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## **Pest risk assessment made by France on Banana streak virus (BSV) considered by France as harmful in French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion - Scientific Opinion of the Panel on Plant Health**

R. Baker, D. Caffier, J.W. Choiseul, P. de Clercq, E. Dormannsne-Simon, B. Gerowitt, O.E. Karadjova, G. Lövei, A. Oude Lansink, David Makowski, et al.

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**Pest risk assessment made by France on *Banana streak virus* (BSV) considered by France as harmful in French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion<sup>1</sup>**

**Scientific Opinion of the Panel on Plant Health**

(Question No EFSA-Q-2006-109)

**Adopted on 12 March 2008**

**PANEL MEMBERS**

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**SUMMARY**

Following a request from the European Commission, the Panel on Plant Health was asked to deliver a scientific opinion on 30 pest risk assessments made by France on organisms which are considered by France as harmful in four French overseas departments, i.e. French Guiana, Guadeloupe, Martinique and Réunion. In particular, the Panel was asked whether these organisms can be considered as harmful organisms for the endangered area of the above departments, in the meaning of the definition mentioned in Article 2.1.(e) of Directive 2000/29/EC and thus potentially eligible for addition to the list of harmful organisms in Directive 2000/29/EC.

This document presents the opinion of the Panel on Plant Health on the full<sup>2</sup> pest risk assessment conducted by France on *Banana streak virus* (BSV) with French Guiana, Guadeloupe, Martinique and Réunion considered as endangered area.

BSV is a virus in the genus *Badnavirus*, family *Caulimoviridae*, which infects banana and plantain. *Banana streak virus* is no longer the name for a unique virus since several distinct species, in what is now a BSV-complex, have recently been identified. In this document BSV covers all known species and strains in the BSV-complex.

The Panel examined in detail the risk assessment and considered the accuracy and quality of the information provided and methods applied for pest risk assessment purposes. The review was based on the principles of the International Standard on Phytosanitary Measures ISPM No.

<sup>1</sup> For citation purposes: Scientific Opinion of the Panel on Plant Health on a request from the European Commission on Pest risk assessment made by France on *Banana streak virus* (BSV) considered by France as harmful in French overseas departments of French Guiana, Guadeloupe, Martinique and Réunion. *The EFSA Journal* (2008) 667, 1-24

<sup>2</sup> The full pest risk assessments have been made according to the Guidelines for the European and Mediterranean Plant Protection Organisation (EPPO) pest risk assessment scheme in EPPO Standard PM 5/3 (1) (EPPO Bulletin 27, 281-305).

11<sup>3</sup>: Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms (2004) by the International Plant Protection Convention (FAO, 2007b).

Although the information provided in the French risk assessment required updating with additional information available since the assessment was carried out, the Panel agrees that BSV, now recognised as a species complex of banana streak viruses, is a serious pathogen of banana, and poses a potential risk to banana production in the French overseas departments.

The French document concludes that the phytosanitary risk associated with BSV is extremely high particularly due to the risk of activated virus pathogens in the *M. balbisiana* genome during import or production of vitroplants. However, analytical methods for virus indexing developed since the French assessment, now enable detection of the endogenous nature (of BSV) in the *Musa balbisiana* genome. In addition, the Panel considers the phytosanitary risk overrated.

The Panel agrees that BSV has a high probability of entry and a high probability of establishment in the French overseas departments, in the absence of existing controls. It agrees that the international movement of large quantities of vitroplants represents the most important entry pathway. The Panel further considers that virus indexing of mother plants used for vitroplant production provides an effective means to prevent entry of BSV.

Uncertainties are noted particularly regarding the role of mealybug vectors in BSV transmission and dissemination of the disease, and on the potential economic impact of BSV in the PRA area<sup>4</sup>. However, the Panel regards BSV as a serious pathogen of banana and the economic impact of the disease increasing with the percentage of BSV occurring in the field. Hence in the absence of virus indexing, the importation of large quantities of BSV-infected vitroplants is likely to have a serious economic impact especially for Guadeloupe and Martinique, where banana production represents a very significant proportion of agricultural activities.

The overall conclusion of the Panel is that BSV is appropriate for analysis of risk management options and is thus potentially eligible for addition to the list of harmful organisms of Directive 2000/29/EC.

**Key words:** *Banana streak virus*, BSV, EPRV genome activation, French Guiana, Guadeloupe, Martinique, *Musa balbisiana* B genome, pest risk assessment, potential harmful organism, Réunion, vitroplants

<sup>3</sup> ISPM: International Standard for Phytosanitary Measures. ISPM No. 11: Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms.

<sup>4</sup> PRA area is the area in relation to which a Pest Risk Analysis is conducted [FAO, 2007a].

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## BACKGROUND AS PROVIDED BY THE EUROPEAN COMMISSION<sup>5</sup>

The current Community plant health regime is established by Council Directive 2000/29/EC on protective measures against the introduction into the Community of organisms harmful to plants or plant products and against their spread within the Community (OJ L169, 10.7.2000, p. 1), as last amended by Commission Directive 2006/35/EC (OJ L88, 25.3.2006, p. 9).

The Directive lays down, amongst others, the technical phytosanitary provisions to be met by plants and plant products and the control checks to be carried out at the place of origin on plants and plant products destined for the EC or moved within the EC, the list of harmful organisms whose introduction into or spread within the EC is prohibited and the control measures to be carried out at the outer border of the EC on arrival of plants and plant products. A harmful organism is defined in its Article 2.1.(e) as: any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products.

However, the provisions of the Directive are at present not yet applicable to trade in plants and plant products between the French overseas departments and the remainder of the Community. In view of the special nature of the agricultural production of the French overseas departments, additional protective measures justified on grounds of the protection of health and life of plants and plant products therein should be given.

France has therefore prepared for 4 departments (Guadeloupe, Guyana, Martinique and Réunion) 130 pest risk analyses (PRA) on organisms which are considered by France as harmful for the most important crops grown in these departments, such as banana, sugar cane, pine apple, rice, coffee, orchids, Palmae, etc. These PRAs cover a wide range of harmful organisms, such as insects and mites (54), fungi (14), bacteria (20) and virus (42).

In accordance with the discussions on this topic in the meeting of the Standing Committee on Plant Health on 27 and 28 April 2006, it was agreed that in a first phase France would select 30 PRAs among the 130 PRAs initially transmitted. They cover harmful organisms (insects, mites, fungi, bacteria and virus) affecting citrus fruit and bananas grown in the above departments.

Two types of PRA have been made: a full PRA for harmful organisms for which the probability of introduction into the French overseas departments is high with economic important crops and a simplified PRA for organisms for which the probability of introduction is extremely low.

The full PRAs have been made according to the Guidelines for the European and Mediterranean Plant Protection Organisation (EPPO) pest risk assessment scheme in EPPO Standard PM 5/3 (1) (EPPO Bulletin 27, 281-305). This scheme aims at assessing the potential risk of a particular pest (or harmful organism) for a clearly defined area through a quantitative evaluation of that risk based on questions to which replies are given on a 1-9 scale. Expert judgement is used in interpreting the replies. Moreover for each of the 130 harmful organisms a data sheet containing the most important data on the organism has been made according to the EPPO Standard PM 5/1 (1) on Checklist of information required for PRA (EPPO Bulletin 23, 191-198). The guidelines are based on many years experience of EPPO experts in the EPPO Panel on PRA and the EPPO Panel on phytosanitary measures. They conform with the International Standards on Phytosanitary Measures (ISPM) No 11 (Guidelines on PRA for quarantine pests) and use the terms of ISPM No 5 (Glossary of phytosanitary terms).

The simplified PRAs contain in a “synthetic fiche” the information available allowing the assessment of the risk associated with the relevant organism.

<sup>5</sup> Submitted by the European Commission, ref. SANCO E/1/VE/svi D(2006)510488

**TERMS OF REFERENCE AS PROVIDED BY THE EUROPEAN COMMISSION**

EFSA is requested, pursuant to Article 29(1) and Article 22(5) of Regulation (EC) No 178/2002, to provide a scientific opinion on 30 PRAs made by France on organisms which are considered by France as harmful in 4 French overseas departments, i.e. Guadeloupe, French Guiana, Martinique and Reunion, and in particular whether these organisms can be considered as harmful organisms for the endangered area of the above departments in the meaning of the definition mentioned in Article 2.1.(e) of Directive 2000/29/EC and thus potentially eligible for addition to the list of harmful organisms in Directive 2000/29/EC.

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## ASSESSMENT

### 1. Introduction

This document presents the opinion of the Panel on Plant Health on the pest risk assessment conducted by France on *Banana streak virus* (BSV) with French Guiana, Guadeloupe, Martinique and Réunion considered as endangered area.

#### 1.1. General introduction to *Banana streak virus* (BSV)

BSV is a plant virus with a circular double stranded c. 7.4 kbp DNA genome encapsidated in bacilliform particles. BSV can cause a serious disease of banana, affecting plant growth, fruit yield and quality. Symptoms of BSV infections are mostly expressed on leaves and consist of chlorotic streaks that eventually turn necrotic. Very severe symptoms, with dark blotches on pseudostem and midribs, splitting of outer leaf sheaths, twisted leaves, severely malformed fingers, aberrant bunch emergence and reduced bunch sizes have also been described (Gauhl and Pasberg-Gauhl, 1994). Some infected plants have been reported to die as a result of splitting of the pseudostem at ground level (Lockhart and Jones, 2000). Leaf symptoms of BSV in banana can be transient. Symptom expression is often followed by an asymptomatic phase.

Although the disease was first described in 1958 from Côte d'Ivoire (Lassoudière, 1974), the viral aetiology of the disease was only elucidated by Lockhart in 1986 with the identification and characterisation of this hitherto unknown virus in 'Dwarf Cavendish' (AAA genome) grown in southern Morocco. Prior to this description, the banana streak disease was regarded as a type of banana mosaic disease attributed to a strain of *Cucumber mosaic virus*. The virus has been found in many banana cultivars and, to date, the disease is reported from nearly all countries where banana is grown.

BSV can also be found integrated into the banana genome. Many of those integrations consist of non-functional, partial BSV sequences and occur in the A genome derived from *M. acuminata* and the B genome derived from *M. balbisana*. Complete BSV genomes are also found in banana but only in cultivars with B genomes. Under specific conditions during the process of *in vitro* propagation, complete integrated sequences can be activated to form fully functional infectious viruses.

#### 1.2. The document under scrutiny

The assessment of risks of the organism is presented by the French risk assessors in a "full" pest risk assessment made according to the Guidelines for the European and Mediterranean Plant Protection Organisation (EPPO) pest risk assessment scheme [EPPO Standard PM 5/3 (1) of the EPPO Bulletin 27, 281-305].

Based on this document France requested *Banana streak virus* (BSV) be added to the list of harmful organisms in Directive 2000/29/EC.

#### 1.3. Evaluation procedure

The Panel examined in detail the documents provided, and considered the accuracy and quality of the information and methods applied for pest risk assessment purposes. The review was based on the principles of the International Standard on Phytosanitary Measures ISPM No. 11:



Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms (2004) by the International Plant Protection Convention (FAO, 2007b).

The evaluation of the French document was conducted on the basis of an English translation from an original submission in French, which remains the reference language.

Detailed comments have been made only for the questions where it was considered that the French assessment is incorrect or could be improved. Where the Panel has uncovered new information that supports the pest risk assessment, this has been noted. While the literature has been checked and additional data has been sought, no new analysis has been undertaken. The Panel has noted where it considers the risk scores provided by France were too low or too high.

#### **1.4. General comments on the document**

The document comprises 26 pages and is divided into two parts:

- Part I provides background information required for the assessment
- Part II contains the assessment of the risks posed by the organism.

The document includes 11 references. Many statements made in the document are neither substantiated by references nor supported by verifiable data. In some areas references are incorrectly cited and interpreted.

The document was compiled in 2003 and, therefore, new information was reviewed and updated where relevant to the risk assessment. Many issues have not been dealt with in detail, despite the availability of relevant information at the time of conducting the original assessment.

#### **1.5. Methodology applied for the risk assessment**

The Panel considered the methodology used in the risk assessment provided in Part 2 of the document and concluded that:

- The document does not take into account the new situation in the pest risk assessment area in the absence of the current regulations.
- The probabilities of entry, establishment and spread and the potential impacts (economic, social, environmental) of the pathogen in the pest risk assessment area have not been clearly outlined for each of the French overseas departments to take account of their specific characteristics related to their geographic location and the differing importance of the host plants in each region.
- Probabilities of entry and establishment, introduction, impacts and an overall risk rating are expressed both in qualitative terms such as “low” “moderate” “high” and semi-quantitatively score of 1-9 etc. However, the numeric and descriptive ratings used in the document are not explained, and thus do not allow for accurate interpretation.
- A number of estimates provided in Part 2 (Pest Risk Assessment) cannot be justified or substantiated by the information provided in Part 1 of the document.
- The method of combining risk ratings and ascribing an overall risk rating is not defined and assumes equal weighting to the questions.



## 2. Evaluation of the pest risk assessment

### 2.1. Pest categorization

#### 2.1.1. Identity of pest

The French document identifies BSV as a species of the genus *Badnavirus*. In more recent diversity studies (Geering *et al.*, 2000; Geering *et al.*, 2005b; Harper *et al.*, 2005) BSV isolates from geographically diverse origins were fully analysed and are now recognised as distinct virus species. The banana streak virus complex to date comprises the species *Banana streak GF virus* (BSGFV), the *Banana streak Mysore virus* (BSMysV) (Geering *et al.*, 2005b) and the *Banana streak OL virus* (BSOLV). As new sequence data on BSV become available, more BSV species are being described (Lheureux *et al.*, 2007). For clarity, the Panel uses the abbreviation BSV when referring to all virus species causing streak disease of banana and sharing similar biological and molecular characteristics.

The banana streak viruses are members of the genus *Badnavirus* in the family *Caulimoviridae*. These plant viruses have circular dsDNA genomes, utilise a reverse transcription step for replication and as pararetroviruses, can integrate into the host plant genome. As stated in the French document, integrated BSV sequences that can recombine to form fully functional viruses with all characteristics of the wild type virus can be found incorporated into the genome of banana cultivars carrying the B genome originating from the wild banana species *M. balbisiana* (Harper *et al.*, 1999; Ndowora *et al.*, 1999). Those complete viral integrations are called endogenous pararetrovirus (EPRV). Incomplete BSV sequences are also frequently found in the banana genome but these cannot give rise to episomal virus particles (Geering *et al.*, 2001). Those non-infectious integrated viral sequences are diverse and known for the genomes of *M. acuminata*, *M. balbisiana* and *M. schizocarpa*. They are called endogenous banana viruses (Lafleur *et al.*, 1996; Geering *et al.*, 2005a) and have no known function.

BSV is related to *Sugarcane bacilliform virus* (SCBV) with a number of isolates showing serological reactions with this virus (Lockhart and Olszewski, 1993). SCBV has a broader host range and since its mealybug vector, *Saccharicoccus sacchari*, can infest banana, banana streak disease is occasionally found to be caused by SCBV (Jaufeerally-Fakim *et al.*, 2006). While few incidences of SCBV infections of banana have been reported, these findings highlight the need to adequately identify and discriminate BSV from SCBV, which is a different virus species.

#### Methods for detection

After a review of the available literature (Lockhart, 1986; Dahal *et al.*, 1998a; Dahal *et al.*, 1998b; Lockhart and Jones, 2000; Harper *et al.*, 2004), the Panel concluded that symptom expression cannot be directly assigned to a virus isolate, host genotype or climatic condition. Plants often do not show symptoms for a number of months before temperature changes provoke a symptomatic phase (Lockhart, 1995; Dahal *et al.*, 1998b). The Panel agrees that the often obscure symptom expression and the uneven BSV distribution makes a diagnosis based on foliar symptoms very unreliable (Jones and Lockhart, 1993). Thus symptoms on plants cannot be used to determine the identity of the species of BSV pathogen. It further acknowledges that detection and distinction between episomal and integrated forms of the virus are a crucial aspect in indexing for BSV. In the French document, considerable difficulties in BSV detection are stated. However, the Panel acknowledges that with current knowledge and a combination of tests, a reliable detection of BSV and discrimination of integrated virus sequences from episomal virus can be achieved.

The French document states that EM examination of semi-purified BSV preparations from infected leaves, with or without serological capture using a specific BSV antiserum, is the most effective method for BSV detection in banana. PCR techniques with capturing BSV particles using an antiserum (immuno-capture PCR) and PCR using degenerate primers to cover a broad spectrum of BSV variants, strains and species are also used for virus detection. However, because of genome integrated BSV, PCR alone is sometimes difficult to undertake and interpret.

The Panel reviewed the current status on BSV detection (Thottappilly *et al.*, 1997; Harper *et al.*, 1998; Ndowora *et al.*, 1999; Geering *et al.*, 2000; Lheureux *et al.*, 2003; Harper *et al.*, 2004; Jaufeerally-Fakim *et al.*, 2006) and concludes that with a series of serological and molecular approaches, all forms of BSV can be reliably detected.

The Panel stresses that there remains a degree of uncertainty in virus diagnosis due to the high variability of the BSV species complex (Jaufeerally-Fakim *et al.*, 2006; Lheureux *et al.*, 2007). However, whilst acknowledging that the presence of BSV cannot be detected on the basis of visual symptoms, the Panel does not agree with the statement in the document that suggests that there is difficulty in distinguishing healthy and infected material since the application of combined procedures and/or consecutive re-testing, permits a reliable detection of BSV in banana.

### 2.1.2. Presence or absence in PRA area

The French document states that BSV is not endemic in the overseas departments, but indicates the presence of the Mysore strain linked to the cultivation of the banana cultivar 'Mysore' in Guadeloupe. The Panel notes that this statement in the French document is not substantiated by a reference or further information. However, it does indicate that BSMysV was present in Guadeloupe in 2002.

BSV occurs in bred banana hybrids in Guadeloupe. Lheureux *et al.* (2003) provide experimental evidence for BSV infected banana resulting from breeding experiments with F1 hybrid populations from inter-specific crosses between virus-free *M. acuminata* and *M. balbisiana* derived-parents. Activated BSOLV caused disease in 139 from 249 rooted plantlets. When BSOLV infected banana plants were grown in the open field in Guadeloupe and observed for 2 years, field spread was not observed.

Recent evidence of natural occurrence of BSOLV, BSGFV and BSMysV in Guadeloupe was presented by Pèrèfarres *et al.* (2007) using an assay for the sole detection of episomal viruses. All three BSV virus species were found with high prevalence in plantain (AAB genome) grown in home gardens and small plots for local consumption, while the occurrence of BSV in Cavendish cultivars (AAA genome) grown on plantations for the export industry was negligible.

The French document also states the presence of BSV in Réunion, with supporting reference not provided. BSV was unequivocally detected in Réunion on plants 'Petite Nain' from the Cavendish subgroup showing symptoms of banana streak disease (Lavigne, 2000). In Réunion the proportion of diseased plants varied from 20-50% with farmers not relating symptoms to the presence of a disease. Spread of the disease was not related to an insect vector since scale insects were absent on banana.

BSV has not been reported from French Guiana nor from Martinique. Given the wide geographic distribution of BSV (Lockhart and Jones, 2000) uncertainty exists whether the virus is absent in these French overseas departments.

### 2.1.3. Regulatory status

BSV is listed in Annex II of the current regulations of the French overseas departments that comprises organisms that may not be introduced if present in certain plants of plant products. Exemptions are for banana in vitro cultures that may be brought into the French overseas departments subject to one year quarantine subject to virological indexing for a number of viruses including BSV.

For the French overseas departments the French document states that BSV is regulated in Annex II B comprising organisms that may not be introduced if present in certain plants or plant products. This comprises roots or underground plant parts, plantlets, seedlings, foliage, leaves etc. For Réunion, this decree extends to true seeds of species in the family Musaceae.

BSV is subject to mandatory and permanent control in Guadeloupe and Martinique (Annex A). For French Guiana, BSV is under compulsory control (Annex B). For Réunion, BSV is not mentioned as a pathogen subject to mandatory control. The French document refers to exemptions allowing banana imports into the French overseas departments. The decree of 1995 (JORF 19/11/1995) permits the importation of vitro plants into the French overseas departments provided that tissue cultures are derived from mother stocks that had undergone quarantine for one year, to ensure freedom from BSV.

### 2.1.4. Potential for establishment and spread in the PRA area

The Panel agrees with the risk assessor that BSV has potential for establishment in the PRA area, considering its reported presence in Guadeloupe and Réunion and the current geographical distribution of the pathogen in countries with similar climates and that susceptible host plants are grown in all the French overseas departments.

The French document states that *M. balbisiana* hybrids, which are intensively propagated by in-vitro culture, have proved to be infected by BSV after planting out and have helped generate sources of infection in many parts of the world where bananas are cultivated.

The Panel shares this view in general, but notes that BSV was already widespread before the dissemination of hybrids with B genomes and that the predominant reason for virus spread is the indiscriminate use of infected planting material.

### 2.1.5. Potential for economic consequences in the PRA area

The French document describes the importance of banana for the economy of Guadeloupe and Martinique with industrial production of Cavendish cultivars for export and the widespread use of plantains as food for local consumption. Banana is important as a subsistence crop in French Guiana and Réunion.

BSV is a serious virus disease of banana resulting in reduced fruit yield and quality. It can cause serious damage to certain cultivars.

### 2.1.6. Conclusion of pest categorization

BSV is a complex of virus species with a large molecular variability but distinct molecular characteristics which allows for their unambiguous identification. BSV is reported as present in Guadeloupe, with a high prevalence in plantain (AAB genome) grown in home gardens and small plots for local consumption. The occurrence of BSV in Cavendish cultivars (AAA genome) grown on plantations for the export industry was negligible. The Panel therefore considers there is potential for economic consequences arising from new introductions of BSV in Cavendish cultivars in Guadeloupe.

The presence of BSV in Réunion was confirmed with the cultivar ‘Petite Nain’ from the Cavendish subgroup with 20-50% diseased plants in the field, showing banana streak disease symptoms. With the exchange of planting material over many years, the Panel acknowledges that there is uncertainty concerning the absence of BSV in French Guiana and Martinique. BSV can cause a serious disease of banana, affecting plant growth, fruit yield and quality. It has the potential to establish in the PRA area due to the presence of suitable host plants and a potential for economic consequences.

## 2.2. Assessment of the probability of introduction and spread

### 2.2.1. Probability of entry of the pest

#### 2.2.1.1. Identification of pathways

The French document considers the vitroplant pathway as the main means of entry of BSV into the French overseas departments. Other plant material of the *Musaceae* is also identified as a pathway, but is not analysed further in the risk assessment. The Panel considers that conventional propagating material (suckers) would also represent an important pathway in the absence of the current regulations.

Import of banana fruits from other areas is not considered a possible pathway by the Panel because BSV has not been detected in fruits, the virus is neither mechanically transmitted, nor is it likely that insect transmission to the fruit can occur.

#### 2.2.1.2. Probability of the pest being associated with the pathway at origin

BSV has worldwide distribution and it is likely to be present in most, if not all, banana growing areas of the world. The international movement of conventional planting material, such as suckers, corms and corm pieces infected with BSV, is believed to be the main means of dissemination of BSV in the past. Infected plant material may be selected in the absence of symptom expression in mother plants.

BSV can be introduced with tissue culture material that has not been indexed for BSV. Mass-produced banana vitroplants thus represent an important pathway of entry for BSV. The Panel agrees that episomal BSV may have been initiated as a result of tissue culturing, but notes that vitroplants of Cavendish cultivars (AAA genome), are free of EPRVs, and these are the main banana imports into the PRA area. The import of vitroplants of banana with a B genome has a higher probability of association with episomal BSV which may have been initiated as a result of tissue culturing.

#### 2.2.1.3. Probability of survival during transport or storage

Banana plant propagation material is usually transported and stored under cool conditions (Lassoudière, 2007) which do not affect the survival of the pathogen.

#### 2.2.1.4. Probability of pest surviving existing pest management procedures

The probability of entry is rated high for vitroplants of *M. balbisiana* hybrids.

With the detection methods which are now available, the argument used in the French document stating that healthy and infected material cannot be distinguished, is considered by the Panel to be no longer valid.

The Panel further recognises that the critical issue in virus indexing of banana vitroplants is detection of episomal virus and does not agree with the French document that genome integrated forms of BSV present an additional risk. The Panel therefore concludes that EPRVs integrated into the B genome of banana do not present an additional concern provided that virus indexing for episomal BSV has been undertaken on imported tissue cultured material with a B genome.

The French document considers the phytosanitary risk associated with BSV extremely high since material with no apparent symptoms, but integrated viral sequences in the *M. balbisiana* genome, has the potential to reconstitute to BSV while under conditions of physiological stress associated with the production of vitroplants. Integrated sequences of BSV competent to recombine to complete viruses (EPRVs) are only found in banana cultivars carrying the B genome from *M. balbisiana*. Progenies from such parental lines derived from tissue culture can become virus infected through activation of the EPRVs (Dahal *et al.*, 1999; Harper *et al.*, 1999; Ndowora *et al.*, 1999). Cultivars of the Cavendish subgroup (AAA genome) are not at risk of *de-novo* infection since integrated BSV sequences can not recombine to viable virus.

The expression of EPRVs appears to be regulated by B genome-linked regulatory factors (Lheureux *et al.*, 2003) allowing BSV activation only in banana material with a B genome.

The French document specifies that micropropagation and water stress are the stimuli for EPRV activation into BSV. While there is experimental evidence for micropropagation being a stimulus (Dallot *et al.*, 2001) there is no proof for water stress activating EPRVs. Since no reference was provided and the Panel was unable to find confirmatory information, the Panel considers this statement for EPRV activation under field conditions speculative and unsubstantiated. Hence, there is no evidence that integrated sequences are activated in the field.

While the tissue culture process is clearly implicated in genome activation (Dallot *et al.*, 2001), there exists a high degree of uncertainty as to the precise conditions that activate EPRVs. The most critical phase for EPRV activation during micropropagation appears to be the proliferation stage associated with the intense production of newly formed and developing buds, while rooting and acclimatisation stages of *in vitro* propagation have little or no effect (Dallot *et al.*, 2001). However, the available information on EPRV activation is limited and uncertainty exists about the molecular and biochemical processes involved.

#### 2.2.1.5. Probability of transfer to a suitable host

Transfer of the pathogen to a suitable host is assured when infected propagation material is brought into the PRA area and vegetative propagation is pursued. The Panel considers the probability of transfer of the pathogen to a suitable host is low since insect transmission albeit experimentally possible is unlikely to contribute significantly to virus spread.

#### 2.2.1.6. Conclusion on the probability of entry

The conclusion in the French document on the probability of entry is unclear, with insufficient information provided to explain the rating given. Concluding comments state that the probability of entry is variable and the Panel agrees that the probability of entry is highly dependent on the implementation of effective virus-testing procedures for vitroplants, which represent the main pathway. The French document states there is a serious risk for vitroplants of *M. balbisiana* hybrids and low probability for Cavendish cultivars of the Cavendish subgroup (AAA genome). The Panel agrees that these Cavendish cultivars, which represent the largest quantities of vitroplants imported into the PRA area, are not at risk of *de-novo* infection from integrated BSV sequences.



The Panel recognises that the critical issue in virus indexing of banana vitroplants is detection of episomal virus but does not agree that genome integrated forms of BSV present an additional risk by remaining undetected and subsequent virus infections upon induction. It concludes that EPRVs integrated into the B genome of banana do not present a serious and additional concern provided that virus indexing for episomal BSV has been undertaken on imported tissue cultured material with a B genome.

The expression of EPRVs appears to be regulated by B genome-linked regulatory factors (Lheureux *et al.*, 2003) allowing BSV activation in banana with a B genome. While the tissue culture process is clearly implicated in genome activation (Dallot *et al.*, 2001), there exists a high degree of uncertainty as to the precise conditions that activate EPRVs.

The Panel concludes there remains a high risk of entry of infected plant material, in the absence of current regulations and particularly in the absence of virus-testing to ensure the production of BSV-free vitroplants.

### 2.2.2. Probability of establishment

#### 2.2.2.1. Availability of suitable hosts, alternate hosts and vectors in the PRA area

The French document notes that the host range of BSV is restricted to *Musa* spp. The Panel notes that cultivars in genomes AAB plantain cooking and dessert banana, AAA dessert and cooking banana, and ABB (cooking banana) can be natural hosts and that *Ensete ventricosum* (enset) is an experimental host. Enset in cultivation in Ethiopia has been seen with BSV-like symptoms and a badnavirus has been implicated as the pathogen (Tessera and Quimio, 2000). In addition, SCBV, which is very closely related to BSV with strains possibly overlapping between species, is found in all noble canes (*Saccharum officinarum*), a fairly large number of commercial *Saccharum* hybrids and in collections of *S. barberi*, *S. robustum*, *S. spontaneum* and *S. sinense* (Lockhart *et al.*, 1996). *Musa textilis* (abaca) and the ornamental species in the *Heliconia* and *Strelitzia* genera cannot be infected with BSV (Lockhart, 1995). As the host range of BSV seems likely to be restricted to banana, no other host is known to contribute to the epidemiology of BSV (Lockhart, 1995).

In 2006, dessert bananas of the Cavendish sub-group were produced commercially on 7300 ha in Martinique (Agreste, 2007a) and on 2240 ha in Guadeloupe (Agreste, 2007b). In the same year, in Réunion 500 ha were cultivated with bananas (Agreste, 2007c). Data from 2005 show 355 ha of bananas in French Guiana (INSEE, 2007).

Banana, plantain and cooking bananas are grown in family gardens in the French overseas departments for household consumption. The importance of this production is underpinned by food consumption data for Guadeloupe and Martinique (AFSAA, 2007). In 2006 family gardens occupy 1080 ha in Martinique, 615 ha in Guadeloupe and 2890 ha in Réunion (Agreste, 2007a, b and c). In French Guiana, banana and plantain are among the associated crops of the shifting cultivation, which is practiced on 33 % of the total utilized agricultural area (PDR Guyane, 2007).

#### 2.2.2.2. Suitability of environment

The French document states that BSV can be expressed where the banana plant grows and that the climatic conditions in the French overseas departments permit symptom expression. The Panel agrees with this general view and further specifies that BSV infections can establish wherever suitable environmental conditions for banana cultivation prevail. This is definitely

the case for the French overseas departments and evidenced by the recent findings of occurrence of BSV in Guadeloupe (Pèrèfarres *et al.*, 2007) and Réunion (Lavigne, 2000).

However, the Panel stresses that for disease establishment an efficient pathway of transmission and virus dissemination is required. Natural spread is slow on Guadeloupe as it is in most areas where BSV is endemic and it can be assumed that these epidemic parameters are not different in other French overseas departments under consideration.

#### 2.2.2.3. Cultural practices and control measures

The French document does not suggest measures to prevent the establishment of BSV. The Panel concludes that early detection of infected plants followed by removal of these plants is the only way to prevent establishment of the virus.

#### 2.2.2.4. Conclusion on the probability of establishment

The Panel agrees with the conclusion in the French document, concludes that the probability of establishment is high, and considers

- the ecoclimatic conditions of the French overseas departments are suitable for the banana host;
- the ecoclimatic conditions are unlikely to affect BSV;
- BSV is noted as already present in Guadeloupe and in Réunion.

### 2.2.3. Probability of spread after establishment

The French document states that the key element of BSV dissemination over long distances is the movement of infected planting materials, and emphasises the risk of virus spread from activated EPRVs integrated in the *M. balbisiana* genomes with episomal BSV behaving identical to the wild type virus.

While the Panel agrees that BSV can be disseminated with infected planting material, no evidence has been found that those integrated sequences are activated in the field and many banana cultivars with B genomes remain unaffected by BSV.

In the French document, several species of mealybugs transmitting BSV in a semi-persistent manner are listed. However, virus spread by vector transmission is considered slow due to the restricted mobility of the vector. The Panel agrees with this assessment of natural spread of BSV, but notes some uncertainty as regards the role of mealybug vectors in BSV transmission. Under experimental conditions, badnaviruses, including BSV, are readily transmitted by mealybugs, especially their highly mobile first instar larvae (crawlers) that are also easily dispersed with wind (Lockhart *et al.*, 1992). However, field observations in many production areas do not support an active role for these insects in the spread of BSV (Lockhart, 1995). Nevertheless, observations in Ecuador indicate that vector transmission can be significant in spreading banana streak disease (Lockhart and Jones, 2000). In Ecuador, ants were active in moving the mealybug vectors from plant to plant. However, high mealybug activity and farming by ants leading to epidemics may only occur in a few environments.

There is no experimental evidence that *Pseudococcus comstocki*, the most common mealybug infesting banana in Ecuador, is capable of transmitting BSV and the involvement of this mealybug in BSV epidemics is circumstantial. BSV has been experimentally transmitted by *Planococcus citri* Risso (Hemiptera; Pseudococcidae) and *Saccharicoccus sacchari*, Cockerell (Hemiptera; Pseudococcidae) (Lockhart *et al.*, 1992). However, no evidence is provided that these species occur on banana under natural conditions (Kubiriba *et al.*, 2001a; Kubiriba *et*



*al.*, 2001b). *Planococcus musae*, a new mealybug species found in Nigeria (Matile-Ferero and Williams, 1995) has been found on pseudostems and roots of banana in fields infected with BSV, but its involvement in transmission has not yet been proven (Dahal *et al.*, 1998b). Even though vector transmission studies with mealybug populations including *Dysmiococcus brevipes* (pineapple mealybug) collected from banana in Uganda (Kubiriba *et al.*, 2001b) might indicate for efficient vector transmission, these data are still pending confirmation from field surveys.

The limited comparative, experimental data on vector transmission (Kubiriba *et al.*, 2001b) do not indicate differences in the efficacy of mealybugs to transmit BSV. Furthermore comparative data from virus transmission studies with mealybugs and BSV species that might indicate differential vector transmission are not available.

For the PRA area, no information was found on mealybug virus vectors present on banana. However, it can be assumed that *S. sacchari*, the pink sugarcane mealybug, found wherever sugarcane is cultivated, is also present in the French overseas departments. This mealybug species is an experimental vector for BSV, but there is no evidence for its competence under field conditions (Kubiriba *et al.*, 2001a). Recent virus surveys in Guadeloupe (Pèrèfarres *et al.*, 2007) provide evidence for BSV occurrence in farmers' fields. The results indicate that, under conditions prevailing in Guadeloupe, there is only negligible spread of BSV from infected AAB plantains grown in small plots and back gardens to Cavendish cultivars, which are cultivated in large commercial plantations. This provides circumstantial evidence that vectors have no or only a limited contribution to spread and dissemination of BSV in Guadeloupe. Current cultural practices or prevailing environmental conditions, that may not favour the mealybug vector, seem to be preventing significant spread of BSV from the inoculum reservoir in plantains to commercially grown Cavendish cultivars.

The Panel concludes that, besides the experimental identification of several mealybug species as BSV vectors, the role of these insects in BSV epidemics is rather circumstantial and uncertain. From the limited information on vector transmission of BSV and on badnavirus transmission in general, it is not known if mealybugs present in the French overseas departments are, or can become, efficient vectors of newly introduced BSV species or strains.

#### **2.2.4. Conclusion in probability of introduction and spread**

The probability of introduction is rated as high. The Panel agrees with the statement in the French document that there is a high risk of entry of the virus into the French overseas departments with BSV infected vitroplants.

##### Probability of entry

In reaching its conclusion, the Panel considered the following points:

- BSV is likely to be present wherever banana is grown;
- BSV exists as a number of separate species with considerable virus genome diversity;
- BSV can be disseminated in banana propagating material, especially mass produced vitroplants;
- BSV can arise from integrated sequences in the B genome of banana during tissue culture, but not from integrated sequences in the 'A' genome.

The Panel concludes that (1) there is a high probability of entry of BSV if propagating material is imported without pre- or post-entry virus indexing and (2) the implementation of a competent virus indexing regime will significantly reduce the risk of inadvertent entry of BSV.

#### Probability of establishment

The French document gives a maximum rating for probability of establishment. The Panel agrees with this rating and considers

- the ecoclimatic conditions of the French overseas departments are suitable for the banana host;
- the ecoclimatic conditions are unlikely to affect BSV;
- BSV is already established in Guadeloupe and in Réunion.

However, the Panel disagrees with the significance given to vector transmission in disease dissemination. There is very limited evidence for field spread of BSV and the Panel was unable to confirm a significant role of mealybug species in spreading the banana streak disease. Only in one case is field transmission by mealybugs reported and this occurred under very specific conditions (Lockhart and Jones, 2000). Thus, while BSV has a high potential for establishment, the low vector transmission shows only a very limited potential for natural spread with disease dissemination largely by virus-infected propagating material

### 2.3. Assessment of potential economic consequences

#### 2.3.1. Direct pest effects

##### 2.3.1.1. Crop quality and/ yield losses

The French document lists leaf symptoms, reduced plant growth, reduced quality and production of fruit and plant death as damage resulting from BSV infections in some Cavendish cultivars.

Leaf symptoms vary from chlorotic streaks to necrotic leaf blotches, can have serious adverse effects on plant growth, flower and fruit development and the quantity and quality of marketable fruits harvested from banana infected with BSV. The Panel notes that symptoms are variable with severe symptoms documented from some banana growing areas (Lockhart 1986; 1995). However, it appears that severe symptoms occur only on certain cultivars in certain environments. In virus studies conducted in Nigeria, Dahal *et al.* (2000) noted that despite high disease incidence, symptoms in improved banana hybrids and in landraces can be absent or mild, despite high virus concentrations. In addition, the results of this study, directly comparing BSV-infected with virus-free genotypes, showed that BSV infections have significant effects on bunch weight and number of hands and fruits.

Overall, the Panel concludes that the damage caused by BSV under field conditions is difficult to assess. The direct effects of the disease on crop yield depend on BSV incidence, climatic factors, banana cultivar and the level of management. High disease incidences arise in plantain, which is propagated conventionally. Well-managed banana plantations, can compensate for the damage caused by BSV (Daniells *et al.*, 2001). In low-input agriculture, where plants suffer from nutrient and water stress, yield losses can then be considerably higher (Lassoudière, 1974; Lockhart and Jones, 2000).

As stated in the French document, information on the economic significance of BSV is scarce. There is great variability in yield losses recorded at experimental sites (Dahal *et al.*, 2000). In a controlled experiment with infected and healthy ‘Williams’ Cavendish banana, Daniells *et al.* (2001) made detailed descriptions of yield reductions due to BSV infection. They reached the conclusion that effects on yield under Australian conditions were small. Under good conditions for banana growth, the plants were able to compensate for the adverse effects of the disease with the only pronounced effects being the delay of bunch emergence and maturation, which contributed 6% of the overall yield loss of 11% per annum.

In light of the difficulties in evaluating yield losses due to BSV, the Panel recognises that some of the commercially grown ‘Cavendish’ dessert bananas are particularly susceptible to BSV (Lassoudière, 1974; Lockhart, 1986). As stated in Dahal *et al.* (2000), BSV can have significant effects on fruit yield, hence economic damage will rise with increasing virus incidence, whether severe symptoms are found on the plants or not.

Hence, despite the uncertainties in adequately estimating economic impact, the Panel concludes that the BSV can cause a serious virus disease of banana, with the severity of symptoms dependent on cultivar, cultural and climatic conditions.

#### 2.3.1.2. Control measures, efficacy and costs

The French document states that due to the lack of chemical control and resistant cultivars, only the implementation of eradication programs removing infected plants and replacing them with disease-free material can effectively control BSV.

The Panel agrees with this general statement. However, it questions the practicality of this measure, as it requires an unambiguous virus diagnosis, which is very difficult due to transient or missing symptoms in BSV infected plants. Further, while eradication on plantation crops might be feasible, the widespread and scattered cultivation of banana and plantain on small scale farms and in home gardens in the French overseas departments presents a serious impediment towards eradication of virus source plants and BSV control.

Thus the Panel concludes that efficient control of BSV can only be achieved by rigorous pre-entry virus indexing and the use of virus-free planting material. It further notes that there are no reports of EPRV activation of BSV in banana grown under natural field conditions.

The French document reports attempts to eradicate BSV-infected, symptomatic plants from banana plantations in Venezuela, Costa Rica and Cuba by rouging infected plants and replacing them with healthy material. It assumes that virus entry is through massive introduction of apparently healthy interspecies hybrids carrying BSV. The French document does not appraise the success of these efforts, but from similar efforts to eliminate diseased plants in Ecuador (Lockhart and Jones, 2000) the limitations of these practices to stop virus spread are evident. Still, with only limited field spread by mealybug vectors as is probably the case in the French overseas departments, elimination of infected plants might be feasible. Daniells *et al.* (2001) found only negligible field spread of BSV in banana plantations in North Queensland even when healthy and infected plants were in close proximity. Therefore, removal of infected plants would be appropriate for controlling BSV outbreaks in some environments.

The French document makes a general statement on use of unaffected plantlets for control, which does not satisfactorily address this section. Nevertheless, there are no data available on costs incurred from control measures, neither for BSV nor for any other banana virus. Hence the Panel cannot satisfactorily deal with this issue, but wishes to stress that pre-entry control (that is virus indexing of mother stock material prior to initiation of tissue cultures and their subsequent entry into the French overseas departments) is a key pre-emptive measure with comparatively low costs.

### 2.3.2. Indirect pest effects

#### 2.3.2.1. Export markets

Martinique exported a net total of 228,358 tonnes ( $\approx$  178 mln euros)<sup>6</sup> of bananas in 2005, representing 93% of local production (Aumand, 2006). In 2004, 251,695 tonnes of bananas were exported, representing 89% of the total production of banana varieties intended for export (Agreste, 2006a). In Guadeloupe, the export of bananas was 65,730 tonnes in 2004 and 51,700 tonnes ( $\approx$  37 mln euros)<sup>6</sup> in 2005, *i.e.* respectively 75% and 80% of the total production of banana varieties intended for export (Agreste, 2006b).

Banana production of Guadeloupe and Martinique is mainly exported, with the EU being the primary trading partner (Lassoudière, 2007). In French Guiana and Réunion, banana production is for local consumption only (DAF Guyane, 2001; Le Jeannic, 2002).

The Panel agrees with the statement in the French document that a massive introduction of disease via infected vitroplants would have a devastating effect on the production capacity of the overseas departments and could result in the collapse of the export industry in the Guadeloupe and Martinique.

Under the current EU regulations (Directive 2000/29/EC), the introduction of BSV into the French overseas departments would not evoke quarantine restrictions to fruit trade. Nevertheless, the marketability of the fruit could be reduced and future export to banana producing countries could be compromised.

#### 2.3.2.2. Social consequences

The document does not address any potential social consequences as a result of the pathogen's establishment in the PRA area. Other pest risk assessments provided by France show that banana production is important for employment in Guadeloupe and Martinique. The banana industry provides 7,000 direct jobs in Martinique and 10,000 direct and indirect jobs in Guadeloupe.

Plantain and cooking banana are an important staple food and a large fraction is household-produced. These bananas have *M. balbisiana* B genome components. However, BSV has been found in Guadeloupe and negative effects have not been reported. Therefore although expected to be limited, there is uncertainty relating to the social consequences of BSV.

#### 2.3.2.3. Environmental consequences

The document does not discuss potential environmental consequences. The Panel is of the opinion that environmental consequences may be associated with changes in land cover due to a reduced presence of banana plants in commercial plantations, small holdings and private gardens.

### 2.3.3. Conclusion of the assessment of economic consequences

The document concludes that the economic consequences as a result of the introduction of Banana streak virus into the PRA area would be low due to efficient control. This estimate is shared by the Panel in the light of the current regulation. However, in the absence of the current regulations, the economic consequences would be relative to the numbers of plants imported

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<sup>6</sup> based on average prices at departure for the first semester 2005 (Agreste 2006. La statistique agricole. Le Bulletin. Séries chronologiques, 13, Guadeloupe, 1<sup>er</sup> Semestre 2006, 4 pp.)

that putatively carry BSV, are being cultivated for some years prior to outbreak of the disease and eradication.

On the basis of the information provided in the document and on additional literature and experts consulted the Panel concludes that should Banana streak virus enter and establish in the PRA area:

- Within commercial plantations of dessert bananas the potential economic impact would be high for commercial plantations in Guadeloupe and Martinique.
- Plantain and cooking banana are an important staple food and a large fraction is household-produced (AFSSA, 2007). The disease was found in home gardens in Guadeloupe in 2007, however impacts on the crop not reported. Disruption of subsistence production and consumption patterns is not expected to occur since the disease is unlikely to spread and can be controlled by eradication of infected plants.

The French document states a considerable economic impact with introduction and establishment of BSV that is more significant for the commercially producing Guadeloupe and Martinique islands than for French Guiana or Réunion.

The Panel considers that there are significant uncertainties about the potential economic impact of BSV in the PRA area. It regards BSV as a disease of banana, which can lead to variable yield losses depending on host cultivar and location. Although it has been found on banana in Guadeloupe, no information is available on affect on yield and also on the severity of symptoms. BSV has been found in banana grown commercially for export and also for local consumption. However, natural spread from local cultivars into export plantations is extremely low indicating low vector activity. However, a large influx of BSV-infected, commercially-produced, vitroplants into Guadeloupe has the potential to cause serious impact.

The Panel considers that yield losses would be correlated with the percentage of virus-infected plants in the field. So far, observations made in Guadeloupe indicate a very low incidence of BSV in commercial plantations thus currently causing a very low economic impact. This situation should continue provided an effective pre-entry, BSV screening-programme is implemented.

#### **2.4. Comments on the conclusion of the pest risk assessment**

The document concludes that banana streak virus should be classified as a quarantine organism for the endangered area of French Guiana, Guadeloupe, Martinique and Réunion.

The Panel considers banana streak virus appropriate for stage 3 of Pest Risk Analysis, i.e. the evaluation of pest risk management options for the endangered area of French Guiana, Guadeloupe, Martinique and Réunion.

The final conclusion reached by the French document is that the phytosanitary risk is extremely high and cites material with *M. balbisiana* chromosome in its genome as a major risk factor. The Panel considers the phytosanitary risk associated with introduction of BSV into the French overseas departments as moderate since the main pathway of virus entry, that is vitroplants, can be controlled. Natural disease spread by vectors from virus-infected plants established in the field is considered limited. Limited spread may occur if traditional propagating material (suckers) were obtained from these infected plants. Large scale spread would occur if infected plants were used as mother stock for tissue culture.

An additional phytosanitary risk associated with importation of banana vitroplants with a B-genome cannot be assumed provided that adequate virus indexing has been conducted on this material. This indexing would need to be more carefully done taking EPRVs in mother stocks



and their activation into account. Testing of cultivars with only the ‘A’ genome is done safely by testing of mother stocks for virus freedom.

The Panel further stresses that despite the high molecular diversity of BSV now reported from many studies, it regards BSV as a serious pathogen of banana with the economic impact of the disease increasing with the percentage of BSV occurring in the field.

#### **2.4.1. Degree of uncertainty**

The French document does not address any uncertainties. The Panel considers there are uncertainties in the following areas:

- virus diagnosis due to the variability of the BSV species complex,
- the extent to which BSV is present in the PRA area,
- the role of mealybug vectors in BSV transmission,
- the potential economic impact of BSV in the PRA area, due to variable yield losses depending on host cultivar and location,
- the potential for environmental and social consequences, as these are not addressed in the French document.

### **CONCLUSIONS AND RECOMMENDATIONS**

Although the information provided in the French risk assessment required updating with additional information available since the assessment was carried out, the Panel agrees that BSV, which is now recognised as a species complex of banana streak viruses, is a serious pathogen of banana, and poses a potential risk to banana production in the French overseas departments.

The French document concludes that the phytosanitary risk associated with BSV is extremely high particularly due to the risk of activated virus in the *M. balbisiana* genome during import or production of vitroplants. However, the Panel considers the phytosanitary risk to be lower than stated, as analytical methods for virus indexing, developed since the French assessment, now enable detection of endogenous BSV in the *Musa balbisiana* genome. The Panel agrees that BSV has a high probability of entry and a high probability of establishment in the French overseas departments, in the absence of existing controls. It agrees that the international movement of large quantities of vitroplants represents the most important entry pathway. The Panel further considers that virus indexing of mother plants used for vitroplant production provides an effective means to prevent entry of BSV.

Uncertainties are noted particularly regarding the role of mealybug vectors in BSV transmission and dissemination of the disease, and on the potential economic impact of BSV in the PRA area. However, the Panel regards BSV as a serious pathogen of banana and the economic impact of the disease increasing with the percentage of BSV occurring in the field. Hence in the absence of virus indexing, the importation of large quantities of BSV-infected vitroplants is likely to have a serious economic impact especially for Guadeloupe and Martinique, where banana production represents a very significant proportion of agricultural activities.

The overall conclusion of the Panel is that BSV is appropriate for analysis of risk management options and is thus potentially eligible for addition to the list of harmful organisms of Directive 2000/29/EC.

## DOCUMENTATION PROVIDED TO EFSA

1. Letter, dated 14 July 2006 with ref. SANCO E/1/VE/svi D(2006) 510488 from P. Testori Coggi to C. Geslain-Lanéelle.
2. Analyse du Risque Phytosanitaire BAN-v3 : *Banana streak badnavirus* - BSV. Rédaction : M. L. Caruana / CIRAD – Août 2003.

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