**EUROPEAN AND MEDITERRANEAN PLANT PROTECTION ORGANIZATION**
**ORGANISATION EUROPEENNE ET MEDITERRANEENNE POUR LA PROTECTION DES PLANTES**

**12-18190 (**12-17834**,** 12-17593, 12-17485)

# Report of a Pest Risk Analysis for *Candidatus* Liberibacter solanacearum in Solanaceae and its vector *Bactericera cockerelli*

This summary presents the main features of a pest risk analysis which has been conducted on the pest, according to EPPO Decision support scheme for quarantine pests.

**Pests:** ***Candidatus* Liberibacter solanacearum and its vector *Bactericera cockerelli***

**PRA area:** EPPO region

**Assessors:** Expert Working group for the PRA on *Candidatus* Liberibacter solanacearum and its vector *Bactericera cockerelli:*


Dr Neil GILTRAP - Food and Environment Research Agency, York (United Kingdom)
Dr Joe MUNYANEZA **-** USDA-ARS Yakima Agricultural Research Lab- Wapato (USA)
Dr Anne NISSINEN - MTT Agrifood Research Finland -Jokioinen (Finland)
Dr Tarek SOLIMAN - Business Economic Group - Wageningen University - Wageningen (Netherlands)
Dr Leif SUNDHEIM (Core member) - Norwegian Institute for Agricultural and Environment Research - Aas (Norway)
Dr Emilio STEFANI - Dept.Universita degli Studi UNIMORE - Reggio Emilia (Italy*)*
Dr Leon TJOU-TAM-SIN - National Reference Laboratory - Wageningen (Netherlands)
Dr Dirk Jan VAN DER GAAG (Core member) - Plant Protection Service - Wageningen (Netherlands)

EPPO Secretariat
Ms Muriel Suffert
Ms Fabienne Grousset – Consultant for EPPO who has prepared the draft PRA.


**Date:** 2010-11-30/12-03 (but as new information appeared during the consultation process, some was included in the PRA after consultation of the EWG by e-mail). Core members (DJ. Van der Gaag, L. Sundheim, G. Schrader, N. Ustun, F. Petter) reviewed the draft PRA in autumn 2011. The risk management part was presented to the Panel on Phytosanitary Measures for Potato in 2012-02, and reviewed by the Panel on Phytosanitary Measures in 2012-03. The Working Party on Phytosanitary Regulations amended some parts in 2012-06.

## STAGE 1: INITIATION

**Reason for doing PRA**: In 2008, a new bacterial species '*Candidatus* Liberibacter solanacearum' was found associated with diseases of potato, tomato and other solanaceous crops in the Americas, and the bacterium was also discovered in New Zealand. In particular, it was found associated with a potato disease called 'zebra chip' which has caused significant economic losses, by reducing both yield and quality of potato crops. The pathogen is transmitted by a vector, the leaf psyllid *Bactericera cockerelli* (Hemiptera, Triozidae), which lives among others on plants of the Solanaceae family, especially tomato and potato. The EPPO Working Party on Phytosanitary Regulations decided in June 2010 that a PRA should be performed on *Ca*. L. solanacearum, which was considered absent of the EPPO region.

At the same period, a different haplotype of *Ca*. L. solanacearum was reported on carrots in Finland, associated with the carrot psyllid *Trioza apicalis* (Hemiptera, Triozidae). It now appears that this haplotype is present in carrot in several EPPO countries. However, to date there does not seem to be a pathway between carrot and solanaceous plants because the vectors identified so far in carrot do not feed on Solanaceae. As a result, it seems relevant to assess the risk of the *Ca.* L. solanacearum - *B. cockerelli* – complex in Solanaceae.

**Taxonomic position of pest:** ***Candidatus* Liberibacter solanacearum** (Liefting *et al.* 2008a, 2008b, 2009a, 2009c)
Order: Rhizobiales, Family: Phyllobacteriaceae
*Candidatus* Liberibacter solanacearum (Liefting *et al.* 2008a, 2008b, 2009a, 2009c)
Synonym: *Candidatus* Liberibacter psyllaurous (Hansen *et al.*, 2008)

***Bactericera cockerelli*** (Sulc) 1909
Order: Hemiptera, Family: Triozidae
Synonym: *Paratrioza cockerelli* (Sulc)
Common names: tomato psyllid, potato psyllid

## STAGE 2: PEST RISK ASSESSMENT

### PROBABILITY OF INTRODUCTION

***Entry***

Geographical distribution:
(see PRA record for references)

*Ca*. L. solanacearum
**EPPO region:** absent on Solanaceae, recently found in carrot in Finland, Norway and Sweden and Spain, and in celeriac in Spain
**North America**:
- USA: Arizona, California, Colorado, Kansas, Nebraska, Nevada, New Mexico, Oregon, Texas, Washington, Wyoming
- Mexico (Coahuila, Sinaloa, Nuevo Leon, State of Mexico)
**Central America**: Guatemala, Honduras
**Oceania**: New Zealand

*B. cockerelli*
**EPPO region:** absent
**North America**:
- Canada (Alberta, British Columbia, Ontario, Quebec, Saskatchewan). It may survive all year round in protected conditions but outdoor populations only occur late in the growing season after migration from USA.
- USA: Arizona, California, Colorado, Idaho*, Kansas, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Dakota*, Oklahoma, Oregon*, South Dakota, Texas, Utah, Washington*, Wyoming.
- Mexico (Chihuahua, Coahuila-Nuevo León, Guanajuato, Sonora and Sinaloa, Tlaxcala)
*Late season presence only, migrate late into the growing season
**Central America**: Guatemala, Honduras
**Oceania**: New Zealand

Major host plants or habitats:
(see PRA record for references)

*Ca*. L. solanacearum
Most of the host plants of *Ca*. L. solanacearum belong to Solanaceae. Major hosts are:
- potato (*Solanum tuberosum*),
- tomato (*Solanum lycopersicum*),
- *Capsicum* spp. (including bell pepper/sweet pepper *Capsicum annuum*, and chilli *C. frutescens*),
- tamarillo (*Solanum betaceum)*
- as well as a number of weeds, e.g. *Solanum elaeagnifolium*, *Lycium barbarum*.

Only in the EPPO region, *Ca.* Liberibacter solanacearum is reported in carrot (*Daucus carota*) and in celeriac (*Apium graveolens rapaceum*), both belonging to the family Apiaceae.

<u>*B. cockerelli*</u>

*B. cockerelli* has a wider host range than *Ca*. L. solanacearum: this species can be found on numerous species in 20 plant families, and can complete its life cycle on some Solanaceae, Convolvulaceae and Lamiaceae (e.g. Al-Jabr, 1999, based on earlier publications). Wallis (1955) mentions 46 species on which the insect can reproduce, of which 42 are Solanaceae. The following species are generally cited amongst its preferred hosts: tomato (*Solanum lycopersicum*), potato (*Solanum tuberosum*), aubergine *(Solanum melongena*), and peppers (*Capsicum* sp.) (Biosecurity Australia, 2009; Yang & Liu, 2009).

<u>Which pathway(s) is the pest likely to be introduced on:</u>

**The EWG considered that to cover the risk of entry of the bacterium in Solanaceae, entry of its vector *B. cockerelli* should be prevented. The main pathways are**:

- **Fruit of Solanaceae (in particular tomato, Capsicum spp., eggplant, tamarillo, Cape gooseberry) from countries where *B. cockerelli* occurs**

The bacterium may be in the fruit of host plants or inside the vector itself carried in its host plants. Because its vector *B. cockerelli* has a broader host range among Solanaceae and there are uncertainties on the exact host range of *Ca.* L. solanacearum, this pathway is extended to all Solanaceae.

- **Plants for planting of Solanaceae (except seeds) from countries where *B. cockerelli* occurs**

The bacterium may be in the plants or inside the vector itself carried in its host plants. Because its vector *B. cockerelli* has a broader host range among Solanaceae and there are uncertainties on the exact host range of *Ca.* L. solanacearum, this pathway is extended to all Solanaceae.
This pathway does not include seed potato (covered in a specific pathway)
*This pathway is closed for most countries in the PRA area (import prohibited), but not for all.*

- **Seed potatoes (including microplants and minitubers) and ware potatoes from countries where *B. cockerelli* occurs**

Potato tubers may be infected by the bacterium (Hansen *et al.*, 2008, Liefting *et al.*, 2008a). The psyllid vectors will not be associated with potato tubers as they can only be associated with green parts.
Infected tubers could be a source of inoculum of the bacterium in potato fields. In theory ware potatoes are a very unlikely pathway because they should not be planted and therefore transfer of the bacterium from the tuber to host crops in the PRA area is impossible. It was nevertheless taken into account as they are subject to less control measures and may still be planted by individuals.
*This pathway is closed for most countries in the PRA area (import prohibited), but not for all.*

<u>**Other pathways identified but not studied further:**</u>

- ***B. cockerelli* on plants for planting of *Micromeria chamissonis, Mentha* spp., *Nepeta* spp. and *Ipomoea batatas***

These four species can sustain the development of *B. cockerelli*, and plants for planting could carry any stage of the vector, carrying the bacterium or not. The EWG considered that this is a relevant pathway (they might be imported as ornamental or herb) but it is not considered in detail due to lack of information on trade. Other aspects are similar to the consideration of plants for planting of Solanaceae. However in contrast to Solanaceae plants for planting, there are no restrictions on the movement of this material in most countries of the PRA area.

- ***B. cockerelli* on living parts of Solanaceae (except fruits, seeds and plants for planting)**

This covers especially cut flowers and cut branches. The EWG considered that this is a relevant pathway but it is not considered in detail due to lack of information on trade. In contrast to Solanaceae plants for planting, there are no restrictions on the movement of this material in most countries of the PRA area (e.g. EU, Norway and Switzerland).

- **Host weeds**

The bacterium may be present in weeds (e.g. found in containers of pot plants). However, in the absence of *B. cockerelli*, transfer to susceptible host in the PRA area appears unlikely.
*B. cockerelli* feeds on a number of weeds. When the psyllid acquires the bacterium, it is then transmitted to its progeny. Living/green weeds may carry infective eggs or nymphs (adults are likely to leave if disturbed).

- ***B. cockerelli* on other plants indicated on host lists**

A number of plants are identified in the literature as minor hosts, or as plants on which *B. cockerelli* feeds but does not reproduce, or as plants on which it overwinters. In theory infested psyllids may enter in association with these plants. Comprehensive host lists are given in Wallis (1955) and Trumble (2010) and include lettuce, sunflower, pea, radish, vetches/beans, corn, and sugar beet as “less known-hosts”. It is thought that such commodities would not be imported from North America or New Zealand as plants that would be able to carry *B. cockerelli*. Spruce and other conifers (pine, cedar) are also mentioned in the literature as possible overwintering plants (for adult stages only).

- **Entry of *Ca.* L. solanacearum with other psyllid vectors**

*Ca.* L. solanacearum has already been shown to have two psyllid vectors, so there are suspicions to date that more psyllid species are vectors of this bacterium. In New Zealand, the bacterium has been found on *Acizzia* and *Trioza* psyllids (species not mentioned) collected from *Acacia* and *Pittosporum* species (Scott *et al*., 2009). The bacterium may enter together with such species, but there are too many uncertainties to assess this pathway.

**<u>Pathways considered not likely</u>**

- **Transfer of *Ca.* L. solanacearum from infested carrot or celeriac**

In Finland, the vector on carrot is *T. apicalis* and in the Canary Islands, it is *Bactericera trigonica.* Both do not feed on Solanaceae. In mainland Spain the vector is not confirmed and only reported as *Bactericera* sp.

- **Natural spread**

*Ca.* L. solanacearum is unlikely to reach the PRA area through the natural spread of *B. cockerelli*. Even if *B. cockerelli* is reported to be transported long distances by wind current, it is not considered possible that it will be transported from the Americas or New Zealand to the PRA area. The vectors known in the EPPO region on carrot do not feed on Solanaceae. However, this pathway will need to be reconsidered if other vectors are identified in the PRA area.

- **Seeds of cultivated host plants**

*Ca.* L. solanacearum has not been shown to be transmitted by seed.
*B. cockerelli* is not associated with seed.

- **Hitchhiking of infective *B. cockerelli***

Adults are not likely to stay on commodities at export, conveyances, etc. as they would fly away. They would also not survive in transport without suitable plants to feed on (for longer than e.g. 2-3 days), except at cold temperatures.

*B. cockerelli* can be transported on other goods (e.g. clothing cited by Teulon *et al.*, 2009) but this would likely result in local spread.

***Establishment***

<u>Plants at risk in the PRA area:</u> Solanaceae crops such as potato (*Solanum tuberosum*), tomato (*Solanum lycopersicum*), and *Capsicum* spp. are largely cultivated throughout the PRA area, in field and under protected conditions as well as in gardens.

<u>Climatic similarity of present distribution with PRA area (or parts thereof):</u> The bacterium can survive over a wide range of temperatures, as shown from its current distribution (and is already present in carrot and celeriac in Nordic countries and in Spain). Its distribution in solanaceous crops in the PRA area will be restricted to areas where *B. cockerelli* may establish. Given its current distribution in the Americas and New Zealand, it is thought that *B. cockerelli* would be able to establish and overwinter outdoors in the Southern and Central European part of the PRA area, as well as in areas with mild winters in the Northern part of the PRA area. It is unlikely to establish in the Eastern part of the region (east of Poland). However transient populations could occur there after migration, similar to the situation in Canada late in the season after migration from southern USA.

<u>Characteristics (other than climatic) of the PRA area that would favour establishment:</u> In some part of the PRA area, solanaceous crops are grown all year round (e.g. in the Mediterranean area); host weeds or volunteers may be found in potato or tomato crops. Their presence will favour survival or reproduction of the bacterium (and its vector) and therefore establishment (provided that a vector is present).

There is no effective management practice against *Ca.* L. solanacearum itself. Insecticides that are already applied may affect population development of the vector but they are unlikely to be able to prevent establishment.

<u>Which part of the PRA area is the area of potential establishment:</u> Southern and Central European parts of the PRA area, as well as areas with mild winters in the Northern part of the PRA area. The bacterium and its vector may also establish in the whole PRA area under protected conditions.

**POTENTIAL ECONOMIC CONSEQUENCES**

**How much economic impact does the pest have in its present distribution:** *Ca.* L. solanacearum causes severe damage in potato, tomato and Capsicum in its current area of distribution. It causes losses in yield and quality (which may result in lot rejection). Pest control against the vector requires intensive monitoring and insecticide spraying, resulting in high costs in the open field as well as in glasshouse. For example in New Zealand, Berry (2010) reports estimated economic losses to potato industry in 2008-2010 of approx. EUR 57 million and increased management cost of approx. EUR 400-680/ha.

In areas where *Ca.* L. solanacearum is not reported to occur, *B. cockerelli* can also cause economic losses on its own (although apparently less than if associated with the bacterium). The associated disorder is called “psyllid yellows”, presumably caused by a toxin that is transmitted during the insect’s feeding activities, especially nymphs. However, the nature of this toxin has not yet been demonstrated. It may be another pathogen not yet identified.

**Describe damage to potential hosts in PRA area:**

On potato symptoms include: purple top, shortened internodes, smaller leaves, enlargement of the stems, swollen axillary buds and aerial tubers. Potato chips made from infected tubers present dark stripes which become markedly more visible after frying (hence the disease name 'Zebra chip'), leading to rejection from the potato chip industry. When planted, infected tubers may not produce plants.

On tomato symptoms include: 'spiky' and chlorotic apical growth, leaf curling, mottling, plant stunting, and in some cultivars fruit deformation. On capsicum affected plants develop: chlorotic or pale green leaves, sharp tapering of leaf apex, upward leaf curling, shortened internodes and petioles, necrosis of apical meristem, flower abortion, and plant stunting.

**Infected potato tubers after frying.** JE Munyaneza (USDA-ARS)

***Bactericera cockerelli.*** JE Munyaneza (USDA-ARS)

**Chlorosis and purpling of zebra chip plants at a trial in Texas (US)** (Crosslin et al., 2010).

**How much economic impact would the pest have in the PRA area:**

The impact of the *Ca*. L. solanacearum and *B. cockerelli* is likely to be massive in the PRA area. It is not easy to determine which part of the damage by the complex *B. cockerelli*/*Ca.* L. solanacearum is due to *B. cockerelli* alone. However both pests may destroy the crops if no control measures are applied.

The pests are likely to cause damage in all parts of the PRA area, on their host plants especially potato and tomato, both in the field and in greenhouses. *Ca.* L. solanacearum affect both crop yield and quality (e.g. for potato, sugar content and specific gravity).

Control of the disease relies on implementation of intensive control measures against the psyllid vector. Specific monitoring activities and control measures are likely to be necessary. Biological or IPM systems in host crops will be disrupted at least in the first years after introduction.

Presence of both pests in the PRA area would certainly causes losses in export markets.

For field grown potatoes and tomatoes, the risk will be higher for areas where the vector can survive all year round. The Mediterranean Basin seems to be most suitable because of the climate and the cropping pattern (availability of hosts all year round). It is difficult to estimate how far north and east in the PRA area the complex *B. cockerelli*/ *Ca.* L. solanacearum will be able to establish and/or migrate to and cause damage (uncertainties concerning reservoir plants, migration, and survival of the vector at low temperatures and in the absence of a suitable host). The infection by the bacterium does not necessarily result in disease symptoms in the fields in areas where the temperatures are colder (e.g. Washington, South Island of New Zealand). The reasons why *B. cockerelli* does not survive in winter in the north-western part of its range (e.g. Washington) are not clear, i.e. whether this is due to climatic conditions (too cold?) or to other factors (absence of overwintering plant).

## CONCLUSIONS OF PEST RISK ASSESSMENT

**Summarize the major factors that influence the acceptability of the risk from this pest:**

*Ca*. L. solanacearum and *B. cockerelli* are pests of potato, tomato and Capsicum which are important crops in the PRA area.

Severe damage has been noted in North America and in New-Zealand where outbreaks have occurred.

In the case of introduction of *Ca*. L. solanacearum together with *B. cockerelli*, they would have a high probability of establishment wherever host plants are present. Eradication or containment would be difficult due to fact that they might not be detected before they have already established and caused damage. Producers will have to change their pest management practice to cope with these new pests.

| | |
|---|---|
| **Estimate the probability of entry:** | The probability of entry is considered **very low in the absence of a vector and moderate to low if a vector is already present** or if the known vector *B. cockerelli* would be introduced with the bacterium (or before). There is therefore a medium uncertainty for assessment of entry.<br>Some pathways are closed for some countries of the PRA area, in particular Plants for planting of Solanaceae and Potatoes for the EU.<br><br>The main pathway of concern is therefore the **Fruit of Solanaceae** from countries where *B. cockerelli* occurs. As the critical point is transfer of infective psyllids to host plants, the main risk will be where packaging of imported fruit occurs in close proximity of greenhouses where solanaceous hosts are grown. Vine tomatoes present a higher risk as they are harvested and marketed with parts of branches which may result in a higher concentration of the pest.<br><br>The other pathways (Plants for planting of *Micromeria chamissonis*, *Mentha* spp., *Nepeta* spp. and *Ipomoea batatas*, and Living parts of Solanaceae (except fruits, seeds and plants for planting) are probably minor (because of minimal trade) but are not currently regulated in any EPPO countries. |
| **Estimate the probability of establishment:** | The probability of establishment is **high** in cases where a vector is present or introduced at the same time. Transient population may occur in areas where the *B. cockerelli* cannot survive all year round.<br>Uncertainties: this area is limited by the establishment of *B. cockerelli*. If other psyllids present in the PRA area could act as vector of the bacterium for Solanaceae, probability of establishment will be very high. |
| **Estimate the probability of spread:** | The probability of spread of *Ca*. L. solanacearum depends on whether a vector is present or introduced at the same time. It is:<br>**- very low if no vector is present**<br>**- high if a vector is present or introduced at the same time**. The pest and its vector are then likely to spread rapidly.<br>*B. cockerelli* is a good flyer and is reported to spread long distance (e.g. several hundreds of kilometres a year), with prevailing winds (Abdullah, 2008; Wallis, 1955). |
| **Estimate the potential economic impact:** | In the case of introduction of *Ca*. L. solanacearum together with *B. cockerelli*, a **massive** impact is expected comparable to that in its current area of distribution. Losses of crops, export markets and additional costs are expected be massive in the PRA area. |
| **Degree of uncertainty** | The main uncertainties are associated with the possible vectors of *Ca*. L. solanacearum. If a psyllid present in the PRA area could act as a vector for the bacterium on Solanaceae, this will increase the probability of establishment and spread (it may also increase the area of potential establishment if it has different climatic requirements). If a new vector can transmit the bacterium between carrot and Solanaceae (or if reservoir plants are common to different vectors), this PRA will need to be revised.<br>The extent of the presence of *Ca*. L. solanacearum in carrot should also be clarified. |

Uncertainties also exist on

- the host range of the bacterium and its vectors. This could in particular add new pathways for entry. It is also not known on which plants *Ca*. L. solanacearum and *B. cockerelli* overwinter.
- influence of climate on symptoms expression of the bacterium
- persistence of the bacterium in the vector
- role of seed potatoes in the transmission of the bacterium

*A EUPHRESCO research programme on Epidemiology and diagnosis of potato phytoplasmas and* Ca *L. solanacearum was initiated in 2011 and may help clarify some uncertainties*.

**OVERALL CONCLUSIONS**

In EU countries, where import of potatoes and plants for planting of solanaceous plants are prohibited, the risk of introduction is probably very low as long as the current regulations are in place. The risk for other countries in the PRA area is probably small as the pathways are small. However, the whole PRA area would be at risk of severe consequences in case of introduction of the bacterium and association with a vector. It therefore seems important to prevent introduction of both *Ca*. L. solanacearum and *B. cockerelli*.

## STAGE 3: PEST RISK MANAGEMENT

### IDENTIFICATION OF THE PATHWAYS

**Pathways studied in the pest risk management**

- **Fruit of Solanaceae (in particular tomato, *Capsicum* spp., eggplant, tamarillo, Cape gooseberry)**
- **Plants for planting of Solanaceae (except seeds)**
- **Seed potatoes (including microplants and minitubers) and ware potatoes**

No detailed analysis was performed for "Plants for planting of *Micromeria chamissonis*, *Mentha* spp., *Nepeta* spp. and *Ipomoea batatas*", and for "Living parts of Solanaceae (except fruits, seeds and plants for planting)" but the EWG considered that the same measures as for Plants for planting of Solanaceae will be relevant.

### IDENTIFICATION OF POSSIBLE MEASURES

**Possible measures for pathways**

- **Fruit of Solanaceae (in particular tomato, Capsicum spp., eggplant, tamarillo, Cape gooseberry**

To prevent entry of the complex, measures target host of *B. cockerelli.*

*Measures related to consignments:*

- Visual inspection is not sufficient to detect both pests.
- Testing of the consignment: some detection tests for Ca *L. solanacearum* exist but are not currently applied for routine testing. There is not yet an agreed Diagnostic Protocol to detect Ca *L. solanacearum*.
- Treatment: removal of green parts followed by washing, and inspection of consignment. This measure is only practical for tomato. Such treatment will remove *B. cockerelli* from the consignment. The bacterium may be found in the fruit flesh but it is very unlikely that a vector at destination feeds on the fruit flesh and acquires the bacterium. This option should be combined in a Systems Approach.
- Treatment: methyl bromide fumigation

Methyl bromide treatment is required in Australia as a measure in a Systems Approach for tomato fruits from New Zealand (Biosecurity Australia, 2009). It should be noted that methyl-bromide is no longer registered in the EU and in many other EPPO countries and will be phased out in 2015. Another type of fumigation may be effective but no specific data is currently available.

The Panel on Phytosanitary Measures considered that both treatments (washing and fumigation) should be applied to tomato fruits (in addition to removal of green parts) to guarantee pest freedom of the consignment. Fruit should be packed on the same site as treatment.

- Import under specific conditions (e.g. immediate processing of the fruit and destruction of the waste, or immediate processing during winter) is possible, but it is not practical and difficult to control in practice. If green parts are discarded, some individuals of *B. cockerelli* might be able to complete development. For import during winter, there is at present not enough information about temperature requirements of the vector and under which conditions it can survive host plant free periods. Therefore, it is not possible to assess the level of risk reduction and to set exact requirements under which conditions import would be possible with a very low risk of introduction.

Considering that the risk of transfer of Ca *L. solanacearum* from an infested fruit to a crop in the PRA area is very unlikely if *B. cockerelli* is not introduced at the same time as the infested fruit, only measures against *B. cockerelli* are retained for this pathway.

*Measures related to the crop or to places of production:*

- Grow the crop under specific conditions:

Host plants should be cultivated under complete physical protection excluding *B. cockerelli* with the application of stringent sanitation measures (removal of plant debris and possible hosts of the vector in the surroundings). It should also include monitoring and packing on the site to prevent reinfestation. The Phytosanitary Compliance Programme for Export Loose Tomato Fruit to Australia of New Zealand (MAFBNZ, 2009) provide for measures targeting *B. cockerelli* (e.g. control strategies, monitoring). This option should be combined with treatment of the consignment and should only be implemented on the basis on bilateral agreement.

- Pest-free area or pest-free site of production

Considering the long-distance annual migrations of the complex *B. cockerelli*/*Ca*. L. solanacearum, the size of the pest-free area should be sufficient to guarantee that *B. cockerelli* will not arrive in the area through natural spread. For the countries where *B. cockerelli* is currently known to be present, this option was not considered possible by the EWG.
The following requirements should be applied:
- detailed monitoring, inspections and surveying to demonstrate freedom from *B. cockerelli*,
- limitation on material used in the area to prevent introduction of *B. cockerelli* in the PFA.

Pest-free sites of production may theoretically be established under complete physical protection (screened greenhouses with complete control of the vector). However, the Panel on Phytosanitary Measures considered that it was difficult to implement in practice in commercial production and did not recommend this option.

- **Plants for planting of Solanaceae (except seeds)**

For the EU, import of plants for planting of *Solanaceae* is prohibited (except from European countries and countries in the Mediterranean region) (EU Directive 2000/29/EC). This pathway is also closed for at least Norway and Switzerland.

*Measures related to consignments:*

- Visual inspection is not sufficient to detect both pests (plants may be asymptomatic; some life stages of *B. cockerelli* are very difficult to detect).

- Testing of the consignment: some detection tests exist but are not currently applied for routine testing. There is not yet an agreed Diagnostic Protocol to detect Ca *L. solanacearum* in plants. It should be noted that infective *B. cockerelli* may be present on plants even if these plants do not test positive for Ca *L. solanacearum*.

- Post-entry quarantine was not considered as a realistic option because the quarantine period would be too long for the intended use of seedlings and young plants. A post-entry quarantine period might be feasible for small quantities of high value material.

*Measures related to the crop or to places of production:*

- Certification scheme: this measure was considered difficult to implement in practice because of the difficulty to ensure the absence or control of psyllid populations at critical times, and because of the absence of validated standard protocol to test for Ca *L. solanacearum*. For these reasons, certification is not considered as a possible measure for imports from countries where both the bacterium and vector is present. It could be reliable for an area where the vector is absent once a reliable testing system is available.

- Pest-free area

Considering the long-distance annual migrations of the complex *B. cockerelli*/*Ca.* L. solanacearum, the size of the pest-free area should be sufficient to guarantee that *B. cockerelli* will not arrive in the area through natural spread. For the countries where *B. cockerelli* is currently known to be present, this option was not considered possible by the EWG.

The following requirements should be applied:

- detailed monitoring, inspections and surveying to demonstrate freedom from *Ca*. L. solanacearum in Solanaceae production
- detailed monitoring, inspections and surveying to demonstrate freedom from *B. cockerelli*
- limitation on material used in the area to prevent introduction of *Ca*. L. solanacearum in Solanaceae production in the PFA.

-Pest-free sites of production may theoretically be established under complete physical protection (with use of seedlings free from *Ca*. L. solanacearum grown in screened greenhouses with complete control of the vector). However, the Panel on Phytosanitary Measures considered that it was difficult to implement in practice in commercial production and did not recommend this option.

- **Seed potatoes (including microplants and minitubers) and ware potatoes**

For the EU, import of seed and ware potato is prohibited (except from European countries and countries in the Mediterranean region) (EU Directive 2000/29/EC). This pathway is also closed for at least Norway and Switzerland. *B. cockerelli* cannot be associated with this pathway.

*Measures related to consignments:*

- Visual inspection: Symptoms of zebra chip might be observed in tubers, but some tubers may be asymptomatic.

- Testing: The detection tests published have been developed for research and monitoring of the disease in the crops but have not been evaluated extensively for phytosanitary purposes. They are considered adequate for testing in Post-entry quarantine but not yet for routine testing of large volumes. More adequate tests may be available in the near future.

- Post-entry quarantine: this option may be adequate for small quantities of high grade microplants or minitubers.

- Limited end use: Consignments of ware potatoes are intended only for consumption. However, there is a risk that consumers may use infected ware potatoes as seed potatoes in private gardens. To address this risk, ware potatoes could be allowed only for processing for industrial purposes in facilities with approved waste disposal facilities.

*Measures related to the crop or to places of production:*

-Production in a certification scheme (for seed potato). Existing certification schemes do not take into account *Ca*. L. solanacearum but this bacterium may be addressed in such system as soon as reliable tests are developed. In areas where the vector, *B. cockerelli*, is present pest freedom cannot be guaranteed by a certification scheme unless seed potatoes are only produced under complete physical protection.

- Pest-free area

Considering the long-distance annual migrations of the complex *B. cockerelli*/*Ca.* L. solanacearum, the size of the pest-free area should be sufficient to guarantee that *B. cockerelli* will not arrive in the area through natural spread. Pest freedom should be based on surveillance of solanaceous host plants.

For the countries where *B. cockerelli* is currently known to be present, this option was not considered possible by the EWG.

**EVALUATION OF THE MEASURES IDENTIFIED IN RELATION TO THE RISKS PRESENTED BY THE PATHWAYS**

The trade in the commodities from outside the EPPO region is limited so impact on trade should be minor.

**Degree of uncertainty** Uncertainties in the management part are:

- Availability of reliable tests for *Ca*. L. solanacearum
- Possibility to implement a certification scheme
- Practical implementation of import under specific conditions
- Efficacy of other fumigation than methyl bromide

## IDENTIFICATION OF POSSIBLE MEASURES
**PC= Phytosanitary certificate, RC=Phytosanitary certificate of re-export**

| | |
|---|---|
| **Fruits of Solanaceae** | PC and, if appropriate, RC<br>PFA for *B. cockerelli* **OR**<br>Pest-free site under screenhouse for *B. cockerelli* (on the basis of bilateral agreement) **OR**<br>For tomato only: Systems Approach: grown under protected conditions, removal of green parts followed by washing and fumigation, and inspection of consignment (on the basis of bilateral agreement) |
| **Plants for planting of Solanaceae**<br>*This pathway is closed for most countries in the PRA area (e.g. the EU), but not for all.* | PC and, if appropriate, RC<br>PFA for *B. cockerelli* **and** *Ca.* L. solanacearum in Solanaceae |
| **Seed potatoes (including microplants and minitubers)**<br>*This pathway is closed for most countries in the PRA area (e.g. the EU), but not for all.* | PC and, if appropriate, RC<br>PFA for *Ca.* L. solanacearum in Solanaceae **OR**<br>Post-Entry Quarantine for high grade material |
| **Ware potatoes**<br>*This pathway is closed for most countries in the PRA area (e.g. the EU), but not for all.* | PC and, if appropriate, RC<br>PFA for *Ca.* L. solanacearum in Solanaceae production **OR**<br>Processing for industrial purposes |
| **Plants for planting of *Micromeria chamissonis*, *Mentha* spp., *Nepeta* spp. and *Ipomoea batatas*** | PC and, if appropriate, RC<br>PFA for *B. cockerelli* and for *Ca.* L. solanacearum in Solanaceae |
| **Living parts of Solanaceae (except fruits, seeds and plants for planting)** | PC and, if appropriate, RC<br>PFA for *B. cockerelli* and for *Ca.* L. solanacearum in Solanaceae |

## References

Abdullah NMM. 2008. Life history of the potato psyllid *Bactericera cockerelli* (Homoptera: Psyllidae) in controlled environment agriculture in Arizona. African Journal of Agricultural Research. 2008. 3: 1, 060-067

Al-Jabr AM. 1999. Integrated Pest Management of Tomato / Potato Psyllid, *Paratrioza cockerelli* (Sulc) (Homoptera: Psyllidae) with Emphasis on its Importance in Greenhouse Grown Tomatoes. Dissertation. Colorado State University

Berry NA, Scott I, Thompson S, Beard D. 2010. *Detection of Candidatus Liberibacter solanacearum in trapped insects and non-crop plants in New Zealand*. in Proceedings of the 10th annual 2010 zebra chip reporting session (Workneh & Rush Editors). Hyatt DFW Airport, Dallas, TX, November 7-10, 2010

Biosecurity Australia. 2009. Final pest risk analysis report for “Candidatus Liberibacter solanacearum” in fresh fruit, potato tubers, nursery stock and its vector the tomato-potato psyllid. Biosecurity Australia, Canberra. 110p

Hansen AK, Trumble JT, Stouthamer R, Paine TD. 2008. A new huanglongbing species, "Candidatus Liberibacter solanacearum," found to infect tomato and potato, is vectored by the psyllid Bactencera cockerelli (Sulc). Applied and Environmental Microbiology. 2008. 74: 18, 5862-5865

Liefting LW, Perez-Egusquiza ZC, Clover GRG, Anderson JAD. 2008a. A new '*Candidatus* Liberibacter' species in *Solanum tuberosum* in New Zealand. Plant Disease. 2008. 92: 10, 1474

Liefting LW, Sutherland PW, Ward LI, Paice KL, Weir BS, Clover GRG. 2009a. A new '*Candidatus* Liberibacter' species associated with diseases of solanaceous crops. Plant Disease. 2009. 93: 3, 208-214

Liefting LW, Ward LI, Shiller JB, Clover GRG. 2008b. A new '*Candidatus* Liberibacter' species in *Solanum betaceum* (Tamarillo) and *Physalis peruviana* (Cape Gooseberry) in New Zealand. Plant Disease. 2008. 92: 11, 1588

Liefting LW, Weir BS, Pennycook SR, Clover GRG ABSTRACT. 2009c. '*Candidatus* Liberibacter solanacearum', associated with plants in the family Solanaceae. International Journal of Systematic and Evolutionary Microbiology. 2009. 59: 9, 2274-2276

Teulon DAJ, Workman PJ, Thomas KL, Nielsen MC. 2009. *Bactericera cockerelli*: incursion, dispersal and current distribution on vegetable crops in New Zealand. New Zealand Plant Protection. 2009. 62: 136-144.

Wallis RL. 1955 Ecological studies on the potato psyllid as a pest of potatoes. USDA Technical Bulletin. 1107: 25.

Yang XB, Liu TX. 2009. Life history and life tables of *Bactericera cockerelli* (Homoptera: Psyllidae) on eggplant and bell pepper. Environmental Entomology, 38: 6, 1661-1667.