classified as an A2 disease, what means that it continues under control of the Secretariat of Sanitary Defense, Brazilian Ministry of Agriculture. Additionally, the sanitary defense agencies of each state also implement control actions in the border, and inside the state as well, aiming at preventing the disease introduction. There are official regulatory rules to be applied national wide, but each state can establish their own criteria that give support to specific actions without overcoming the official national regulations. The sanitary defense agencies of each state have been acting on public information of the problem and, specially on inspection of the commercialization of banana fruits and movement of *Musaceae* plant parts. Since black Sigatoka is a disease under quarantine regulation, its detection in a given state will prohibit fruit export to states still free of the disease, in attention to official regulations. At present brazilian states that are still free of black Sigatoka are requesting a “permit for transportation of banana plant material” in order to allow the entrance of banana fruits and planting material; other restriction measures are: boxes made of wood, used for transportation of banana fruits, are not allowed do be brought back to states where black Sigatoka has not been detected yet; and it is not permitted the transportation of banana leaves in vehicles loaded with any kind of goods.

Generation of knowledge and information about the pathogen

Restriction measures put in place when a disease under quarantine restrictions, such as black Sigatoka, is introduced in a given area usually result in non satisfaction by the growers due to the generation of economics and social problems. Banana growers, professionals of the banana retail market, and extension workers believe that being black Sigatoka a leaf disease it is not reasonable to prohibit banana fruit movement from affected area to regions still free of that disease. Such a situation gave rise to lots of pressure from most of the sectors related to the banana industry, and specially from the politicians. In fact, there were no scientific results to support those restriction measures. To overcome that situation, researches were planned to study *M. fijiensis* conidial survivability on the surface of several materials/tissues such as wood, plastic, cotton, pasteboard, tire,

iron, banana leaves and fruits (Hanada et al., 2002), all of them thought to be able to transport and to disseminate *M. fijiensis* conidia to long distance. Results showed that the conidia of *M. fijiensis* remained viable up to 60 days on the surface of banana leaves and cotton tissue; up to 30 days on the surface of pasteboard, wood, plastic and tire; up to 18 days on the surface of banana fruits; and up to 10 days on iron. The studies were conducted under three environments: 1 – under controlled conditions with temperature varying from 17.8°C to 20.1°C, and relative humidity from 40% to 50%; 2 – under laboratory conditions, temperature varying from 23,6°C to 29,8°C, and relative humidity from 55% to 75%; and 3 – packinghouse conditions, where the temperature varied from 22,2°C to 30,9°C, and the relative humidity from 60% to 92%. Results obtained were similar in all three environmental conditions evaluated.

Studies related to "in vitro" culture of *M. fijiensis* under laboratory conditions showed that potato-dextrose-agar (PDA) and V8$CaCO_3$-agar were the culture media that enabled better sporulation of the pathogen after 15 days of incubation, being 10 days under dark followed by 5 days under continuous light (Hanada et al., 2002a). The *M*. *fijiensis* condial survivability on the surface of several tissues/materials, as mentioned elsewhere, and the observation that banana fruits of the cultivar Prata Anã from growing areas heavily affected by black Sigatoka may transport up to 11,000 spores of the pathogen on its surface (Hanada et al., 2004), showed the necessity to evaluate chemical compounds in order to select those able to eradicate the spores present on several surfaces. On this regard, Hanada et al. (2004) observed that compounds such as quaternary ammonium, benomyl, ecolife-40 and thyabendazole at 100mg/L completely inhibited spore germination. Similar results were observed when those compounds were used at 100mg/L or 200 mg/L either as immersion treatment or sprayed on banana fruits harvested in orchard affected by black Sigatoka.

RECOMMENDATION OF RESISTANT VARIETIES

In the past 5 years the banana breeding program of *Embrapa Cassava* & *Fruits* have recommended, either in cooperation with other research institutes or by itself, several new banana cultivars, that show resistance to the main phytosanitary constraints as described bellow:

'Caipira', known all over the world as 'Yangambi km 5', is a dessert variety of banana, belonging to the AAA genomic group, that shows medium to tall plant height, and small and very sweet fruits. 'Caipira' was selected based on evaluations performed in several banana growing areas in Brazil where it showed very strong vegetative vigor, resistance to black Sigatoka, to yellow Sigatoka and to Fusarium wilt (Panama disease), showing also resistance to the rhizome weevil as expressed by low infestation levels of that pest.

'Thap Maeo', Introduced from Thailand, is a variety that belong to the AAB genomic group and very similar to the Mysore cultivar, differing from it because 'Thap Maeo' does not show infection by the viruses common in 'Mysore'. 'Thap Maeo' shows medium to tall height, small fruits, resistance to yellow and black Sigatoka and to Fusarium wilt; it also shows low infestation level by the rhizome weevil and nematodes. A very important characteristic of this cultivar is its rusticity expressed on low fertility soils where its average yield is around 25 ton/ha/year. Grown on soil with appropriated fertility the Thap Maeo's average yield may be as high as 35 ton/ha/year.

The variety FHIA-18 is a hybrid obtained from crossings involving the cultivar Prata Anã (AAB). FHIA-18 shows medium height, fruits very similar to those of 'Prata Anã', but with a sweeter taste. It was introduced from the Fundación Hondureña de Investigación Agricola, evaluated in several banana growing areas and selected because of its desirable characteristics. FHIA-18 is a tetraploid hybrid that belongs to the AAAB genomic group having as the main important characteristic its resistance to black Sigatoka, the most serious banana disease.

Pacovan Ken (PV42-68) is a tetraploid hybrid, AAAB genomic group, that shows tall plant height. This banana hybrid was obtained at the *Embrapa Cassava* & *Fruits*, Cruz das Almas, Bahia, Brazil from crossings between the cultivar Pacovan (AAB) and the diploid hybrid (AA) M53. 'Pacovan Ken' shows number and size of fruits, as well as yield higher than those of 'Pacovan', its female parental. Additionally, the fruits of this new cultivar are sweeter than those of 'Pacovan' and show resistance to finger detachment similar to that cultivar. Besides being resistant to black Sigatoka, 'Pacovan Ken', also express resistance to yellow Sigatoka and to Fusarium wilt.

'Preciosa' (PV42-85), similar to 'Pacovan Ken', is a tetraploid hybrid, AAAB genomic group, that shows tall plant height. This banana hybrid was obtained at *Embrapa Cassava* & *Fruits*, Cruz das Almas, Bahia, Brazil from crossings between the cultivar Pacovan (AAB) and the diploid hybrid (AA) M53. This new cultivar is rustic, tall, with fruits larger and sweeter than those of 'Pacovan', and showing resistance to finger detachment similar to its female parental. Besides expressing resistance to black Sigatoka, 'Preciosa' also shows resistance to yellow

Sigatoka and to Fusarium wilt. This variety was initially recommended to be planted in the State of Acre where black Sigatoka is the most serious banana phytosanitary constraint.

Maravilha (FHIA-01) is a tetraploid hybrid, AAAB genomic group, generated from the crossing 'Prata Anã' (AAB) x SH 3142 (AA). This variety was introduced from the Fundación Hondureña de Investigación Agricola, evaluated in several banana growing areas in Brazil and selected to be planted in the Rio Branco banana growing region, State of Acre. 'Maravilha' shows medium height, fruits and yield larger than those of 'Prata Anã', pulp with a little acid taste, and expresses resistance to black Sigatoka and to Fusarium wilt.

DISEASE MANAGEMENT; CULTURAL CONTROL

In order to enable the banana cultivation in black Sigatoka affected regions in Brazil, the first step adopted was to replace the susceptible cultivars for resistant ones. The occurrence of that disease in areas, such as the Amazon Region, where the banana crop, despite having a high social significance, has little economic importance, made possible the implementation of that strategy. On this regard, states located in the North Region of Brazil, such as the Amazonas, played a very important role in the technology transfer and adoption of banana cultivars resistant to black Sigatoka, specially during the years following the detection of that disease in Brazil. Up to year 2002, a total of 2,384,053 banana tissue culture plantlets were commercialized in areas affected by black Sigatoka, with Caipira, Thap Meo and FHIA 18 constituting the most commercialized varieties (Cordeiro & Matos, 2003). In general, the propagate planting material was bought by official state agencies and provided to the banana growers. At present, fruits of those varieties are a commonly found in local markets of the North Region. Its is also very common the participation of banana growers in the news, talking about their positive experiences on the cultivation of black Sigatoka resistant banana varieties.

Besides growing resistant varieties, research bas also been conducted aiming at studying black Sigatoka management in orchard planted with susceptible varieties. Plant densities varying from 1,111 to 2,500 plants/ha of the plantain variety D' Angola (AAB), were evaluated in experimental plots exposed to the sun light in comparison with plots, 1,111plants/ha, planted under shade conditions. It was observed that the plots planted with the density of 2,500 plants/ha, showed positive and significant differences regarding to the number of functional leaves at flowering and at harvest, and significantly lower disease severity. There was no significant difference relative to bunch weight but due to the higher plant density, there was significant increase in the yield. The plots cultivated under shade conditions showed significantly lower disease severity, larger number of functional leaves at flowering and at harvest, and bigger bunch weight in comparison with the other treatments (Cavalcante, et al., 2004). These results creates an expectation that the shaded banana cultivation system, due to its environmentally sustainable characteristics, will probably evolve towards the agroforestry system, a new production system currently under use in the Amazon Region.

Trials were also set to evaluate the effect of fungicides on the control of black Sigatoka in the State of Amazonas, in order to generate information possible to be incorporated to banana production systems that use higher levels of technology. Thus, Gasparotto et al. (2003), evaluated several fungicides and concluded that mancozeb, 1,500g/ha; trifloxistrobin, 75g/ha; tebuconazole, 100mL/ha; propiconazole, 100mL/ha; difenoconazole, 100mL/ha; imibenconazole, 150g/ha; thiophanate-methyl, 350mL/ha; bitertanol, 125g/ha and ecolife, 1L/ha, were effective against the pathogen. Under the tropical humid climate, characteristics of the Amazon Region, the number of sprays to control black Sigatoka was 26 when using systemic fungicides and 52 for contact fungicides. As an alternative control measure it was evaluated the effect of fungicide application at the junction area of the leaf number two with the pseudostem of the banana plant (Gasparotto et al. 2003a). That work enabled the conclusion that flutriafol applications, 2 mL commercial product per plant (0,375 g a.i./plant), at 60 days interval, is efficient to control black Sigatoka. This control technique, although showing some difficulty to be performed, has the advantage to promote more efficient control of the disease, requires a smaller number of fungicide application, can be adopted by small growers, and reduces environmental contamination since the compound is applied directly to the banana plant, there is no derive, do not require the mixing with either water or spray oil, and strongly reduces risk of human contamination. In Brazil that technique may be of great interest of banana growers of regions where the banana crop is cultivated under irrigated conditions because there are legal restrictions that must be observed in order to put in place aerial spray to control black Sigatoka in those areas.

IMPACTS DUE TO BLACK SIGATOKA INCIDENCE

The detection of black Sigatoka in the State of Amazonas in 1998, caused a very strong concern to the sanitary defense agencies. Initial actions constitute the search for information about the disease and the pathogen itself, followed by the implementation of several training activities and inspections, in order to understand the rapid

dissemination of the disease all over the North Region of Brazil (except in the State of Tocantins), reaching the State of Mato Grosso, located in the Center West Region. Legal actions prohibiting the movement of fruits from affected areas to the disease free States resulted in disagreements, discussion and lots of pressure from politicians. An example of such a situation is the fact that part of the State of Mato Grosso was recognized as black Sigatoka free area.

The higher impact, that may be considered a positive one, happened in the State of Amazonas, where black Sigatoka susceptible varieties have been progressively replaced by resistant ones as mentioned elsewhere in this paper. Yield losses about 100% of the Pome type varieties and about 70% of the Terra type of plantain due to the incidence of black Sigatoka gave support to that change. Other positive aspect that supported that change was the fact that *Embrapa* recommended resistant varieties immediately after the disease was first detected in that region. That action caused a strong positive impact to the banana growers and the society in general.

In the past five years, black Sigatoka seemed to have its movement paralyzed in the State of Mato Grosso. Such observation, some how, promoted a kind of slowing down in putting in place restriction measures regarding to that problem. The recent detection of black Sigatoka in the State of São Paulo, in, June, 2004, brought back the importance of that disease to the brazilian banana industry, since São Paulo is the most important banana growing state in Brazil, devoted specially to the Cavendish subgroup. The prevalence of Cavendish type of banana in São Paulo will probably lead to problems related to the replacement of the susceptible varieties since black Sigatoka resistant varieties belonging to the Cavendish subgroup are not available. The socioeconomic impact of the presence of black Sigatoka in the State of São Paulo has not been completely established but, since the state is prohibited to send banana fruits to other brazilian states still free of that disease, there is a strong uncertainty among the growers who have in the banana crop their main economic activity. It is important to mention that the black Sigatoka affected area in the State of São Paulo is located in the "Vale do Ribeira" where there are around 40,000 ha planted with bananas. The fact of the "Vale do Ribeira" to be a region under environmental preservation, constitutes a point to be considered since there are regulations for the implementation of chemical control.

Additionally, there is strong concern of the other banana growing states located in the vicinities of São Paulo because the risk of having their banana orchards infected by *M. fijiensis* increased significantly.

BIBLIOGRAPHY

CAVALCANTE, M. de J. B.; LEDO, A. da S.; GONDIM, T. M. de S.; COSTA, F. H. S.; FERREIRA, J. B.; AZEVEDO, de F. F.; CORDEIRO, Z. J. M. e MATOS A. P. de. 2004. Evaluation de cv. Angola under different management systems. IN: 1st International Congress on Musa Harnessing research to improve livelihoods, 6-9 July, Penang, Malaysia, p. 164-165. (Abstract Guide).

CORDEIRO, Z. J. M.; MATOS, A. P. de; SILVA S. de O. e. 1998. Black Sigatoka confirmed in Brazil. Infomusa , Montpellier, França, v. 7, n. 1, p. 31.

CORDEIRO, Z. J. M.; MATOS, A. P. de. 2003. Impact of *Mycosphaerella* spp. in Brazil. IN: JACOME, L.; LEPROIVRE, P.; MARIN, D.; ORTIZ, R.; ROMERO, R. and ESCALANT, J. V. (editors), *Mycosphaerella* leaf spot diseases of bananas: present status and outlook. Proceedings of the 2nd International Workshop on Mycosphaerella leaf spot diseases, San José, Costa Rica, 20-23 may 2002. P. 91-97.

GASPAROTTO, L.; SANTOS, A. J. T.; PEREIRA, J. C. R.; PEREIRA, M. C. N. 2003. Sigatoka-negra: situação atual e avanços obtidos. IN: MATOS, A. P. de & MEISSNER FILHO, P. E. Anais do V Simpósio Brasileiro sobre Bananicultura e I Workshop do genoma Musa, Paracatu. P. 28 – 34.

GASPAROTTO, L.; SANTOS, A. J. T.; PEREIRA, J. C. R.; PEREIRA, M. C. N. 2003a. Flutriafol no controle da Sigatoka negra da bananeira. Fitopatologia Brasileira, v. 28 (suplemento), p. s312.

HANADA, R. E.; GASPAROTTO, L. e PEREIRA J. C. R. 2002. Sobrevivência de conídios de *Mycosphaerella fijiensis* em diferentes materiais. Fitopatologia Brasileira, v. 27, p. 408-411.

HANADA, R. E.; GASPAROTTO, L. e PEREIRA J. C. R. 2002a. Esporulação de *Mycosphaerella fijiensis* em diferentes meios de cultura. Fitopatologia Brasileira, v. 27, p. 170 - 173.

HANADA, R. E.; GASPAROTTO, L. e PEREIRA J. C. R. 2004. Eficiência de desinfestantes na erradicação de conídios de *Mycosphaerella fijiensis* aderidos à superfície de bananas. Fitopatologia Brasileira, v. 29, p. 094 – 096.

IBGE - Instituto Brasileiro de Geografia e Estatística, *Produção Agrícola Municipal*. Disponível em :<http://www.sidra.ibge.gov.br>. Acesso em: 19 mar. 2004.

IBGE - Instituto Brasileiro de Geografia e Estatística. Censo Agropecuário 1996. Disponível em: <http://www.sidra.ibge.gov.br/cgi-bin/prtabl>. Acesso em: 19 mar. 2004a.

PEREIRA, J. C. R.; GASPAROTTO, L.; COELHO, A. F. S.; URBEN, A. 1998. Ocorrência da Sigatoka-negra no Brasil. Fitopatologia Brasileira, v. 23, p. 295. (abastract).