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Importation of fresh highbush and rabbit-eye blueberry (*Vaccinium corymbosum* L & *V. virgatum* Aiton) fruit into the Continental United States from Uruguay



A Pathway-Initiated Risk Assessment

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Executive Summary

The Dirección General de Servicios Agrícolas (DGSA) in Uruguay prepared this qualitative pest risk assessment to examine the plant pest risks associated with the importation of fresh blueberry fruit (*Vaccinium corymbosum* L. and *Vaccinium virgatum* Aiton) from Uruguay into the continental United States. The *Guidelines for Pathway-Initiated Pest Risk Assessment* (v. 5.02; USDA, 2000) were followed in the preparation of this risk assessment. For this risk assessment, we assumed that any blueberry fruits imported into the continental United States would undergo minimal postharvest fruit processing, which includes culling, packing, and forced air cooling, but no washing or other treatment. A pest survey in a blueberry production site in Uruguay did not reveal any quarantine significant pests likely to follow the pathway; however, a search of print and electronic resources did suggest the following quarantine pests may be associated with blueberry fruit and consequently follow the pathway:

Anastrepha fraterculus (Wiedemann) (Diptera: Tephritidae)
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)

Anastrepha fraterculus and *Ceratitis capitata* had high pest risk potentials. Four risk mitigation options were identified that may reduce the risk of this pest being introduced into the continental United States.

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I. Introduction

This risk assessment was prepared by the Division de Proteccion Agricola, Direccion General de Servicios Agricolas (DGSA) in Uruguay for Plant Protection and Quarantine (PPQ), Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) to examine potential plant pest risks associated with the importation of fresh blueberry fruit (*Vaccinium corymbosum* L. and *Vaccinium virgatum* Aiton) from Uruguay into the continental United States. (Hereafter, the use of the term blueberry(s) will refer to the above-mentioned species unless otherwise noted.) Following submission to PPQ, this risk assessment was reviewed and finalized by PPQ risk analysis staff.

This is a qualitative pest risk assessment which expresses risk in qualitative terms of High, Medium or Low rather than in numerical terms, such as probabilities or frequencies. The details of methodology and rating criteria are in the Guidelines for Pathway-Initiated Pest Risk Assessment, Version 5.02 (USDA, 2000), which are based on the standards provided by the International Plant Protection Convention (IPPC) of the United Nations' Food and Agriculture Organization (FAO). Phytosanitary terms conform to the IPPC's Glossary of Phytosanitary Terms (IPPC, 2006).

This risk assessment is one component of a complete pest risk analysis, which the IPPC (IPPC, 2004) describes as having three stages: Stage 1, Initiation, Stage 2, Risk Assessment, and Stage 3, Risk Management. This document satisfies IPPC (IPPC, 2004) requirements for Stages 1 and 2.

Blueberries belong to the genus *Vaccinium* L. (Ericaceae), which contains between 150 to 450 species (Van Steenis, 1972). In addition to blueberries, this genus includes cranberries, bilberries, and lingonberries (Caruso and Ramsdell, 1995). *Vaccinium* occur worldwide, with the highest biodiversity in the Himalayas, New Guinea, and the Andean Region of South America. The largest fruited cranberries and blueberries are native to North America (Caruso and Ramsdell, 1995). Within the United States, four species of blueberries are cultivated: *V. corymbosum*, *V. myrtilloides*, *V. angustifolium* and *V. virgatum* (Caruso and Ramsdell, 1995). The two blueberry species proposed for import in this risk assessment are native to the United States (USDA-NRCS, 2005).

In the 1900s, cultivated blueberries were introduced to the Netherlands, Germany, New Zealand, Poland, Japan, United Kingdom, Chile, southeastern Europe, and China from North America. In most of these countries it took some time for blueberry production to move from test plots to a commercial level. For example, blueberries were introduced to South America in the early 1980's to evaluate their production potential. By 1993, following 10 years of cultivation, blueberries yielded significant production with 575 hectares planted in Chile and less than four hectares in Argentina. In some countries, including China, Mexico, Brazil, Uruguay and Thailand, commercial production is at the initial experimental or early commercial production stages (Strik, 2005). The four blueberry species described above are cultivated in Europe, Australia, Chile, and New Zealand (Caruso and Ramsdell, 1995).

In 2003, North America accounted for about 75% of the planted area and 82% of the total highbush blueberry (*V. corymbosum*) production in the world (Strik, 2005). Currently, more than 30 U.S. States and Eastern Canada produce blueberries. In 2003, South America accounted for about 11% of the world's blueberry production area, with 65% of the South American portion occurring in Chile, where blueberry production first began. At this time,

there were an estimated 1200 hectares of blueberries planted in Argentina and 25 hectares in Brazil (Strik, 2005).

Recent commercial production of blueberries in Uruguay is limited to highbush (*V. corymbosum* L.) and rabbiteye (*V. virgatum* Aiton). The first blueberry plantations were initiated in 2000. By 2003 there were eight hectares in production, while in 2004, 100 hectares were planted. It is expected that an additional 100 hectares will be planted by 2005 (MGAP, 2005a). Blueberry plantations are located in Salto, Paysandú, Colonia, San José, Canelones, Montevideo, Maldonado, Lavalleja and Rocha departments. The majority of the plants used in blueberry plantations are micro-propagated plants that come from laboratories in Argentina and Uruguay (70%). The other 30% are propagated through traditional nursery operations (e.g., cuttings, bare-rooted plants). All of the blueberry stock originated in the United States.

Blueberries are planted in the autumn or spring. Planting is made on ridges at a distance of 2.8 – 3 m between rows and from 0.7 to 1 m between plants, resulting in a density of 3,300 to 5,400 plants per hectare. Ridges are covered with pine-chip or bark mulch to maintain adequate soil pH and humidity, favor root growth, and prevent weed development. Plastic mulch is also used. Plants are irrigated by drip irrigation systems in the soil/mulch. In Uruguay, blueberry plants are deciduous, remaining dormant during winter and actively growing during the spring and autumn (MGAP, 2005a).

Highbush blueberry (*Vaccinium corymbosum*) is the primary species cultivated in Uruguay, particularly the varieties: O'Neil, Misty, and Georgiagem. Leaf and flower phenology of these varieties differ slightly, affecting the harvest periods. In general, flowering occurs from the mid-July to mid-September (winter to early spring in Uruguay). The fruit harvest peaks from the last week of October to the first week of December. Uruguay proposes to export fresh blueberry fruits to the continental United States from mid-October to mid-December.

The main cultural problems associated with blueberry production in Uruguay include late frosts, poor soil drainage, undesirable soil pH, and excessive rainfall in the spring. Thus far, pests have not been problematic in blueberry crops. A national pest survey was conducted between 2004-2005 to identify the pests of blueberries in Uruguay. A total of 23 pests and pathogens were identified (Appendix A), none of which cause major economic damage. Thus, up to now, insect and pathogen management strategies have not been necessary for this crop, although specific blueberry cultural practices (e.g., pruning) and preventive fungicide treatments are used to maintain a healthy crop. Fungicide treatments include a winter treatment with captan to prevent wounds and cankers, and two to four spring treatments at flowering, fruit setting and pre-harvest also with captan. When conditions are favorable for the development of *Botrytis*, a preventive treatment with iprodione, at flowering, is applied, in addition to three post-harvest treatments of captan.

Blueberries are harvested when they turn approximately three quarters blue. Farmers recommend watering the rows between blueberry bushes right before harvest to minimize dust that may be stirred during harvest. Blueberries are hand-picked in the early morning to avoid high temperatures and are directly placed in plastic boxes, which are protected from the sun, and can hold approximately four kilograms of fruit. From the field, boxes are taken to a packing facility where the high quality fruit is selected and packed in the shell packs (125-175 grams) in which they will be sold. Fruit is not washed or treated. Shell packs are placed in containers that hold 8 to 12 shell packs each. Within six hours after harvest, these

containers are forced air-cooled at production sites to lower field temperatures down to 6-8°C, and then are stored in cooled chambers at 1°C, until export. From the production sites to the export points, fruit containers are loaded onto refrigerated trucks that maintain a storage temperature of 1°C. Prior to exportation, the fruit is inspected for a phytosanitary certificate. Fruit pallets are then hermetically sealed with a thermal blanket that maintains the temperature during transport (Monteiro, 2005). Gel packs are also kept on the pallets to help keep the commodity cool.

For this risk assessment, we assumed that any blueberry fruits imported into the Continental United States would undergo minimal postharvest fruit processing, which includes culling, packing, and forced air cooling, but no washing or other treatment.

In 2003 and 2004, blueberries were exported to the European Union via air under the conditions described above (Monteiro, 2005). 353 kg of blueberries were exported in 2003 (Belgium), and 2675 kg were exported in 2004 (Belgium, Germany, Spain, France and Italy). Based on current production rates, it is estimated that Uruguay will be able to export 15 tons in 2005 and 40 tons in 2006 (MGAP, 2005a).

II. Risk Assessment

2.1 Initiating Event: Proposed Action

This risk assessment was developed by the Direccion General de Servicios Agrícolas as part of its request to the USDA for authorization to import fruit of two species of blueberries (*Vaccinium corymbosum* and *V. virgatum*) into the continental United States. Entry of this commodity into the continental United States establishes a potential pathway for the entry of plant pests. Title 7 of the Code of Federal Regulations 319, Part 56 (7CFR § 319.56) provides regulatory authority for the importation of fruits and vegetables from foreign sources into the United States.

2.2 Assessment of Weediness Potential of *Vaccinium* spp.

The potential of *Vaccinium corymbosum* and *V. virgatum* to become weeds after they enter the continental United States was assessed. Overall, this assessment found these species to not be invasive. Because they are native to the United States, a formal weed risk assessment was not required (Table 1) (USDA, 2000).

Table 1. Process for determining the weediness potential of Highbush and Rabbit-eye blueberry, *Vaccinium corymbosum* L. and *V. virgatum* Aiton (Ericaceae)

***Vaccinium corymbosum* L.**

Common Names: American blueberry, Blueberry, Highbush blueberry, Swamp blueberry (USDA-ARS, 2005).

Synonyms: *Cyanococcus corymbosus* (L.) Rydb., *C. cuthbertii* Small, *Vaccinium constablaei* Gray, *V. corymbosum* L. var. *albiflorum* (Hook.) Fern., *V. corymbosum* L. var. *glabrum* Gray (USDA-ARS, 2005; USDA-NRCS, 2005).

***Vaccinium virgatum* Aiton**

Table 1. Process for determining the weediness potential of Highbush and Rabbit-eye blueberry, *Vaccinium corymbosum* L. and *V. virgatum* Aiton (Ericaceae)

Common Names: Southern black blueberry; Rabbit-eye blueberry (USDA-ARS, 2005).

Synonyms: *Cyanococcus virgatus* (Ait.) Small, *Vaccinium amoenum* Ait., *V. ashei* Rehd., *V. corymbosum* L. var. *amoenum* (Ait.) Gray, *V. parviflorum* Gray, *V. virgatum* Ait. var. *ozarkense* Ashe, *V. virgatum* Ait. var. *speciosum* Palmer (USDA-ARS, 2005).

Note: There is some controversy regarding taxonomic relationships within *Vaccinium*, particularly the blueberry (Weakley, 2005). Some taxonomists use a broader definition of species than others recognizing a smaller set of species. For example, some taxonomists include the rabbit-eye blueberry (*V. ashei*) within *V. corymbosum*. Until these taxonomic issues are resolved with definitive studies, this assessment considers *V. corymbosum* in a narrower sense as described in Weakley (2005).

Rabbit-eye blueberries have traditionally been known as *V. ashei* (Caruso and Ramsdell, 1995); however, according to the United States National Plants Database, *V. ashei* is now a synonym of *V. virgatum* (USDA-NRCS, 2005). Because most of the pest literature refers to *V. ashei*, it is necessary to do a literature review using both names when compiling the pest list.

Phase 1: Distribution in the United States: *Vaccinium corymbosum* is native to the eastern and north central United States (USDA-NRCS, 2005). *Vaccinium virgatum* is native to the southeastern United States (USDA-NRCS, 2005).

Phase 2: Invasive / Weed Status: Listing as weed

No (Holm *et al.*, 1977; Reed, 1977; Gunn and Ritchie, 1988; Holm *et al.*, 1991; Holm *et al.*, 1997; Weber, 2003; Skinner *et al.*, 2005; Swearingen, 2005; WSSA, 2005; 7 CFR § 360, January 1, 2005).

Yes A Global Compendium of Weeds (Randall, 2005).

No Other scientific literature.

Phase 3: Summary and Conclusions: *Vaccinium corymbosum* is listed as a weed in New Zealand by the Global Compendium of Weeds; however, no other information was found to confirm or describe the status of this plant in New Zealand. Regardless of its status in New Zealand, it is native to the continental United States. It is recommended that fresh fruits of *Vaccinium corymbosum* and *V. virgatum* be considered for importation following an appropriate pest risk assessment.

2.3 Decision History, Current Status, and Pest Interceptions

Over the last 80 years, the United States has received approximately 30 requests for the importation of blueberries and other *Vaccinium* species. During the first part of the twentieth century (1924-1937), the United States received and approved numerous requests from European countries for the importation of blueberries and other *Vaccinium* species (Table 2). Then between 1951 and 1989, the United States denied importation requests from several countries because there was no acceptable treatment for medfly (*Ceratitis capitata*). These requests typically came from countries located entirely within tropical climates. Because medfly was either not found in Chile and Tasmania (Australia) or had a restricted distribution, these countries were allowed to export blueberries into the United States, provided that agricultural inspection at U.S. ports did not reveal any flies. Then, beginning in 1992, the United States began to approve the import of blueberries from tropical countries because an acceptable treatment for medfly (methyl bromide fumigation) had been developed.

Table 2. Prior decisions the United States has made regarding requests to import blueberries and other <i>Vaccinium</i> species.				
Year	Commodity	Country	Decision	Reasons / Conditions
1924	Cranberries	Sweden	Approved	
1924	Bilberry (<i>V. myrtillus</i>)	Norway	Approved	
1924	Cowberries (<i>V. vitis-idaea</i>)	Finland	Approved	
1925	<i>Vaccinium</i> sp. (blueberries, huckleberries, cranberries, lingonberries)	Norway	Approved	
1925	<i>Vaccinium</i> sp. (blueberries, huckleberries, cranberries, lingonberries)	Sweden	Approved	
1926	<i>Vaccinium</i> sp. (blueberries, huckleberries, cranberries, lingonberries)	Finland	Approved	
1927	<i>Vaccinium</i> sp. (blueberries, huckleberries, cranberries, lingonberries)	Poland	Approved	
1928	Blueberries, cranberries, lingonberries, partridge berries, whortleberries, huckleberries	Russia	Approved	
1932	Cranberries	Estonia	Approved	
1936	Cranberries	Japan	Approved	
1936	Cranberries	Latvia	Approved	
1937	Lingonberries, cranberries, blueberries, whortleberries, etc.	Demark	Approved	
1951	Blueberries	Australia	Denied	No treatment for medfly
1951	<i>Vaccinium</i>	New Zealand	Approved	
1953	<i>Vaccinium</i>	Iceland	Approved	
1980	<i>Vaccinium</i> sp. (blueberries)	Australia	Denied	No treatment for medfly
1982	Blueberries (<i>Vaccinium</i> sp.)	Chile	Approved	Inspect & treat if warranted
1984	Blueberries	Tasmania (Australia)	Approved	With inspection
1988	Blueberries	France	Denied	No acceptable treatment for medfly

Year	Commodity	Country	Decision	Reasons / Conditions
1988	Blueberries	Guatemala	Denied	No acceptable treatment for medfly
1988	Blueberries	Argentina	Denied	No acceptable treatment for medfly
1988	Blueberries	Colombia	Denied	No acceptable treatment for medfly
1989	Blueberries	South Africa	Denied	Due to Comprehensive Anti-Apartheid Act of 1986 (Embargo)
1992	Blueberries	Mexico	Approved	Subject to inspection
1992	Blueberries	Bolivia	Approved	Subject to inspection and fumigation for medfly
1993	Blueberries	Peru	Approved	Fumigate for medfly
1993	Blueberries	Ecuador	Approved	Fumigate for medfly
1994	Blueberries	Argentina	Approved	Fumigate for medfly

Since the United States started conducting risk assessments in the mid 1990's, following the recommended procedures of the International Plant Protection Convention, only one risk assessment, for blueberries from Colombia, has been conducted. The risk assessment did not identify any quarantine pests likely to follow the pathway on fresh blueberries from Colombia.

Currently, blueberries are authorized entry into the United States from Argentina, Bolivia, Chile, Ecuador, Mexico and Peru (USDA-APHIS, 2005a). *Vaccinium spp.* are authorized from Armenia, Australia (Tasmania only), Azerbaijan, Belarus, Belgium, Bulgaria, Denmark, Estonia, Finland, Georgia, Iceland, Japan (except from Amami, Bonin, Ryukyu, Tokara and Volcano Islands), Kazakhstan, Krygyzstan, Latvia, Lithuania, Moldova, Netherlands, New Zealand, Norway, Poland, Russian Federation, Sweden, Tajikistan, Turkmenistan, Ukraine, United Kingdom, and Uzbekistan (USDA-APHIS, 2005a).

APHIS-PPQ maintains a database (Port Information Network database or PIN-309) of all the interceptions of pests and pathogens on commodities entering the United States. The database includes interceptions on permit cargo, general cargo, ship's quarters, ship's holds, passenger baggage, ship stores, mail and other pathways. This database was examined to determine which pests and pathogens have been intercepted on *Vaccinium* fruit. According to the database, between 1985 and 2005 (PIN-309 query November 1, 2005), the United States intercepted 1119 pests and pathogens on *Vaccinium spp.* (Table 3). The majority of these interceptions (986) occurred on fruit.

Organism	Reported Origin	Imported As	Where Intercepted	Frequency
Acanthosomatidae sp.	Chile	Fruit	Permit Cargo	1
Acari sp.	New Zealand	Fruit	Baggage	1
Acrididae sp.	Chile	Fruit	Permit Cargo	1
<i>Agrotis</i> sp.	Chile	Fruit	Permit Cargo	4

Table 3. Organisms intercepted on <i>Vaccinium</i> spp. at U.S. ports-of entry (1985 – 2005)				
Organism	Reported Origin	Imported As	Where Intercepted	Frequency
Aleyrodidae sp.	Russian Federat	Plant	Permit Cargo	1
<i>Anacamptis</i> sp.	Chile	Fruit	Permit Cargo	1
Aphididae sp.	Chile	Fruit	Permit Cargo	1
Aphididae sp.	Russian Federat	Plant	Permit Cargo	1
<i>Apion</i> sp.	Chile	Fruit	Permit Cargo	7
<i>Apion</i> sp.	Jamaica	Fruit	Baggage	1
Arctiidae sp.	Chile	Fruit	Permit Cargo	1
<i>Arhyssus tricostatus</i>	Chile	Fruit	Permit Cargo	1
<i>Athlia rustica</i>	Chile	Fruit	Permit Cargo	4
<i>Bergallia</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Blapstinus punctulatus</i>	Chile	Fruit	Permit Cargo	1
<i>Botryosphaeria</i> sp.	New Zealand	Fruit	Permit Cargo	1
Brachycerinae sp.	New Zealand	Fruit	Permit Cargo	1
<i>Bufomibcrus</i> sp.	Honduras	Leaf	Baggage	1
<i>Calpodes</i> sp.	Honduras	Leaf	Permit Cargo	1
Chrysomelidae sp.	Chile	Fruit	Permit Cargo	3
Cicadellidae sp.	Chile	Fruit	Permit Cargo	6
Coccidae sp.	Italy	Fruit	Baggage	1
Coccidae sp.	Russian Federat	Cutting	Baggage	1
Coccidae sp.	Singapore	Cutting	Permit Cargo	1
<i>Colletotrichum</i> sp.	Indonesia	Cutting	Permit Cargo	1
<i>Coniothyrium</i> sp.	Indonesia	Cutting	Permit Cargo	1
<i>Conoderus rufangulus</i>	Chile	Fruit	Permit Cargo	1
<i>Conotrachelus</i> sp.	Honduras	Leaf	Permit Cargo	2
<i>Copitarsia</i> sp.	Chile	Fruit	Permit Cargo	27
Coreidae sp.	Chile	Fruit	Permit Cargo	1
Coreidae sp.	Chile	Leaf	Permit Cargo	1
Cosmopterigidae sp.	Chile	Fruit	Permit Cargo	2
Cosmopterigidae sp.	New Zealand	Fruit	Permit Cargo	1
Crambidae sp.	Chile	Fruit	Permit Cargo	1
<i>Ctenopseustis obliquana</i>	New Zealand	Fruit	Permit Cargo	2
Curculionidae sp.	Honduras	Leaf	Permit Cargo	1
Delphacidae sp.	Chile	Fruit	Permit Cargo	28
<i>Dexicrates robustus</i>	Chile	Fruit	Permit Cargo	2
Diaspididae sp.	Indonesia	Cutting	Permit Cargo	1
Diptera sp.	New Zealand	Fruit	Permit Cargo	1
<i>Eoreuma</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Epiphyas postvittana</i>	New Zealand	Fruit	Permit Cargo	7
Eumolpinae sp.	New Zealand	Fruit	Permit Cargo	2
<i>Fiorinia</i> sp.	Singapore	Cutting	Permit Cargo	1

Table 3. Organisms intercepted on <i>Vaccinium</i> spp. at U.S. ports-of entry (1985 – 2005)				
Organism	Reported Origin	Imported As	Where Intercepted	Frequency
<i>Frankliniella australis</i>	Chile	Fruit	Permit Cargo	31
<i>Frankliniella cestrum</i>	Chile	Fruit	Permit Cargo	8
<i>Frankliniella</i> sp.	Chile	Fruit	Permit Cargo	6
Gelechiidae sp.	Bosnia	Plant	Baggage	1
Gelechiidae sp.	Chile	Fruit	Permit Cargo	20
Gelechiidae sp.	Ecuador	Fruit	Baggage	1
Gelechiidae sp.	New Zealand	Fruit	Permit Cargo	2
Geometridae sp.	Chile	Fruit	Permit Cargo	3
Geometridae sp.	New Zealand	Fruit	Permit Cargo	1
<i>Gonocerus acuteangulatus</i>	Netherlands	Cut Flower	Permit Cargo	1
Gracillariidae sp.	Norway	Cutting	Permit Cargo	1
Gracillariidae sp.	Unknown	Leaf	Quarters	5
<i>Grammophorus minor</i>	Chile	Fruit	Permit Cargo	1
Gryllidae sp.	Chile	Fruit	Permit Cargo	1
<i>Gryllus</i> sp.	Chile	Fruit	Permit Cargo	4
Hadeninae sp.	Chile	Fruit	Permit Cargo	3
Heliethinae sp.	Chile	Fruit	Permit Cargo	2
Hesperiidae sp.	Chile	Fruit	Permit Cargo	1
<i>Hoplosphyrum griseus</i>	Chile	Fruit	Permit Cargo	8
<i>Hylamorphia elegans</i>	Chile	Fruit	Permit Cargo	4
<i>Kuschelina decorata</i>	Chile	Fruit	Permit Cargo	61
<i>Kuschelina</i> sp.	Chile	Fruit	Permit Cargo	3
Lepidoptera sp.	Hawaii	Fruit	Baggage	1
Lepidoptera sp.	New Zealand	Fruit	Permit Cargo	2
<i>Leptoglossus chiliensis</i>	Chile	Fruit	Permit Cargo	63
<i>Lexiphanes</i> sp.	Chile	Fruit	Permit Cargo	2
<i>Ligyryus villosus</i>	Chile	Fruit	Permit Cargo	1
<i>Listroderes</i> sp.	Chile	Fruit	Permit Cargo	2
<i>Lithraeus egenus</i>	Chile	Fruit	Permit Cargo	3
Lycaenidae sp.	Chile	Fruit	Permit Cargo	1
Lygaeidae sp.	Chile	Fruit	Permit Cargo	2
Lygaeoidea sp.	Honduras	Leaf	General Cargo	2
<i>Microgryllus pallipes</i>	Chile	Fruit	Permit Cargo	8
Miridae sp.	New Zealand	Fruit	Permit Cargo	1
<i>Naupactus xanthographus</i>	Chile	Fruit	Permit Cargo	2
<i>Nematus desantisi</i>	Chile	Fruit	Permit Cargo	2
<i>Nematus oligospilus</i>	Chile	Fruit	Permit Cargo	1
Noctuidae sp.	Chile	Fruit	Permit Cargo	12
Noctuidae sp.	Honduras	Leaf	General Cargo	1
Nodonota sp.	Honduras	Leaf	General Cargo	1

Table 3. Organisms intercepted on <i>Vaccinium</i> spp. at U.S. ports-of entry (1985 – 2005)				
Organism	Reported Origin	Imported As	Where Intercepted	Frequency
<i>Nomophila</i> sp.	Chile	Fruit	Permit Cargo	4
<i>Nycterinus</i> sp.	Chile	Fruit	Permit Cargo	1
Nymphalidae sp.	Honduras	Leaf	General Cargo	1
<i>Nysius huttoni</i>	New Zealand	Fruit	Permit Cargo	1
<i>Nysius</i> sp.	Chile	Fruit	Permit Cargo	4
Olethreutinae sp.	Chile	Fruit	Permit Cargo	1
Olethreutinae sp.	India	Fruit	Baggage	1
Olethreutinae sp.	Indonesia	Cutting	Permit Cargo	1
Olethreutinae sp.	New Zealand	Fruit	Permit Cargo	2
Olethreutinae sp.	Russian Federat	Cutting	Baggage	1
<i>Orthotomicus</i> sp.	Chile	Fruit	Permit Cargo	1
Pentatomidae sp.	Chile	Fruit	Permit Cargo	3
Pentatomidae sp.	Guatemala	Fruit	Baggage	1
Pentatomoidea sp.	Chile	Fruit	Permit Cargo	2
<i>Pestalotiopsis</i> sp.	New Zealand	Fruit	General Cargo	3
Phlaeothripidae sp.	Japan	Seed	Baggage	1
Phlaeothripidae sp.	New Zealand	Fruit	Permit Cargo	2
<i>Phoma</i> sp.	New Zealand	Fruit	Permit Cargo	1
<i>Phoma</i> sp.	Norway	Seed	Permit Cargo	1
<i>Phyllophaga</i> sp.	Honduras	Leaf	Permit Cargo	1
<i>Plagiognathus</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Planotortrix excessana</i>	New Zealand	Fruit	Permit Cargo	2
<i>Platynota</i> sp.	Ecuador	Fruit	Permit Cargo	1
<i>Polydrusus</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Porotermes quadricollis</i>	Chile	Fruit	Permit Cargo	8
<i>Prietocella barbara</i>	New Zealand	Cut Flower	Permit Cargo	1
<i>Prietocella barbara</i>	New Zealand	Fruit	Permit Cargo	4
<i>Proeulia</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Pseudaonidia trilobitiformis</i>	Puerto Rico	Leaf	Baggage	1
Pseudococcidae sp.	Chile	Fruit	Permit Cargo	242
Pseudococcidae sp.	Indonesia	Cutting	Permit Cargo	1
Pseudococcidae sp.	New Zealand	Fruit	Permit Cargo	13
Pseudococcidae sp.	Nicaragua	Fruit	Baggage	1
Pseudococcidae sp.	Philippines	Cutting	Permit Cargo	1
Pseudococcidae sp.	Spain	Cutting	Permit Cargo	1
<i>Pseudococcus</i> sp.	Chile	Fruit	Permit Cargo	52
<i>Pseudococcus</i> sp.	New Zealand	Fruit	Permit Cargo	1
Psychidae sp.	New Zealand	Fruit	General Cargo	1
Psyllidae sp.	Chile	Fruit	Permit Cargo	1

Table 3. Organisms intercepted on <i>Vaccinium</i> spp. at U.S. ports-of entry (1985 – 2005)				
Organism	Reported Origin	Imported As	Where Intercepted	Frequency
Pterophoridae sp.	Canada	Plant	Mail	1
<i>Pucciniastrum</i> sp.	Norway	Leaf	Permit Cargo	1
<i>Pucciniastrum</i> sp.	Norway	Seed	Permit Cargo	1
<i>Pucciniastrum</i> sp.	Unknown	Leaf	Permit Cargo	1
Pyralidae sp.	New Zealand	Cut Flower	Permit Cargo	1
Pyralidae sp.	United Kingdom	Fruit	Baggage	1
Pyraustinae sp.	Honduras	Leaf	General Cargo	1
Rhopalidae sp.	Chile	Fruit	Permit Cargo	3
Riodinidae sp.	Honduras	Leaf	Permit Cargo	2
<i>Selenomphalus euryae</i>	Indonesia	Cutting	Permit Cargo	1
<i>Septoria</i> sp.	Hawaii	Leaf	Baggage	1
<i>Septoria</i> sp.	Indonesia	Cutting	Permit Cargo	1
<i>Sericoides</i> sp.	Chile	Fruit	Permit Cargo	2
<i>Sibinia albovittata</i>	Chile	Fruit	Permit Cargo	3
<i>Sibinia</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Sitona</i> sp.	Chile	Fruit	Permit Cargo	9
Sminthuridae sp.	Chile	Fruit	Permit Cargo	1
<i>Tarsonemus</i> sp.	Chile	Fruit	Permit Cargo	1
<i>Tetralopha</i> sp.	Honduras	Leaf	Permit Cargo	2
Thripidae sp.	New Zealand	Fruit	Baggage	1
Thripidae sp.	New Zealand	UNKNOWN	Permit Cargo	4
<i>Thrips obscuratus</i>	New Zealand	Fruit	Permit Cargo	1
<i>Thrips</i> sp.	New Zealand	Fruit	Permit Cargo	1
Thysanoptera sp.	New Zealand	Fruit	Permit Cargo	1
Tineidae sp.	Chile	Fruit	Permit Cargo	1
Tortricidae sp.	Canada	Fruit	Permit Cargo	1
Tortricidae sp.	Chile	Fruit	Permit Cargo	8
Tortricidae sp.	Netherlands	Cut Flower	Permit Cargo	1
Tortricidae sp.	New Zealand	Cut Flower	Permit Cargo	1
Tortricidae sp.	New Zealand	Fruit	Baggage	2
Tortricidae sp.	New Zealand	UNKNOWN	General Cargo	1
Tortricidae sp.	New Zealand	UNKNOWN	Permit Cargo	44
Tortricinae sp.	Chile	Fruit	Permit Cargo	222
Tortricinae sp.	Ireland	Cutting	Mail	1
Tortricinae sp.	New Zealand	Fruit	Baggage	1
Tortricinae sp.	New Zealand	UNKNOWN	General Cargo	2
Tortricinae sp.	New Zealand	UNKNOWN	Permit Cargo	20
Tortricinae sp.	New Zealand	UNKNOWN	Permit Cargo	1
Tortricinae sp.	Peoples Republi	Cutting	Baggage	1
Tortricinae sp.	Sweden	Plant	Baggage	1

Table 3. Organisms intercepted on <i>Vaccinium</i> spp. at U.S. ports-of entry (1985 – 2005)				
Organism	Reported Origin	Imported As	Where Intercepted	Frequency
Grand Total				1119

2.4 Pest Categorization – Identification of *Vaccinium* spp. Pests in Uruguay

The first step in categorizing quarantine pests is the development of a comprehensive list of pests associated with the commodity and known to occur in the country or region from which the commodity is to be exported. All pests on such a list are considered to be “of potential economic importance” because they are either associated with the plant species or can become associated with it (IPPC, 1996). To identify and categorize the pests of *Vaccinium corymbosum* and *V. virgatum*, multiple data sources were consulted, including, but not limited to, major abstract databases (*e.g.*, CAB Abstracts, and Biological Abstracts), relevant texts and treatises, electronic databases (*e.g.*, The Crop Protection Compendium, ECOPORT, PIN-309 interception records), and primary literature. For each pest, the literature was consulted to determine if it is present in the continental United States, the type of association it has with its host, its quarantine status with respect to the continental United States, and its ability to follow the pathway on imported fruits of *Vaccinium*.

PPQ adheres to the accepted international definition of a quarantine pest, as “a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled” (IPPC, 2006). Following the International Plant Protection Convention (IPPC, 2006), a quarantine pest is a pest that is not present in the United States, or if present, it has a limited distribution and is under official control. Pests that have a limited distribution in the United States and are being considered for official control (as determined by the USDA’s National Identification Services) are also considered as a quarantine pest; these pests are indicated with a pair of brackets (*i.e.*, [Yes]) in Table 4.

For a pest to be able to follow the pathway on commercial shipments of blueberry fruits, it must remain associated with the fruit from the foreign field, where it is harvested, to the United States, where it is consumed. A pest is generally likely to follow the pathway when it is an internal pest (*e.g.*, a fruit fly larvae), microscopic and uneasily seen (*e.g.*, a fungal pathogen), or when it is small and relatively immobile (*e.g.*, a scale). There are many pests that attack fruits and would not remain associated with the fruits as a result of their size and visibility (*e.g.*, an external caterpillar), or because they are relatively mobile and would be readily dislodged from the fruit during handling and processing (*e.g.*, a winged insect).

Pests that have been intercepted by USDA agricultural inspectors on *Vaccinium* in any type of pathway (*e.g.*, commercial shipments, passenger baggage, *etc.*) and that are present in Uruguay were included in the pest list table, even if they were not listed in the literature as a pest of *Vaccinium*. These pests were included because interceptions demonstrate a possible pathway for entry into the United States. Generally, not all pests that have been intercepted on *Vaccinium* fruits (Table 3) are considered likely follow the pathway in commercial shipments because many of these fruits did not go through commercial fruit processing. Furthermore, some of the pest interceptions that are listed in Table 3 probably represent rare hitchhikers or contaminants of commercial shipments. Only interceptions that occur regularly, especially on permitted cargo, are considered as potential pests of *Vaccinium*

species likely to follow the pathway. Intercepted pests that were identified to only the family level were not included in the pest list.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quarantine Pest³	Follows Pathway	Host association
ARTHROPODS					
ACARINA					
<i>Tarsonemus</i> sp. Acarina / Tarsonemidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S, Fl, F (CPC, 2004; PIN309, 2005)	No ⁴	Yes	PIN309, 2005.
<i>Bryobia praetiosa</i> Koch Acarina / Tetranychidae	US, UY (Jeppson et al., 1975; Bentancourt and Scatoni, 1999); Bolland et al., 1998	L, Fl (Jeppson et al., 1975)	No	No	USDA-APHIS-PPQ, 2004; Bolland et al., 1998 ⁵
<i>Tetranychus urticae</i> (Koch) Acarina / Tetranychidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999); Bolland et al., 1998	L (CPC, 2004)	No	No	Casals, 2004; Koch et al., 2000, SAG, 2005; USDA-APHIS-PPQ, 2004
DIPTERA					
<i>Anastrepha fraterculus</i> (Wiedemann) Diptera / Tephritidae	UY, US (TX) (CPC, 2005)	F (CPC, 2005)	[Yes]	Yes	(Vaccaro and Bouvet, 2006)
<i>Ceratitis capitata</i> (Wiedemann) Diptera / Tephritidae	UY (CPC, 2004)	F (CPC, 2004)	Yes	Yes	(Vaccaro and Bouvet, 2006)
COLEOPTERA					
<i>Apion</i> sp. Coleoptera / Curculionidae	US; UY (CPC, 2004; Bentancourt and Scatoni, 1999, Ross, 1997)	L, Fl, F (Bentancourt and Scatoni, 1999; PIN309, 2005)	Yes	Yes ⁶	USDA-APHIS-PPQ, 2004; PIN309, 2005
<i>Conotrachelus</i> sp. Coleoptera / Curculionidae	US; UY ⁷ (CPC, 2004; Bentancourt and Scatoni, 1999, Ross, 1997)	L, F (CPC, 2004; PIN309, 2005)	Yes	Yes ⁸	PIN309, 2005

¹ Geographic Distribution: US (United States), UY (Uruguay)

² Abbreviations to indicate plant parts: R (Roots), L (Leaves), B (Branches), S (Stem), Fl (Flowers), F (Fruit), C (Cotyledons), Sl (Seedlings), Sd (Seed)

³ For organisms identified only to the genus level: PPQ considers these organisms as potentially quarantine species if there are species in the genus that are quarantine pests with respect to the United States, even if the genus in question occurs in the United States.

⁴ The only *Tarsonemus* species present in Uruguay is *Tarsonemus latus* (Bentancourt and Scatoni, 1999); thus, we assumed the *Tarsonemus* species intercepted on blueberry from Uruguay was *T. latus*, which is already present in the United States (CPC, 2004) and, therefore, is not a quarantine pest.

⁵ Bolland *et al.* (1998) cited this pest on *V. myrtillus*

⁶ The species present in Uruguay is *Apion simplex* attacking *Trifolium polimorphum* flowers and developing seeds (Bentancourt and Scatoni, 1999). Not analyzed further, see text in Section 2.5, which follows this table.

Pest	Geographic Distribution¹	Plant Part Association²	Quarantine Pest³	Follows Pathway	Host association
<i>Listroderes</i> sp. Coleoptera / Curculionidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999, Ross, 1997)	R, L, S, F (CPC, 2004; PIN309, 2005)	Yes	Yes ⁹	PIN309, 2005
<i>Naupactus leucoloma</i> Boheman Coleoptera / Curculionidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	R, L (CPC, 2004)	No	No	Casals, 2004, Devotto et al., 2005; Hepp, 2005; INIA, Instituto de Investigaciones Agropecuarias (INIA), 2003; Koch et al., 2000; SAG, 2005.
<i>Naupactus xanthographus</i> (Germar) Coleoptera / Curculionidae	UY (CPC, 2004; Bentancourt and Scatoni, 1999)	R, S, L, F (Casals, 2004; PIN309, 2005; CPC, 2004)	Yes	No ¹⁰	Casals, 2004; Devotto et al., 2005, Hepp, 2005; PIN309, 2005
<i>Diabrotica speciosa</i> (Germar) Coleoptera /Chrysomelidae	UY (Bentancourt and Scatoni, 1999)	R, L, S, F (CPC, 2004)	Yes	No ¹¹	Gonzalez et al., 2005; MGAP, 2005a
<i>Conoderus rufangulus</i> (Gyllenhal) Coleoptera/Elateridae	UY (CPC, 2005)	R, S, L, F (PIN309, 2005; Koch et al., 2000)	Yes	No ¹²	(PIN309, 2005)

⁷ Species present in Uruguay: *Conotrachelus cristatus*, attacking celery (Bentancourt and Scatoni, 1999).

⁸ Not analyzed further, see text in Section 2.5, which follows this table.

⁹ Not analyzed further, see text in Section 2.5, which follows this table.

¹⁰ *Naupactus xanthographus* larvae feed on roots; adults feed on leaves (CPC, 2005). Its association with blueberry fruit is based on only two interceptions in commercial blueberry shipments (Table 3). U.S. port inspectors have intercepted *N. xanthographus* 109 times on fruits of various species (PIN309, 2005); however, in these cases this pest probably contaminated the commodity during harvest or packaging. CPC (2005) reports it as “a potential contaminant of fruit while it is being picked or standing in open bins.” *Naupactus xanthographus* adults are flightless and readily drop when disturbed (CPC, 2005). It is unlikely that *N. xanthographus* will contaminate blueberry cartons in the field because adults are similar in size to blueberries (1.2 – 1.5 cm; Bayer, 2004) and, thus, would be easily noticed. Furthermore, blueberry shipping boxes would not be directly underneath foliage from which adults can fall, because blueberry plants are small to medium sized bushes, (1-6 meters; Caruso and Ramsdell, 1995); cultivated blueberry plants in Uruguay are 1.2 – 1.6 meters (Monteiro, C., 2005). Based on this evidence, we consider *N. xanthographus* unlikely to follow the pathway of imported commercial blueberries.

¹¹ Adults of this chrysomelid feed on the foliage, flowers and fruit of a variety of plants during the day. Adults are capable of flight (CPC 2003). The larvae are pests on roots, especially maize (CPC, 2004). Only one study has shown an association between this pest and blueberries (Gonzalez et al., 2005). This pest is unlikely to follow the pathway on fresh blueberry fruit because adults would be disturbed during harvest and fly off the fruit. *Diabrotica speciosa* has been intercepted only two times by U.S. port inspectors (PIN309, 2004). Based on this evidence, we consider this species unlikely to follow the pathway of imported commercial blueberries.

¹² Association with *Vaccinium* is based on a single interception of *Conoderus rufangulus* on blueberries (PIN309, 2005). Because no other literature records indicated an association between *Vaccinium* and this pest,

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Cyclocephala signaticollis</i> Burmeister Coleoptera / Scarabaeidae	UY (Bentancourt and Scatoni, 1999)	R (Rocca et al., 2005)	Yes	No	Rocca et al., 2005
<i>Blapstinus punctulatus</i> Solier Coleoptera / Tenebrionidae	US (FL, TX); UY (www.coleoptera.org; Bentancourt and Scatoni, 1999)	S, L, F, C, SI (PIN309, 2005; AgroImpulso 2000; Bentancourt and Scatoni, 1999)	[Yes]	No ¹³	PIN309, 2005
HEMIPTERA					
<i>Dialeurodes citri</i> (Ashmead) Hemiptera / Aleyrodidae	US, UY (CPC, 2004; Miller et al., 2000; Bentancourt and Scatoni, 1999)	L (CPC, 2005)	No	No	CPC, 2003; CPC, 2004; USDA-APHIS-PPQ, 2004
<i>Trialeurodes vaporariorum</i> (Westwood) Hemiptera / Aleyrodidae	US, UY (CPC, 2004; Miller et al., 2000; Bentancourt and Scatoni, 1999)	L (CPC, 2004)	No	No	Casals, 2004; Gonzalez et al., 2005; MGAP, 2005a
<i>Aphis gossypii</i> Glover Hemiptera / Aphididae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	S, L, Fl (CPC, 2004)	No	No	Gonzalez et al., 2005, Koch et al., 2000, MGAP, 2005a, SAG, 2005
<i>Myzus persicae</i> (Sulzer) Hemiptera / Aphididae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S (CPC, 2004)	No	No	Buzeta, 1997; Casals, 2004; USDA-APHIS-PPQ, 2004

the single interception most likely represents a rare contaminant; consequently, *C. rufangulus* is not expected to follow the pathway on *Vaccinium* on a regular basis.

¹³ *Blapstinus punctulatus* occasionally attacks the seedlings of sunflower crops in Uruguay. Larvae live underground and surface during the night to feed on seedling stems, cotyledons and young leaves (Bentancourt and Scatoni, 1999; AgroImpulso 2000). This species has been intercepted 326 times on fruit of various commodities (PIN309, 2005); however, based on its terrestrial biology, these interceptions probably represent contamination of fruit at night during packing / processing. Blueberries from Uruguay are picked, packed and force-cooled during the day in the field and then kept in refrigerated chambers during transport to the importing country. *Blapstinus punctulatus* has only been intercepted a single time on blueberry shipments at U.S. ports-of-entry (PIN309, 2005); this is insufficient evidence that it will follow the pathway on fresh blueberry fruit on a regular basis.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Ceroplastes sinensis</i> (Linneo) Hemiptera/ Coccidae	US, UY (Bentancourt and Scatoni, 1999; Polavarapu et al., 2000; Stimmel, J. F., 1998)	L, S, F (Stimmel, J., 1998; PIN309, 2005)	No	Yes	Polavarapu et al., 2000
<i>Coccus hesperidum</i> Linneo Hemiptera/Coccidae	US, UY (CPC, 2004; Polavarapu et al., 2000; Bentancourt and Scatoni, 1999)	L, S (CPC, 2004)	No	No	CPC, 2003; CPC, 2004; Koch et al., 2000; Polavarapu et al., 2000; USDA-APHIS-PPQ, 2004
<i>Saissetia oleae</i> (Olivier) Hemiptera / Coccidae	US, UY (CPC, 2004; Polavarapu et al., 2000; Bentancourt and Scatoni, 1999)	L, S (CPC, 2004)	No	No	Polavarapu et al., 2000, USDA-APHIS-PPQ, 2004
<i>Leptoglossus impictus</i> (Stal) Hemiptera /Coreidae	UY (Bentancourt and Scatoni, 1999)	L (Gonzalez et al., 2005)	Yes	No	Casals, 2004, Gonzalez et al., 2005; Hepp, 2005; MGAP, 2005a
<i>Aspidiotus nerii</i> Bouché Hemiptera / Diaspididae	US, UY (CPC, 2004; Polavarapu et al., 2000; Bentancourt and Scatoni, 1999)	L, B, F (CPC, 2004)	No	Yes	Polavarapu et al., 2000; SAG, 2005; USDA-APHIS-PPQ, 2004
<i>Diaspidiotus perniciosus</i> (Comstock) <i>Cockerell</i> , Hemiptera / Diaspididae	US, UY (CPC, 2005; Polavarapu et al., 2000; Bentancourt and Scatoni, 1999)	L, S, F (CPC, 2004)	No	Yes	CPC, 2003; CPC, 2004; CPC, 2005 Polavarapu et al., 2000
<i>Hemiberlesia rapax</i> (Comstock) Hemiptera / Diaspididae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S, F (CPC, 2004)	No	Yes	CPC, 2003; Koch et al., 2000; SAG, 2005; USDA-APHIS-PPQ, 2004
<i>Lepidosaphes ulmi</i> (Linneo) Hemiptera / Diaspididae	US, UY (CPC, 2004; Polavarapu et al., 2000; Bentancourt and Scatoni, 1999)	L, S (CPC, 2004 USDA-APHIS-PPQ, 2004)	No	No	CPC, 2003; CPC, 2004; Polavarapu et al., 2000; USDA-APHIS-PPQ, 2004
<i>Pseudaulacaspis pentagona</i> (Targioni-Tozzetti) Hemiptera / Diaspididae	US, UY (Polavarapu et al., 2000; Bentancourt and Scatoni, 1999)	R, L, S	No	No	Polavarapu et al., 2000; USDA-APHIS-PPQ, 2004
<i>Nysius</i> sp. Hemiptera / Lygaeidae	US, UY ¹⁴ (CPC, 2004; Jubb et al., 1979; Bentancourt and Scatoni, 1999)	L, F (PIN309, 2005)	Yes	Yes ¹⁵	PIN309, 2005

¹⁴ The species of *Nysius* present in Uruguay, is *Nysius simulans*, which lives on potato, maize and Lucerne crops (Bentancourt and Scatoni, 1999).

¹⁵ Not analyzed further, see text in Section 2.5, which follows this table.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Icerya purchasi</i> Maskell Hemiptera / Margarodidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S (CPC, 2004)	No	No	Casals, 2004; Silva et al., 2005
<i>Pseudococcus calceolariae</i> Hemiptera / Pseudococcidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	R, S, L, B, F (CPC, 2004; SAG, 2005)	No	Yes ¹⁶	Koch et al., 2000; SAG, 2005
<i>Pseudococcus viburni</i> (Signoret) Hemiptera / Pseudococcidae	US, UY (CPC, 2004; Laflin et al., 2004 Bentancourt and Scatoni, 1999)	R, S, B (SAG, 2005)	No	No	SAG, 2005
LEPIDOPTERA					
<i>Mallocephala deserticola</i> (Berg). Lepidoptera/Arctiidae	UY (Bentancourt and Scatoni, 1999)	L Gonzalez et al., 2005	Yes	No	Gonzalez et al., 2005; MGAP, 2005a
<i>Anacampsis</i> sp. Lepidoptera / Gelechiidae	US, UY ¹⁷ (CPC, 2004; Bentancourt and Scatoni, 1999)	L, F (Bentancourt and Scatoni, 1999; PIN309, 2005)	Yes	Yes	PIN309, 2005
<i>Agrotis ipsilon</i> (Hufnagel) Lepidoptera / Noctuidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S (CPC 2004)	No	No	Buzeta, 1997; Casals, 2004; Gonzalez et al., 2005; Hepp, 2005; Koch et al., 2000; MGAP, 2005a; SAG, 2005.
<i>Agrotis</i> sp. Lepidoptera/Noctuidae	US; UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S (CPC, 2004)	Yes	No	PIN309, 2005; USDA-APHIS- PPQ, 2004
<i>Helicoverpa zea</i> (Boddie) Lepidoptera / Noctuidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, Fl, F (CPC, 2004)	No	Yes	Casals, 2004; Koch et al., 2000; USDA-APHIS- PPQ, 2004
<i>Peridroma saucia</i> (Hubner) Lepidoptera / Noctuidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, S, Fl (CPC, 2004)	No	No	CPC, 2003; USDA-APHIS- PPQ, 2004
<i>Rachiplusia nu</i> (Guenée). Lepidoptera / Noctuidae	UY (Bentancourt and Scatoni, 1999)	L (Gonzalez et al., 2005)	Yes	No	Gonzalez et al., 2005; MGAP, 2005a

¹⁶ References of its occurrence on blueberries from Chile indicate that it occurs on branches (SAG, 2005); references of it on other species indicate that it can occur on fruit (CPC, 2004).

¹⁷ There are species of this genera present in both countries. In Uruguay, the species, *A. humilis*, is present on *Trifolium*, and attacks leaves (Bentancourt and Scatoni, 1999)

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Spodoptera eridania</i> (Cramer) Lepidoptera / Noctuidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, F (CPC, 2004)	No	No ¹⁸	CPC, 2003; USDA-APHIS- PPQ, 2004
<i>Spodoptera frugiperda</i> (J. E. Smith) Lepidoptera / Noctuidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, F (CPC, 2004)	No	No ¹⁹	CPC, 2003; USDA-APHIS- PPQ, 2004
<i>Oiketicus platensis</i> (Berg). Lepidoptera/Psychidae	UY (Bentancourt and Scatoni, 1999; Gonzalez et al., 2005)	L (Gonzalez et al., 2005)	Yes	No	Gonzalez et al., 2005; MGAP, 2005a
<i>Nomophila sp.</i> Lepidoptera / Pyralidae	UY (Bentancourt and Scatoni, 1999)	L, F (PIN309, 2005)	Yes	Yes ²⁰	PIN309, 2005
ORTHOPTERA					
<i>Gryllus sp.</i> Orthoptera / Gryllidae	US, UY ²¹ (CPC, 2004; Walker, 1999; Bentancourt and Scatoni, 1999)	L, F (PIN309, 2005)	Yes	No ²²	USDA, 2004; PIN309, 2005
THYSANOPTERA					
<i>Frankliniella occidentalis</i> (Pergande) Thysanoptera / Thripidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, FI (CPC, 2004; Scherm et. al, 1999)	No	No	Scherm et al., 1999, USDA- APHIS-PPQ, 2004
<i>Frankliniella sp.</i> Thysanoptera / Thripidae	US, UY (CPC, 2005)	L, FI, F (CPC, 2005)	Yes	Yes ²³	PIN309, 2005
<i>Thrips sp.</i> Thysanoptera / Thripidae	US, UY (CPC, 2004; Bentancourt and Scatoni, 1999)	L, F (PIN309, 2005)	Yes	Yes ²⁴	PIN309, 2005
BACTERIA²⁵					
<i>Burkholderia andropogonis</i> (Smith) Gillis Burkholderiales / Burkholderiaceae	US, UY (CPC, 2005)	S, L, FI, SI	No	No	CPC, 2005

¹⁸ *Spodoptera eridania* is mainly a defoliating insect. Leaf-eating and skeletonization is the main damage caused to the host plant by *Spodoptera eridania*, and in extreme cases complete defoliation may occur. Larvae are not normally observed because they are nocturnal feeders, but the first two instars are gregarious and can be seen in clusters on the foliage. Based on this evidence, we concluded it is unlikely that this pest will follow the pathway.

¹⁹ This pest is a large external feeder that mostly feeds on leaves, but does attack the fruit of corn (Capinera, 2005); thus, it is unlikely to follow the pathway.

²⁰ Not analyzed further, see text in Section 2.5, which follows this table.

²¹ Species present in Uruguay is *Gryllus assimilis*

²² *Gryllus* species are large, mobile species that readily jump when disturbed, and therefore would be unlikely to remain with the fruit through standard harvest and postharvest handling.

²³ Not analyzed further, see text in Section 2.5, which follows this table.

²⁴ Not analyzed further, see text in Section 2.5, which follows this table.

²⁵ Bacterial Taxonomic Classification (CPC, 2003).

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Pseudomonas syringae</i> pv. <i>syringae</i> van Hall 1902	US, UY (Caruso et al., 1995; CPC, 2004)	L, S, Fl, F (CPC, 2004)	No	Yes	Bradbury, 1986; Caruso et al., 1995; CPC, 2003; CPC, 2004; Guerrero, 2000; Hepp, 2005; SAG, 2005; Strik, 2005
<i>Rhizobium radiobacter</i> (Beijerinck & van Delden) Young et al. (Syn: <i>Agrobacterium tumefaciens</i> (E. F. Smith & Towsend) Conn)	US, UY (CPC, 2004; Caruso et al., 1995; Farr et al., 2005)	R (CPC, 2004; Gonzalez et al., 2005; SAG, 2005)	No	No	Bradbury, 1986; Buzeta, 1997; Caruso et al., 1995; CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a
FUNGI²⁶					
<i>Alternaria alternata</i> (Fr.) Keissl Ascomycetes: Pleosporales	US, UY (Betucci, L. et al., 2004; CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005)	L, FL, F (CPC, 2004)	No	Yes	CPC, 2004; Farr et al., 1989; Farr et al., 2005; Guerrero et al., 1993; Guerrero, 2000; Gonzalez et al., 2005; MGAP, 2005a.
<i>Alternaria tenuissima</i> (Kunze) Wiltshire Ascomycetes: Pleosporales	US, UY (CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L, F (Caruso et al., 1995; Milholland et al., 1984)	No	Yes	Caruso et al., 1995; Cline et al., 2005; CPC, 2004; Farr et al., 2005; Fernandez et al., 2005a; Fernández et al., 2005b; Garcia Salazar, 2002; Gonzalez et al., 2005; MGAP, 2005a; Strik, 2005.
<i>Botryosphaeria dothidea</i> (Moug.) Ces. & de Not. (anamorph <i>Fusicoccum aesculi</i> Corda) Ascomycetes/ Dothideales	US, UY (Betucci L. et al., 2004; CPC, 2004; Farr et al., 2005; Monteiro, 2005)	L, S, B (Caruso et al., 1995; Milholland et al., 1984)	No	No	Caruso et al., 1995; Cline, 1997; Cline et al., 2005; Cuevas et al., 2003; CPC, 2004; Farr et al., 2005; Johnson et al., 2003; SAG, 2004; SAG, 2005; Strik, 2005

²⁶ Fungal Taxonomic Classification (9th Edition of the Dictionary of Fungi, www.indexfungorum.org/Names/Names.asp).

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Botryosphaeria sp.</i> Ascomycetes/ Dothideales	US, UY (Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L, S, B, F (Caruso et al., 1995; Milholland et al., 1984, PIN309, 2005)	Yes	Yes ²⁷	Farr et al., 1989; Farr et al., 2005, Gonzalez et al., 2005; MGAP, 2005a; USDA- APHIS-PPQ, 2004; PIN309, 2005
<i>Botrytis cinerea</i> Pers.: Fr [anamorph] Ascomycetes: Helotiales <i>Botryotinia fuckeliana</i> (de Bary) Whetzel [telomorph]	US, UY (CPC, 2004; Caruso et al., 2005; Farr et al., 2005, Gonzalez et al., 2005; MGAP, 2005a; Weingartner and Klos, 1974)	L, S, B, Fl, F (CPC, 2004; Weingartner and Klos, 1974)	No	Yes	Andrade et al., 1993; Bell et al., 1999; Buzeta, 1997; Caruso et al., 1995; Cline et al., 2005, CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005;; MGAP, 2005a;Smith, 1998; Wright et al., 2005
<i>Cercospora sp.</i> Ascomycetes/Mycospha erellales	US, UY (Altier, N., 1994; Caruso et al., 1995; Farr et al., 2005; Milholland, 1984)	S (Caruso et al., 1995; Milholland, 1984)	Yes	No	Caruso et al., 1995; Farr et al., 1989; Farr et al., 2005; Milholland et al., 1984; Scherm, 1999, USDA- APHIS-PPQ, 2004
<i>Cladosporium sp.</i> Ascomycetes/ Mycosphaerellales	US, UY (Altier, N., 1994; CPC, 2004;Caruso et al., 1995; Farr et al., 2005)	L, S, Fl, F (Caruso et al., 1995)	Yes	Yes ²⁸	Andrade et al., 1993, Farr et al., 1989; Farr et al., 2005; Gonzalez, 2005, MGAP, 2005a
<i>Colletotrichum</i> <i>acutatum</i> Simmonds ex Simmonds Ascomycetes / Phyllachorales	US, UY (Altier, N., 1994; CPC, 2004; Farr et al., 2005)	L, B, F (Caruso et al., 1995)	No	Yes	Caruso et al., 1995; Cline, 1997; Cline et al., 2005; Farr et al., 2005; USDA- APHIS-PPQ, 2004

²⁷ Not analyzed further, see text in Section 2.5, which follows this table.

²⁸ Not analyzed further, see text in Section 2.5, which follows this table.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quarantine Pest³	Follows Pathway	Host association
<i>Colletotrichum gloeosporioides</i> (Penz.) Penz. & Sacc.[anamorph] (= <i>Glomerella cingulata</i>) Ascomycetes / Phyllachorales	US, UY (Betucci, L. et al., 2004; CPC, 2004; Caruso et al., 1995; Farr et al., 2005)	L, B, F (Caruso et al., 1995; Milholland et al., 1984)	No	Yes	Buzeta, 1997; Caruso et al., 1995; Farr et al., 2005; Fernandez et al., 2005a; Garcia Salazar, 2002; Johnson et al., 2003; Midwest Small Fruit Pest Management Handbook, 2004; SAG, 2005; Strik, 2005; Wright et al., 2005
<i>Colletotrichum sp.</i> Ascomycetes / Phyllachorales	US, UY	L, B, F ²⁹ (Horst, 2001)	Yes	Yes ³⁰	USDA-APHIS-PPQ, 2004, PIN309, 2005
<i>Coniothyrium sp.</i> Ascomycetes/ Pleosporales	US, UY (Farr et al., 2005; Weingartner and Klos, 1974)	L, S Weingartner and Klos, 1974	Yes	No	Farr et al., 2005; PIN309, 2005; USDA-APHIS-PPQ, 2004, Weingartner and Klos, 1974
<i>Epicoccum nigrum.</i> Link Anamorphic Ascomycetes	US, UY (Betucci, L. et al., 2004; CPC, 2004; Farr et al., 2005)	L, F ³¹ (Guerrero et al., 1993; Guerrero, 2000; Horst, 2001)	No	Yes	Guerrero et al., 1993; Guerrero, 2000
<i>Epicoccum sp.</i> Anamorphic Ascomycetes	US, UY (Farr et al., 2005; Gonzalez et al., 2005; Weingartner and Klos, 1974)	L, S, F ³² (Gonzalez et al., 2005, MGAP, 2005a; Horst, 2001; Weingartner and Klos, 1974)	No	Yes	Farr et al., 1989; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a; Weingartner and Klos, 1974

²⁹ Association with host plant organs was evaluated at the genus level.

³⁰ Not analyzed further, see text in Section 2.5, which follows this table.

³¹ *Epicoccum nigrum* may be a secondary invader (Horst, 2001). On fruits it causes post-harvest decay, acting as a saprophyte (Guerrero et al., 1993; Guerrero, 2000; Horst, 2001).

³² Association with host plant organs was evaluated at the genus level. These pests cause post-harvest rot.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quarantine Pest³	Follows Pathway	Host association
<i>Fusarium oxysporum</i> Schlechtendahl Ascomycetes / Hypocreales	US, UY (CPC, 2004)	R, S (SAG, 2005)	Yes ³³	No	SAG, 2005
<i>Fusarium sp.</i> Ascomycetes / Hypocreales	US, UY (CPC, 2004; Farr et al., 2005; Weingartner and Klos, 1974)	R, S, L, F, Sd (Horst, 2001; Farr et al., 2005; Weingartner and Klos, 1974)	Yes	Yes ³⁴	Andrade et al., 1993; Farr et al., 2005; Fernandez et al., 2005a; Guerrero et al., 1993; Guerrero, 2000; Weingartner and Klos, 1974; Wright et al., 1998; Wright and Rivera, 2005; Wright et al., 2005
<i>Glomerella cingulata</i> (Stonem.) Spauld. & Schrenk [teleomorph] <i>Colletotrichum</i> <i>gloeosporioides</i> (Penz.) Sacc. [anamorph] Ascomycetes / Phyllachorales Incertae sedis	US, UY (CPC, 2004, Farr et al., 2005, Milholland et al., 1984)	R, S, Fl, F (Caruso et al., 1995; CPC, 2004; Milholland et al., 1984)	No	Yes	Bell et al., 1999; Caruso et al., 1995; CPC, 2004; Farr et al., 1989; Farr et al., 2005; SAG, 2005, USDA- APHIS-PPQ, 2004, Wright et al., 2005
<i>Hainesia lythri</i> (Desm.) Höhnel Ascomycetes / Helotiales	US; UY (Farr et al., 2005)	L (Cuevas et al., 2003; SAG, 2005)	No	No	Cuevas et al., 2003; SAG, 2004; SAG, 2005
<i>Penicillium expansum</i> Link Ascomycetes / Eurotiales	US, UY (Pianzolla, M. J. et al. 2004; CPC, 2004; Farr et al., 2005)	F ³⁵ (CPC, 2004)	No	Yes	CPC, 2003; CPC 2004
<i>Penicillium sp.</i> Ascomycetes / Eurotiales	US, UY (Farr et al., 2005)	F ³⁶ (CPC, 2004)	No	Yes	Andrade et al., 1993; Farr et al., 2005; Guerrero et al., 1993; Guerrero, 2000; SAG, 2005

³³ Some pathovars of *Fusarium oxysporum* are present in the U.S., while others are not and are considered quarantine pests. As with pests identified to only the genus level, this pathogen will be considered a quarantine pest because the particular pathovar that was attacking blueberries may not be in the U.S.

³⁴ Not analyzed further, see text in Section 2.5, which follows this table.

³⁵ *Penicillium*, in general, causes post-harvest decay (Horst 2001).

³⁶ *Penicillium*, in general, causes post-harvest decay (Horst 2001).

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Pestalotia vaccinii</i> (Shear) Guba (syn. <i>Pestalotia guepinii</i> Desmaz. var. <i>vaccinii</i> Shear) Ascomycetes/Xylariales	US, UY (Caruso et al., 1995; Farr et al., 2005; Gonzalez et al., 2005)	S, L (Cuevas et al., 2003; Gonzalez et al. 2005)	No	No	Caruso et al., 1995; Cuevas et al., 2003; Farr et al., 1989; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a; SAG, 2004; SAG, 2005
<i>Pestalotiopsis guepinii</i> (Desm.) Stey. Syn <i>Pestalotia guepinii</i> Desm. Ascomycetes/Xylariales	US, UY (Betucci, L. et al., 2004; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L (Gonzalez et al., 2005; MGAP, 2005a)	No	No	Fernandez et al., 2005a; Fernandez et al., 2005b; Gonzalez et al., 2005; MGAP, 2005a; Wright et al., 2005
<i>Pestalotiopsis sp.</i> Ascomycetes/Xylariales	US, UY (Farr et al., 2005)	L, F (PIN309, 2005)	Yes	Yes ³⁷	PIN309, 2005
<i>Phoma sp.</i> Ascomycetes/ Pleosporales	US, UY (Farr et al., 2005; Weingartner and Klos, 1974)	L, S, F, Sd (Farr et al., 2005; PIN309, 2005; Weingartner and Klos, 1974)	Yes	Yes ³⁸	Farr et al., 2005; PIN309, 2005; Weingartner and Klos, 1974)
<i>Phyllosticta elongata</i> G. J. Weidemann (teleomorph <i>Botryosphaeria vaccinii</i> (Shear) Barr) Ascomycetes/ Dothideales	US, UY (Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L (Farr et al., 2005; Gonzalez et al., 2005)	No	No	Caruso et al., 1995; Farr et al., 1989; Farr et al. 2005; Gonzalez et al., 2005; MGAP, 2005a
<i>Phyllosticta vaccinii</i> Earle Ascomycetes/ Dothideales	US, UY (Caruso et al., 1995; Gonzalez et al., 2005; MGAP, 2005a)	L (Caruso et al., 1995; Farr et al., 2005; Gonzalez et al., 2005)	No	No	Caruso et al., 1995; Cline, 1997; Farr et al., 1989; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a
<i>Phytophthora sp.</i> Oomycetes/Pythiales	US, UY (Farr et al., 2005)	R (Wright et al., 2005; Wright and Rivera, 2005; Northwest Berry & Grape Network)	Yes	No	Fernandez et al., 2005a; Northwest Berry & Grape Network; Scherm 1999, SAG, 2005; Wright et al., 1998; Wright and Rivera, 2005; Wright et al., 2005.

³⁷ Not analyzed further, see text in Section 2.5, which follows this table.

³⁸ Not analyzed further, see text in Section 2.5, which follows this table.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quaran-tine Pest³	Follows Pathway	Host association
<i>Pucciniastrum vaccinii</i> (G. Wint) Jorst (syn. <i>P. myrtilli</i> Arth.) Urediniomycetes Uredinales	US, UY (Caruso et al. 1995; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L (Caruso et al., 1995; Gonzalez et al. 2005)	No	No	Caruso et al., 2005; Farr et al., 2005; Fernandez et al., 2005a; Gonzalez et al., 2005; Hepp, 2005; MGAP, 2005a; Strik, 2005; Wright and Rivera, 2005.
<i>Rhizoctonia solani</i> [anamorph] <i>Thanatephorus cucumeris</i> (Frank) Donk [teleomorph] Basidiomycetes / Ceratobasidiales	US, UY (CPC, 2004; Farr et al. 2005)	R (SAG, 2005)	No	No	Farr et al., 1989; Farr et al., 2005; SAG, 2005.
<i>Rhizopus</i> sp. Zygomycetes / Mucorales	US, UY (CPC, 2004; Farr et al., 2005)	F ³⁹ (Andrade et al., 1993; Guerrero et al., 1993)	No	Yes	Andrade et al., 1993; Guerrero et al., 1993
<i>Rhizopus stolonifer</i> (Ehrenb.) Vuill. Zygomycetes / Mucorales	US, UY (CPC, 2004; Farr et al., 2005)	Fl, F (Guerrero, 2000; SAG, 2005;	No	Yes	Guerrero, 2000; SAG, 2005
<i>Stemphylium botryosum</i> Wallr. Ascomycetes/ Pleosporales	US, UY (CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L, S, FL, F (Gonzalez et al., 2005; Guerrero et al., 1993; Guerrero, 2000)	No	Yes	Guerrero et al., 1993; Guerrero, 2000; Gonzalez et al., 2005; MGAP, 2005a
<i>Stemphylium</i> sp. Ascomycetes/ Pleosporales	US, UY (CPC, 2004; Farr et al., 2005)	S, F (Andrade et al., 1993; Fernandez et al., 2005a; Wright et al., 2005)	Yes	Yes ⁴⁰	Andrade et al., 1993; Farr et al., 1989; Farr et al., 2005; Fernandez et al., 2005a; Wright et al., 2005
<i>Ulocladium</i> sp.	US, UY (CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a)	L (Gonzalez et al., 2005; MGAP, 2005a)	Yes	No	Gonzalez et al., 2005; MGAP, 2005a

³⁹ *Rhizopus*, in general, causes post-harvest rot (Horst 2001).

⁴⁰ Not analyzed further, see text in Section 2.5, which follows this table.

Table 4. Pests associated with commodity (in any country) and present in Uruguay					
Pest	Geographic Distribution¹	Plant Part Association²	Quarantine Pest³	Follows Pathway	Host association
<i>Verticillium</i> sp.	US; UY (CPC, 2004; Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a; Weingartner and Klos, 1974)	R, S (Farr et al., 2005; Gonzalez et al., 2005; SAG, 2005; Weingartner and Klos, 1974)	Yes	No	Farr et al., 2005; Gonzalez et al., 2005; MGAP, 2005a; SAG, 2005; Weingartner and Klos, 1974)
NEMATODES⁴¹					
<i>Pratylenchus penetrans</i> Filipjev & Schuurmans Steckhoven Pratylenchidae	US, UY (Caruso et al., 1995; CPC, 2004)	R (CPC, 2004)	No	No	Caruso et al., 1995; CPC, 2004
<i>Xiphinema americanum</i> Cobb Xiphinematidae	US, UY (Caruso et al., 1995; CPC, 2004)	R (CPC, 2004)	No	No	Caruso et al., 1995; CPC, 2004

No viruses appeared in Table 4 because there are no viruses attacking blueberries in Uruguay. The principal viruses that attack blueberries (Brunt et al., 2006), blueberry leaf mottle virus, blueberry scorch virus, blueberry shoestring virus and tomato ringspot virus, are quarantine pests in Uruguay (MGAP, 2005b)

2.5 Quarantine Pests Likely to Follow the Pathway

A literature review identified 85 pests and pathogens of blueberries that either are or may potentially be associated with blueberries in Uruguay. Not all of these pests are quarantine pests with respect to the United States. Furthermore, not all of these pests are likely to follow the pathway on fresh blueberries from Uruguay under the conditions described at the beginning of this document. Quarantine pests not expected to follow the pathway were not further considered; however, should any of these pests be intercepted in shipments of the commodity, quarantine action may be taken at the port-of-entry, and additional risk analyses may be conducted.

Pest categorization identified 17 quarantine pests likely to follow the pathway. Of these 17 pests, 15 were identified to only the genus level. Although the United States considers unidentified species as potentially quarantine species, these taxa were not further analyzed due to limited taxonomic and/or ecological knowledge about those pests. The lack of species identification may indicate limited taxonomic knowledge about that group, inappropriate life stage for full identification, or poor quality of the specimen. This lack of biological information on any given insect or pathogen should not be equated with low risk. By necessity, pest risk assessments focus on those organisms for which biological information is available and for which effective mitigation procedures may be developed (IPPC, 2004). Agricultural inspectors at the port-of-entry will continue to take action against pests not identified to the species level if other species in the same taxa are quarantine pests. After eliminating those pests for which there was insufficient biological or taxonomic information (Table 5), *Ceratitis capitata* (the Mediterranean fruit fly or Medfly) and *Anastrepha*

⁴¹ Nematode taxonomic classification as in CPC (2004)

fraterculus (the South American fruit fly) remained as quarantine pests that could reasonably follow the pathway on commercial shipments of blueberries from Uruguay. Until recently, there was no conclusive evidence that *Vaccinium* was a host for fruit flies; most references indicated there was an association, but did not provide field or laboratory infestation data. Recent research, however, has demonstrated and quantified infestation of *Vaccinium* by *C. capitata* and *A. fraterculus* (Vaccaro and Bouvet, 2006). Thus, these pests were further analyzed below.

Table 5. Quarantine pests likely to follow the pathway.

Species	Order / Family	Analyzed
<i>Anacamptis</i> sp.	Lepidoptera / Gelechiidae	No
<i>Anastrepha fraterculus</i>	Diptera / Tephritidae	Yes
<i>Apion</i> sp.	Coleoptera / Curculionidae	No
<i>Botryosphaeria</i> sp.	Ascomycetes / Dothideales	No
<i>Ceratitis capitata</i>	Diptera / Tephritidae	Yes
<i>Cladosporium</i> sp.	Ascomycetes / Mycosphaerellales	No
<i>Colletotrichum</i> sp.	Ascomycetes / Phyllachorales	No
<i>Conotrachelus</i> sp.	Coleoptera / Curculionidae	No
<i>Frankliniella</i> sp.	Thysanoptera / Thripidae	No
<i>Fusarium</i> sp.	Ascomycetes / Hypocreales	No
<i>Listroderes</i> sp.	Coleoptera / Curculionidae	No
<i>Nomophila</i> sp.	Lepidoptera / Pyralidae	No
<i>Nysius</i> sp.	Hemiptera / Lygaeidae	No
<i>Pestalotiopsis</i> sp.	Ascomycetes / Xylariales	No
<i>Phoma</i> sp.	Ascomycetes / Pleosporales	No
<i>Stemphylium</i> sp.	Ascomycetes / Pleosporales	No
<i>Thrips</i> sp.	Thysanoptera / Thripidae	No

2.6 Consequences of Introduction – Economic / Environmental Importance

The ability of a pest to become established, spread and cause economic and environmental harm was evaluated in this section using five Risk Elements: climate-host interaction, host range, dispersal potential, economic impact and environmental impact. Pests were assigned a rating of Low (1 point), Medium (2 points), or High (3 points) for each Risk Element (Table 6); a Cumulative Risk Rating was calculated by summing all Risk Elements for each pest analyzed (Table 7; USDA, 2000).

Consequences of Introduction: <i>Anastrepha fraterculus</i> Wiedemann (Diptera: Tephritidae)	Risk Rating
<p>Risk Element #1: Climate-Host Interaction <i>Anastrepha fraterculus</i> most likely represents a species complex that has not been well studied (CABI, 2005). This group ranges from the south of Texas to Argentina (Foote <i>et al.</i>, 1993), including Uruguay where it is widespread (CABI, 2005). These areas generally correspond to US Plant Hardiness Zones 9+. The continental United States spans a wide climatic range from Zone 1 in Fairbanks, Alaska to Zone 10 in Miami, Fl.¹ It is estimated that <i>A. fraterculus</i> could establish in two Plant Hardiness Zones in the continental U.S. (9 & 10). One or more of its potential hosts occurs in these zones (USDA-NRCS, 2007). This pest should be able to survive in areas of the United States corresponding to Plant Hardiness Zones 9-10.</p>	Medium (2)
<p>Risk Element #2: Host Range <i>Anastrepha fraterculus</i> is extremely polyphagous. Preferred hosts are Myrtaceae, including <i>Eugenia</i> and <i>Syzygium</i> spp. (CABI, 2005). A few of the species' many other hosts are <i>Terminalia catappa</i> (Combretaceae), <i>Malus pumila</i> and <i>Prunus</i> spp. (Rosaceae), <i>Annona</i> spp. (Annonaceae), <i>Citrus</i> spp. (Rutaceae), <i>Coffea</i> spp. (Rubiaceae), <i>Ficus carica</i> (Moraceae), <i>Juglans</i> spp. (Juglandaceae), <i>Diospyros kaki</i> (Ebenaceae), <i>Manilkara zapota</i> (Sapotaceae), <i>Persea americana</i> (Lauraceae), <i>Solanum quitoense</i> (Solanaceae), <i>Theobroma cacao</i> (Sterculiaceae), <i>Olea europaea</i> (Oleaceae), and <i>Vitis vinifera</i> (Vitaceae) (CABI, 2005). Recent research indicates that blueberries (<i>Vaccinium</i> spp.) are also hosts of <i>A. fraterculus</i> (Vaccaro and Bouvet, 2006)</p>	High (3)
<p>Risk Element #3: Dispersal Potential Females deposit from 200 to 400 eggs in host fruits (White & Elson-Harris, 1992). The species is multivoltine, there being several generations per year (CABI, 2005). Long-distance dispersal has not been reported for adults of <i>A. fraterculus</i>, however, another member of the genus was trapped a 135 km away from its origin (Fletcher, 1989). The major means for introducing the species to previously uninfested areas is the transport, in international trade, of fruit containing larvae; for most regions, the most important fruits liable to carry this species are mango and guava (CABI, 2005). By all indications, <i>A. fraterculus</i> exhibits high reproductive and dispersal potentials.</p>	High (3)
<p>Risk Element #4: Economic Impact <i>Anastrepha fraterculus</i> is the most economically important species of <i>Anastrepha</i> in Brazil and other South American countries because of its broad host range (Foote <i>et al.</i>, 1993). In Brazil, where it causes severe yield losses in apple, the pest is of major concern to growers, and represents a significant constraint to fresh fruit export into countries with quarantine barriers (Sugayama <i>et al.</i>, 1996). The insect also is an important pest of guava and mango, and to some extent of <i>Citrus</i> and <i>Prunus</i> spp. (CABI, 2005). Even if eggs are not deposited in guava fruit, or do not hatch, the oviposition punctures ("stings") may render fruit unmarketable (Gould and Raga., 2002). <i>Anastrepha fraterculus</i> is a quarantine pest for several countries and regions including Europe (EPPO, 2007); thus, its introduction could result in a loss of foreign markets for American-grown commodities, such as citrus. Establishment of <i>A. fraterculus</i> in the United States would increase production costs in susceptible commodities (EPPO, 2007).</p>	High (3)

¹ (<http://www.usna.usda.gov/Hardzone/ushzmap.html>).

<p>Risk Element #5: Environmental Impact Because it is polyphagous, <i>A. fraterculus</i> can potentially impact numerous species listed as Threatened and Endangered (T&E) in 50 CFR § 17.12. In places where it could establish in the continental United States (Zones 9-10), <i>A. fraterculus</i> could impact a T&E congener of a current host: <i>Prunus geniculata</i> in Florida (USFWS, 2007). If potential T&E plants are considered at the family level, then <i>A. fraterculus</i> could impact an additional 30 taxa. Establishment of <i>A. fraterculus</i> in the United States may necessitate the use of control measures such as pesticide applications (CABI, 2005).</p>	High (3)
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Consequences of Introduction: <i>Ceratitis capitata</i> Wiedemann	Risk Value
<p>Risk Element 1: Climate-Host Interaction <i>Ceratitis capitata</i> is widely distributed in the Mediterranean, South and Central America, west Asia (CPC, 2003) and northern Australia (Hassan, 1977). Based on this distribution and the geographic range predicted by Vera <i>et al.</i> (2002), it is estimated that <i>C. capitata</i> could establish in U.S. Plant Hardiness Zones 8-11. One or more of its potential hosts occur in these Zones (USDA-NRCS, 2002).</p>	High (3)
<p>Risk Element 2: Host Range <i>Ceratitis capitata</i> has been recorded on hosts from numerous plant families, including Anacardiaceae, Arecaceae, Chrysobalanaceae, Cucurbitaceae, Ebenaceae, Lauraceae, Longaniaceae, Malpighiaceae, Meliaceae, Moraceae, Myrtaceae, Oleaceae, Podocarpaceae, Rosaceae, Rubiaceae, Rutaceae, Sapotaceae, Solanaceae and Sterculiaceae (CABI, 2003; Weems, 1981; White and Elson-Harris, 1992).</p>	High (3)
<p>Risk Element 3: Dispersal Potential Female <i>C. capitata</i> can mature and deposit up to 800 eggs during their life (Weems, 1981); there can be several overlapping generations each year (Hassan, 1977). Adult <i>C. capitata</i> can fly up to 20km during their two month life, and larvae can be transported over long distances in infested fruit (CABI, 2003).</p>	High (3)
<p>Risk Element 4: Economic Impact In some Mediterranean countries, <i>C. capitata</i> infests approximately 100% of stone fruits (Weems, 1981). In addition to substantial yield reductions, <i>C. capitata</i> lowers crop values by requiring controls; its establishment in the continental United States would cause a loss in foreign and domestic markets (Weems, 1981). <i>Ceratitis capitata</i> is listed by EPPO as an A2 quarantine pest for Europe (Smith <i>et al.</i>, 1997).</p>	High (3)

<p>Risk Element 5: Environmental Impact</p> <p>Because <i>C. capitata</i> is a polyphagous pest, there are many closely related native Threatened and Endangered species (T&E) (USFWS, 2005) within the same host genera and families that it may also attack. The following T&E species are congeners of known hosts of <i>C. capitata</i>: <i>Eugenia haematocarpa</i>, <i>Eugenia koolauensis</i>, <i>Eugenia woodburyana</i>, <i>Flueggea neowawraea</i>, <i>Juglans jamaicensis</i>, <i>Opuntia treleasei</i>, <i>Prunus geniculata</i>, <i>Santalum freycinetianum</i> var. <i>lanaiense</i>, <i>Scaevola coriacea</i>, <i>Solanum drymophilum</i>, <i>Solanum incompletum</i>, <i>Solanum sandwicense</i>, and <i>Ziziphus celata</i>. If potential hosts are considered at the family level, then there are an additional 174 Threatened and Endangered species that <i>C. capitata</i> may negatively impact across the United States and its territories (USFWS, 2005); however, not all of these may occur within its climatic range. Because of its potential to harm endangered taxa and economically important plants, conservation managers, farmers and horticulturalists would likely need to use chemical and/or biological control programs to control populations of <i>C. capitata</i> (Weems, 1981).</p>	High (3)
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Pest	Climate-Host Interaction	Host Range	Dispersal Potential	Economic Impact	Environmental Impact	Cumulative Risk Rating ¹
<i>Anastrepha fraterculus</i>	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
<i>Ceratitis capitata</i>	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)

¹ Low is 5-8 points; Medium is 9-12 points; and High is 13-15 points

2.7 Likelihood of Introduction

The likelihood of a pest being introduced and establishing a reproductive population is dependent on six independent criteria: 1) the quantity of the commodity imported, 2) the ability of the pest to survive post-harvest treatment, 3) the ability of the pest to survive shipment, 4) the probability the pest will not be detected at the port of entry, 5) the likelihood that it will be moved to a suitable habitat, and 6) the probability that it will come into contact with suitable host material (USDA, 2000). These six sub-elements of the Likelihood of Introduction were evaluated.

Quantity of Commodity Imported Annually

The likelihood that an exotic pest will be introduced into the United States depends on the quantity of the potentially-infested product imported. For qualitative pest risk assessments, the amount of commodity imported is estimated in units of standard 40-foot long shipping containers. According to APHIS's Guidelines for Pathway-Initiated Pest Risk Assessments (USDA, 2000), if the number of containers is less than 10 per year, the risk is considered to be Low; if the number of containers is 10 to 100, inclusively, the risk is considered to be Medium; whereas, if the number of containers is more than 100, the risk is deemed High.

Based on current production rates, it is estimated that Uruguay will be able to export 15 tons of blueberries in 2005 and 40 tons in 2006 (MGAP, 2005). Based on a conversion factor of

approximately 20 tons per 40-foot shipping container (FAS, 2006), 40 tons translates to a predicted volume of approximately two standard 40-foot shipping containers annually. As the quantity of the commodity will be less than 10 containers annually, this risk sub-element was rated Low.

Survive Post-harvest Treatment

Post-harvest treatment refers to any manipulation, handling or specific phytosanitary treatment to which the commodity is subjected. As described in the introduction of this document, blueberry fruit is taken from the field to a packing facility where high quality fruit is selected and packed in the shell packs in which they will be sold. Fruit is not washed or treated. Shell packs are placed in containers which are forced air cooled to low field temperatures in a maximum of six hours after harvest; packs are then stored in cooled chambers at 1°C. Prior to exportation, gel packs are kept on the fruit pallets that are hermetically sealed with a thermal blanket that maintains the temperature during transport.

Generally, internally feeding arthropods are expected to survive minimal post-harvest treatment, such as washing and culling. Because *Ceratitis capitata* and *Anastrepha fraterculus* are internal feeders, they are expected to survive post-harvest culling in host fruits, resulting in a High risk rating.

Survive Shipment

Survival of pests and pathogens during shipment is dependent on several factors, including duration of shipment period, ambient conditions during shipment and application of any particular mitigation procedures. Because this risk assessment considers only unmitigated risk, the latter factor is not relevant. Guidelines have been developed for the optimal shipment conditions that will maintain high product quality for most commodities (*e.g.*, McGregor, 1987). If exported to the continental United States, blueberries would be shipped via air on pallets that are hermetically sealed and maintained cool with ice packs (Monteiro, 2005, pers. comm.). Air shipment of blueberries under cold conditions for 12 hours would not affect fruit fly survival based on current treatment schedules for medfly on other commodities that require treatment for several days (USDA-APHIS, 2006). Therefore, *C. capitata* and *A. fraterculus* have a High risk of surviving shipment.

Not be Detected at the Port-of-Entry

The likelihood that a pest will not be detected at a port-of-entry is dependent on several factors including pest size, mobility, and degree of concealment. In general, internal pests of fruits are highly likely to escape detection, while externally feeding pests are less likely. Because fruit flies are internal pests, it is expected that most infestations would pass unnoticed at U.S. ports, resulting in a High risk rating.

Imported or Moved Subsequently to an Area with an Environment Suitable for Survival

The likelihood that a pest will be moved to an area with a suitable environment for survival is dependent on the potential distribution of markets for the host commodity throughout the country and the presence of suitable habitats for the pest/pathogen. Blueberries have a wide market acceptance throughout the United States. Thus, fruit potentially contaminated with fruit flies will be moved to areas suitable for their survival. Consequently, the risk associated with this sub-element is estimated to be High.

Come into Contact with Suitable Host Material for Reproduction.

Even if the final destination of infested commodities is suitable for pest survival, pests must still come in contact with suitable host material. This process is dependent on two factors, the pest's potential for dispersal, and the presence of host material in the region. Adult fruit flies are winged insects that can disperse relatively far away. Furthermore, they are highly polyphagous and would be expected to find a suitable host nearby. Consequently, the risk associated with this sub-element is estimated to be High.

Cumulative Risk Rating

A Cumulative Risk Rating for the Likelihood of Introduction was obtained by summing the six sub-elements together. Overall, *Ceratitis capitata* has a High likelihood of being introduced into the continental United States and establishing permanent reproductive populations.

Pest	Risk Element 1 Quantity Imported Annually	Risk Element 2 Survive Post-harvest	Risk Element 3 Survive Shipment	Risk Element 4 Not Detected	Risk Element 5 Moved to Suitable Area	Risk Element 6 Contact with Host Material	Cumulative Risk Rating¹
<i>Anastrepha fraterculus</i>	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	High (16)
<i>Ceratitis capitata</i>	Low (1)	High (3)	High (3)	High (3)	High (3)	High (3)	High (16)

¹Low is 6-9 points; Medium is 10-14 points; and High is 15-18 points

2.8 Conclusion: Pest Risk Potential and Pests Requiring Phytosanitary Measures

Pest Risk Potential is an estimation of the risk associated with importation in the absence of mitigation. The overall Risk Potential of a pest is the summation of the Consequences of Introduction and Likelihood of Introduction values for that pest. According to the *Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02* (USDA, 2000), port of entry inspection provides sufficient phytosanitary security for pests assigned Low pest risk potentials, while specific phytosanitary measures may be necessary for pests assigned Medium pest risk potentials and are strongly recommended for pests assigned High pest risk potentials.

Overall, *Anastrepha fraterculus* and *Ceratitis capitata* had High risk ratings for Consequences of Introduction and Likelihood of Introduction, resulting in a High Pest Risk Potential (Table 9). A list of potential risk mitigation options are listed in Appendix B.

PPQ will continue to inspect all commodities that are shipped to U.S. ports. Should inspectors detect any quarantine pests following the pathway on blueberry fruit, appropriate mitigation measures may be used to prevent the introduction of those pests into the United States. Depending on the species intercepted and the frequency of interception, future risk analyses may need to be conducted.

Table 9: Pest Risk Potential			
Pest	Consequences of Introduction Cumulative Risk Rating	Likelihood of Introduction Cumulative Risk Rating	Pest Risk Potential¹
<i>Anastrepha fraterculus</i>	High (14)	High (16)	High (30)
<i>Ceratitis capitata</i>	High (15)	High (16)	High (31)

¹Low is 11-18 points; Medium is 19-26 points; and High is 27-33 points

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IV. Literature Cited.

7 CFR § 360. (January 1, 2005). Code of Federal Regulations, Title 7, Part 360, (7 CFR §360 - Noxious Weed Regulations). United States Government.

AgroImpulso. (2000). Temas tecnicos. Girasol. Plagas In: www.agroimpulso.com.ar/agronomos/temas_tecnicos/girasol/girasol_plaga.htm

Altier, N. (1994). Current status of research on Lotus diseases in Uruguay. In Proceedings of the First International Lotus Symposium. 22-24/3/94. St. Louis, Missouri. USA. Pp. 203.

Andrade, N. and Loyola, N. (1993). Determinación e incidencia de patógenos post-cosecha en frutos de arándano (*Vaccinium sp.*). II Congreso Nacional de Fitopatología. Resúmenes. Simiente 1993 v. 63 (1): 42-63.

- Baptiste, V.R.E.M. (2003). *Tenebrionidae and allied families*. In: www.coleoptera.org
- Bayer CropScience Chile, (2004). Burrito de la vid: *Naupactus xanthographus*. In: www.bayercropscience.cl/soluciones/fichaproblema.asp?id=5
- Beardsley, J. W. and Gonzalez, R. H. (1975). The biology and ecology of armored scales. *Ann. Rev. of Entomol.* Vol. 20. Pg. 47-63.
- Bell, D. K.; Yarborough, D. E. and Dill, J. (1999). Crop Profile for Blueberries (Wild) in Maine. <http://pestdata.ncsu.edu/cropprofiles/docs/MEblueberries-wild.html>.
- Bentancourt, C. and Scatoni, I. (1999). Guía de insectos y acaros de importancia agrícola y forestal en el Uruguay. Editorial Agropecuaria Hemisferio Sur S.R.L. Montevideo. Uruguay.
- Bettucci, L.; Simeatto, S.; Alonso, R. and Lupo, S. (2004). Endophytic fungi of twigs and leaves of three native species of Myrtaceae in Uruguay. *Sydowia* 56 (1) 8 – 23.
- Blatt, C. R., K. I. N. Jensen, W. T. A. Neilson, P. D. Hildebrand, N. L. Nickerson, R. K. Prange, P. D. Lidster, L. Crozier, and J. D. Sibley, editors. (1989). *Lowbush Blueberry Production*. Minister of Supply and Services Canada, Ottawa, Canada.
- Blueberries: *Vaccinium spp.* www.uga.edu/fruit/bluberi.htm.
- Bolland, H. R.; Gutierrez, J. and Flechtmann, C.H.W. (1998). *World Catalogue of the Spider Mite Family (Acari: Tetranychidae)*. Brill Leiden – Boston – Koln. 391 pp.
- Bradbury, J. F. (1986). *Guide to Plant Pathogenic Bacteria*. CAB International Mycological Institute.
- Brunt, A. A., K. Crabtree, M. J. Dallwitz, A. J. Gibbs, L. Watson, and E. J. e. Zurcher. (2006). *Plant Viruses Online: Descriptions and Lists from the VIDE Database*. Version: 20th August 1996. Web site: <http://biology.anu.edu.au/Groups/MES/vide/>. Last accessed: January 12, 2006.
- Buzeta, A. (1997). *Chile: Berries para el 2000*. Fundación Chile. Departamento Agroindustrial.
- Capinera, J. L. 2005. *Featured Creatures*. University of Florida Institute of Food and Agricultural Sciences. Department of Entomology and Nematology. Florida Department of Agriculture and Consumer Services. Division of Plant Industry. *Spodoptera frugiperda*. http://creatures.ifas.ufl.edu/field/fall_armyworm.htm
- Caruso, F. L. and Ramsdell, D. C. (1995). *Compendium of blueberry and cranberry diseases*. St. Paul, MN: APS Press.
- Casals, P. (2004). Universidad de Concepción, Chile. *Insectos y ácaros en arándanos*. Curso Producción Moderna de Arándanos. Curso de Actualización Profesional. Montevideo 23-25/9/04.

Cline, W. O. (1997). Fruit Rot Diseases of Blueberry. College of Agriculture and Life Sciences. Plant Pathology Extension. North Carolina State University. <http://www.ces.ncsu.edu/depts/pp/notes/Fruit/blueberryinfo/berryrots.htm>.

Cline, W. O. et al. (2005). Crop Profile for Blueberries in North Carolina. <http://pestdata.ncsu.edu/cropprofiles/docs/ncblueberries.html>.

Crop Protection Compendium, 2003 Edition. CAB International, Wallingford, UK

Crop Protection Compendium, 2004 Edition. CAB International, Wallingford, UK.

Crop Protection Compendium, 2005 Edition. CAB International, Wallingford, UK.

Cuevas, G.; Acuña R. (2003). Detección de enfermedades del follaje en arándano alto (*Vaccinium corymbosum* L.) en la VIII región, Chile. Foliage diseases detection on highbush blueberry (*Vaccinium corymbosum* L.) in the VIII Region, Chile. XIII Congreso de Fitopatología. Resúmenes. En Prensa.

Devotto, L. and Gerding, P. (2005). Plagas en berries. INIA Quilamapu. Chile. In: Tattersall, Revista on line. Edición 166. <http://www.tattersall.cl/revista/rev166/plagas.htm>

EPPO. (2007). Data sheets on quarantine pests: *Anastrepha fraterculus* European Plant Protection Organization.

Farr, D. F.; Bills, G. F., Chamuris, G. P. and Rossman, A. Y. (1989). Fungi on plants and plant products in the United States. APS Press. St. Paul, Minnesota. USA. 1251 pp.

Farr, D. F.; Rossman, A. Y.; Palm, M. E. & McCray, E. B. (n.d.). (2005). Fungal Databases, Systematic Botany & Micology Laboratory, ARS, USDA. Retrieved November 2, 2005 from <http://nt.ars-grin.gov/fungalatabases/>

FAS. 2006. Glossary. Foreign Agricultural Service, United States Department of Agriculture, Washington, DC. <http://www.fas.usda.gov/agexport/export_plan/glossary.htm#C>.

Fernández, R.; Wright, E. et al. (2005a). Hongos asociados a cultivos de arándano (*Vaccinium corymbosum*) en las provincias de Buenos Aires, Córdoba y Entre Ríos. (Fungi associated to blueberry crops (*Vaccinium corymbosum*) in Buenos Aires, Córdoba, and Entre Ríos provinces) ALF. Libro de Resúmenes XIII Congreso Latinoamericano de Fitopatología. 19-22/4/2005. Villa Carlos Paz, Córdoba, Argentina.

Fernández, R.; Wright, E. et al. (2005b). Sintomatología e incidencia de enfermedades ocasionadas por *Alternaria tenuissima* y *Pestalotiopsis guepini* sobre órganos vegetativos de plantas de arándano (*Vaccinium corymbosum*). (Symptoms and incidence of diseases caused by *Alternaria tenuissima* and *Pestalotiopsis guepini* on blueberry (*Vaccinium corymbosum*) vegetative organs) ALF. Libro de Resúmenes XIII Congreso Latinoamericano de Fitopatología. 19-22/4/2005. Villa Carlos Paz, Córdoba, Argentina.

Fletcher, B. S. 1989. Movements of tephritid fruit flies. In A. S. Robinson and G. Hooper, (Eds.). Fruit flies: their biology, natural enemies, and control (pp. 209-219). Amsterdam: Elsevier.

Foot, R. H., F. L. Blanc, and A. L. Norrbom. (1993). Handbook of the Fruit Flies (Diptera: Tephritidae) of America North of Mexico. Comstock Publ. Assoc., Ithaca, NY, U.S.A.

García – Salazar, C. (2002). Crop Timeline for Blueberries in Michigan and Indiana. Michigan State University Extension. Prepared for the U.S. Environmental Protection Agency Office of Pesticide Programs.

González, P. et al. (2005). Final Report Project: Pests and Diseases Survey in blueberry crop (*Vaccinium spp.*) in Uruguay. August 2004 – June 2005.

Gould, W. P., and A. Raga. (2002). Pests of guava. In J. E. Pena, J. L. Sharp, and M. Wysoki, (Eds.). Tropical Fruit Pests and Pollinators: Biology, Economic Importance, Natural Enemies and Control (pp. 295-313). Wallingford, U.K.: CABI Publishing.

Guerrero, C. J., Pino, M. T. and Bello, M.A. (1993). Patógenos de postcosecha en fruta de variedades de arándano alto (*Vaccinium corymbosum* L.). II Congreso Nacional de Fitopatología. Resúmenes. Simiente 1993 v. 63 (1): 42-63.

Guerrero, C.J. (2000). Situación fitopatológica del arándano alto (*Vaccinium corymbosum* L.) en la IX y X Región. X Congreso Nacional de Fitopatología. Resúmenes. Simiente 2001 v. 71 (1-2): 33-73.

Gunn, C. R., and C. A. Ritchie. (1988). Identification of disseminules listed in the federal Noxious Weed Act. Technical Bulletin Number 1719., United States Department of Agriculture, Agricultural Research Service, U.S.A.

Hassan, E. (1977). Major Insect and Mite Pests of Australian Crops. Ento Press. Gatton, Queensland.

Henderson, R. C. (2001). Habitats of New Zealand soft scale insects. <http://www.landcareresearch.co.nz/research/biodiversity/invertebratesprog>. Date accessed 15/11/2005

Hepp, R. (2005). Enfermedades del Arándano. 2º Seminario de Arándanos Producción y Comercialización. Berries del Uruguay. Junio 16-18, 2005. Montevideo, Uruguay.

Holm, L. G.; Doll, J. Holm, E; Pancho, J.V. and Herberger, J. (1997). World Weeds: natural Histories and Distributions. John Wiley and Sons, NY, NY. 1129 pp.

Holm, L. G., D. L. Plucknett, J. V. Pancho, and J. P. Herberger. (1977). The world's worst weeds: distribution and biology. Krieger Publishing Company, Malabar, Florida, U.S.A.

Holm, L. G., J. V. Pancho, J. P. Herberger, and D. L. Plucknett. (1991). A geographical atlas of world weeds. Krieger Publishing Company, Malabar, Florida, U.S.A.

Holm, L., J. Doll, E. Holm, J. Rancho, and J. Herberger. (1997). World weeds: natural histories and distribution. John Wiley & Sons, Inc., New York, New York, U.S.A.

Horst, R. K. (2001). Wescott's Plant Disease Handbook. 6th Edition. Kluwer Academic Publishers. Boston/Dordrechts/London.

Instituto de Investigaciones Agropecuarias (INIA). Comisión Nacional de Riego. (2003). Producción de arándano. Cartilla Divulgativa. www.chileriego.cl/docs/046.doc

IPPC (1996). International Standards for Phytosanitary Measures. Guidelines for Pest Risk Analysis. Publication No. 2, Secretariat of the International Plant Protection Convention. FAO.

IPPC. (1999). International Standards for Phytosanitary Measures. Requirements for the establishment of pest free places of production and pest free production sites. Publication No. 10, Secretariat of the International Plant Protection Convention. FAO.

IPPC. (2002). International Standards for Phytosanitary Measures. The use of integrated measures in a systems approach for pest risk management. Publication No. 14. Secretariat of the International Plant Protection Convention. FAO.

IPPC, (2004). International Standards for Phytosanitary Measures. Pest risk analysis for quarantine pests, including analysis of environmental risks and living modified organisms. Publication No. 11. Secretariat of the International Plant Protection Convention, FAO.

IPPC (2006). International Standards for Phytosanitary Measures. Glossary of phytosanitary terms. Publication No. 5. Secretariat of the International Plant Protection Convention. FAO.

Jeppson, L. R.; Hartford, H. K. and Baker, E. W. (1975). Mites Injurious to Economic Plants. University of California Press. Berkeley, Los Angeles, London. 614 pp.

Johnson, D. et al. (2003). Crop Profile for Blueberries in Arkansas. <http://pestdata.ncst.edu/cropprfiles/docs/Arblueberry.html>.

Jubb, G. L.; Masteller, E. C.; Wheeler, A. G. (1979). Survey of arthropods in vineyards of Erie County, Pennsylvania: Hemiptera – Heteroptera. Environmental Entomology 8 (6) 982 – 986.

Klag, N. G. (2006). Approval of cold treatment for Argentine blueberries (decision memorandum for executive director). Phytosanitary Issues Management, Plant Protection and Quarantine, U.S.A.

Koch, C.K. and Waterhouse, D.F. (2000). The distribution and importance of Arthropods associated with Agriculture and forestry in Chile (Distribución e importancia de los artrópodos asociados a la agricultura y silvicultura en Chile). ACIAR Monograph N° 68, 234 pp.

Laflin, H. M.; Gullan, P. J., Parrella, M. P. (2004). Mealybug species (Hemiptera: Pseudococcidae) found on ornamental crops in California nursery production. Proceedings of the Entomological Society of Washington 106 (2): 475 – 477.

Liquido, N. J.; Barr, P. G. and Cunningham, R. T. (1998). MEDHOST: An encyclopedic bibliography of the host plants of the Mediterranean fruit fly, *Ceratitidis capitata* (Wiedemann). V. 1. 0. in. United States Department of Agriculture, Agricultural Research Service, HI, U.S.A.

- McGregor, B. M. 1987. Tropical products transport handbook. Agriculture Handbook N° 668, United States Department of Agriculture.
- Midwest Small Fruit Pest Management Handbook. (2004). The Ohio State University. Extension Bulletin 861. <http://ohioline.osu.edu/b861/>
- Milholland, R. D. and Meyer, J. R. (1984). Diseases and arthropod pests of blueberries. Bulletin 468. North Carolina Agricultural Research Service. North Carolina State University.
- Miller, G.L, Jensen, A. S., Nakahara, S., Carlson, R.W., Miller, D.R., & Stoetzel, M. B. (2000). Systematic Entomology Laboratory Whitefly Web Page. Source -- <http://www.sel.barc.usda.gov/>
- MGAP-DGSA. (2005a). Information requested for pest risk analysis to export blueberries fruit (*Vaccinium corymbosum* and *V. ashei*) from Uruguay to United States.
- MGAP - DGSA. (2005b). Importation of fresh blueberry (*Vaccinium spp.*) fruit into the United States from Uruguay. A Pathway Initiated Risk Assessment. Additional Information.
- Monteiro, C. (2005). Cosecha de arandanos en Uruguay. Berries del Uruguay. Pers. Comm.
- Northwest Berry&Grape Information Network. Oregon State University. University of Idaho. Washington State University. USDA-ARS. Blueberry Diseases – Overview. In: <http://berrygrape.oregonstate.edu/fruitgrowing/berrycrops/blueberry/dintro.htm>.
- Pianzolla, M. J.; Moscatelli, M. And Vero, S. (2004). Characterization of *Penicillium* isolates associated with blue mold on apples in Uruguay. Plant. Dis. 88: 23 – 28.
- PIN 309, 2004. Plant Interception network. U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine, Riverdale, Maryland.
- PIN 309, 2005. Port Interception Network. U. S. Department of Agriculture, Animal and Plant Health Inspection Service. Plant Protection and Quarantine, Riverdale, Maryland.
- Polavarapu, S.; Davidson, J. A. And Douglas, R. M. (2000). Life story of the Putnam scale, *Diaspidiotus ancyclus* (PUTNAM) (HEMIPTERA: COCCIDEA: DIASPIDIDAE) on blueberries (*Vaccinium corymbosum*, Ericaceae) in New Jersey, with a world list of scale insects on blueberries. Proc. Entomol. Soc. Wash. 102(3), 2000 pp. 549-560.
- Randall, R. P. (2005). A global compendium of weeds: *Annona cherimola*, *Annona squamosa*, *Dimocarpus longan*, *Garcinia mangostana*, & *Vaccinium corymbosum*. Department of Agriculture of Western Australia. Web site: <http://www.hear.org/gcw/>. Last accessed: November 3, 2005.
- Reed, C. F. (1977). Economically important foreign weeds. Agricultural Research Service, United States Department of Agriculture.
- Rocca, M. et al. (2005). Soil larvae in blueberry crops (*Vaccinium corymbosum*) in Buenos Aires and Entre Rios (Argentina). Actas 1er. Congreso Latinoamericano de Arandanos y otros Berries. 16/9/05. Buenos Aires. Argentina. Pp. 42.

Ross, H. (1997). American Insects: A Handbook of the insects of America north of Mexico. 2nd. Ed. ISBN 0-8493-0212-9

Scherm, H. et al. (1999). Georgia Blueberry Pest Management Survey. In: Blueberry Research at the University of Georgia. 1999 Annual Research Update. Research Report Nr. 662. www.ces.uga.edu/ES-pubs/RR662.pdf

Servicio Agrícola Ganadero. (2004). Detección de enfermedades del follaje en arándano alto (*Vaccinium corymbosum* L.) en la VIII Región, Chile (Foliage diseases detection on highbush blueberry (*Vaccinium corymbosum* L.) in the VIII Region, Chile). Resúmenes de trabajos presentados en el XIII Congreso de la Sociedad Chilena de Fitopatología. Fitopatología, Vol. 39 N° 1. Pp 30.

Servicio Agrícola Ganadero. División Protección Agrícola. Subdepartamento Vigilancia Fitosanitaria. (2005). Situación sanitaria del cultivo de arándano (*Vaccinium spp.*) en Chile. Pers. comm.

Silva, G. et al. (2005). *Icerya purchasi* Maskell (Homoptera: Margarodidae) nuevo insecto asociado a arándano en la zona N de Chile. Actas 1er. Congreso Latinoamericano de Arándanos y otros Berries 16/9/05. Buenos Aires. Argentina. Pp. 37.

Skinner, K., L. Smith, and P. Rice. (2005). Noxious weeds in the US and Canada. University of Montana. Web site: http://invader.dbs.umt.edu/Noxious_Weeds/. Last accessed: February 25, 2005.

Smith, I. M.; McNamara, D. G.; Scott, P. R. and Holdness, M. (Eds.) (1997). Quarantine Pests for Europe, 2nd ed. CAB International. Wallingford, United Kingdom.

Smith, B. J. (1998). Botrytis blossom blight of southern blueberries: Cultivar susceptibility and effect of chemical treatments. Plant Dis. 82: 924-927.

Stimmel, J. F. (1998). Wax Scales, *Ceroplastes spp.* Homoptera: Coccidae. Regulatory Horticulture. Entomology Circular No. 191. Vol. 24, N° 2. Pennsylvania Dept. of Agriculture. Bureau of Plant Industry.

Sugayama, R. L., A. Malavasi, I. Nora, and E. S. Branco. (1996). Ovipositional responses to apple in a caged tree by *Anastrepha fraterculus* in southern Brazil. In McPherson and G. J. Steck, (Eds.). Fruit Fly Pests: A World Assessment of their Biology and Management (pp. 67-69). Delray Beach, FL, U.S.A.: St. Lucie Press.

Strik, B. (2005). Blueberry: An Expanding World Berry Crop. Chronica Horticulturae. Volume 45. N° 1. 2005. International Society of Horticultural Science (ISHS).

Swearingen, J. (2005). Alien Plant Invaders of Natural Areas. National Park Service. Web site: <http://www.nps.gov/plants/alien/list/all.htm>. Last accessed: May 2, 2005.

USDA-ARS. (2005). Germplasm Resources Information Network (GRIN), Online Database: *Annona cherimola*, *Annona squamosa*, *Dimocarpus longan*, *Garcinia mangostana*, *Nephelium lappaceum*, *Vaccinium corymbosum*, and *Vaccinium ashei*. United States Department of

Agriculture, Agricultural Research Service, Systematic Botany and Mycology Laboratory. Web site: <http://www.ars-grin.gov/cgi-bin/npgs/html/paper.pl>. Last accessed: November 3, 2005.

USDA-APHIS. (2002). 7 CFR Parts 300, 301, and 319 (Docket N° 02-071-1). Cold treatment of fruits. Federal Register, Vol. 67, N° 199. Pp. 63529-63536.

USDA-APHIS (2004). 7 CFR Parts 300, 301, and 319 (Docket N° 02-071-2). Cold treatment of fruits. Federal Register, Vol. 69, N° 21. Pp. 4845-4851.

USDA-APHIS. (2005a). Q56 Fresh Fruits and Vegetables Reference Database <https://manuals.cphst.org/q56/Q56Main.cfm>. Last updated 9/02/05.

USDA-APHIS. (2005b). Proposed Rules. 7 CFR Part 319 (Docket No. 03-048-1). Importation of Fruits and Vegetables. Federal Register, Vol. 70. No. 61. Pp. 16431-16445.

USDA-APHIS. (2006). Treatment manual: treatment schedules: T100-schedules for fruits, nuts and vegetables (v. December 18, 2006). Animal and Plant Health Inspection Service, United States Department of Agriculture.

USDA-APHIS-PIM, (2003). Letter from Mrs. C. Enright, Assistant Deputy Administrator to Ms. Ares, Plant Protection Division, DGSA, Uruguay.

USDA-APHIS-PIM. (2005). Letter from Mrs. C. Enright, Assistant Deputy Administrator. Phytosanitary Issues Management to Ms. Ares, Director Plant Protection Division, DGSA, Uruguay

USDA-APHIS-PPQ, (2000). Guidelines for Pathway-Initiated Pest Risk Assessments. Version 5.02. October 17, 2000.

USDA-APHIS-PPQ. (2004). Importation of fresh blueberry (*Vaccinium* spp.) into the continental United States from Colombia. A Pathway-Initiated Risk Assessment, May 10, 2004.

USDA-NRCS. (2002). The PLANTS Database, Version 3.5. National Plant Data center, Baton Rouge, LA 70874-4490 USA. Available: <http://plants.usda.gov>. Accessed: 20 december 2004.

USDA-NRCS (2005). The PLANTS Database: *Annona squamosa*, *Vaccinium corymbosum*, and *Vaccinium virgatum*. National Plant Data Center, Baton Rouge, LA, 70874' 4490 USA. Web site: http://plants.usda.gov/cgi_bin/. Last acceced: November 4, 2005.

USDA-NRCS. (2007). The PLANTS Database. National Plant Data Center. Retrieved January 22, 2007, from http://plants.usda.gov/cgi_bin/.

USFWS. (2007). Threatened and Endangered Animals and Plants. United States Fish and Wildlife Service. Retrieved January 3, 2007, from <http://endangered.fws.gov/wildlife.html#Species>.

Vaccaro, N. C., and J. P. R. Bouvet. (2006). Presence of *Ceratitis capitata* Wied. and *Anastrepha fraterculus* (Wied.) on blueberries (*Vaccinium* spp.) in the department of Concordia, Entre Rios and in the department of Curuzu Cuatia, Corrientes, Argentina [Poster]. Western Hemisphere Fruit Fly Meeting, Brazil.

- Van Steenis, C. G. G. J. (1972). The Mountain Flora of Java. Leiden, E. J. Brill
- Vera, M. T.; Rodriguez, R.; Segura, D. F.; Caldera, J. L. and Sutherst, R. W. (2002). Potential geographical distribution of the Mediterranean fruit fly, *Ceratitis capitata* (Diptera: Tephritidae), with emphasis on Argentina and Australia. Environ. Entomol. 31(6): 1009-1022.
- Walker, T. J. (1998). Trilling field crickets in a zone of overlap (Orthoptera: Gryllidae Gryllus). Annals of the Entomological Society of America 91 (2): 175 – 184.
- Weakley, A. (2005). Flora of the Carolinas, Virginia, and Georgia (June 2005 Draft). University of North Carolina, Herbarium, Chapel Hill, NC, U.S.A
- Weber, E. (2003). Invasive plant species of the world: A reference guide to environmental weeds. CABI Publishing, Wallingford, UK.
- Weems, H. V. (1981) Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae). Florida Department of Agriculture and Consumer Service. Division of Plant Industry. Entomology Circular N° 230.
- Weingartner, D. P. and Klos, E. J. (1974). Fungi associated with blueberry stems in Michigan. Plant Dis. Reporter. Vol. 58. N° 2. 180-181
- White, I. M. and Elson-Harris, M. M. (1992). Fruit Flies of Economic Significance: Their identification and Bionomics. CAB International. Wallingford, United Kingdom.
- Wright, E. R. et al. (1998). Enfermedades del arándano (*Vaccinium* spp.) en los alrededores de Buenos Aires, República Argentina. Fitopatología. Vol. 33. N° 8. Pp. 55.
- Wright, E. R. and Rivera, M. C. (2005). Enfermedades detectadas en cultivos de arándano en la República Argentina. Infoberry. Año II. N° 9. Julio/Agosto 2005. Pp. 28-31.
- Wright, E. R. et. al. (2005). Conocimiento actual sobre enfermedades de arándano. Actas 1er. Congreso Latinoamericano de Arándanos y otros Berries. 16/9/05. Buenos Aires. Argentina. Pp. 113-117.
- WSSA (2005). Weed List. Weed Science Society of America. Web site: <http://www.wssa.net/weednames/common.asp>. Last accessed: February 24, 2005.

Appendix A. Final report: pest and disease survey in blueberry crop (*Vaccinium* spp.) in Uruguay, August 2004- June 2005

FINAL REPORT

Project: *Pests and diseases Survey in Blueberry crop (Vaccinium spp.) in Uruguay*

AUGUST 2004 – JUNE 2005

Responsible Faculty of Agronomy: Lic. Carlos Bentancourt
Ing. Agr. Pablo González

Responsible DGSSAA: Ing. Agr. Ma. Inés Ares

1. Introduction

Blueberry crop has increased in the country in the last 4 years, estimating more than 200 hectares for 2005 (Méndez 2004, Monteiro 2004) looking for alternative crops intended for export. Prices of fresh fruit in Northern Hemisphere markets, mainly USA and Europe, with increasing demand, allow to estimate a promising income of the investment in blueberry crop for export. This crop implies an investment of more than 12.000 American dollars per hectare, covering crop installation which associated with high requirements of labor for installation and production make evident its great potential of socio-economical impact in the country.

Pest risk analysis is an essential step in order to establish phytosanitary requirements by importing countries to allow the import of fresh fruit. On the other hand from an agronomical point of view the knowledge of phytosanitary behavior of the varieties under our conditions determines crop success and will allow to implement appropriate techniques for their prevention and control.

2. General Objective

To survey the presence of pests and diseases in Blueberry crop (*Vaccinium spp*) in Uruguay.

3. Specific Objectives

- To evaluate phytosanitary behavior of blueberries during the complete phenological cycle in Uruguay
- To identify observed pathogens and insects at genus and species level, using classical techniques and supported by keys.
- To quantify relevant phytosanitary problems in the evaluated varieties.

4. Materials and Methods

1. A pilot crop was selected in the farm of Mr. Jorge Moizo located in Peñarol Viejo, Montevideo department within fruit production area in the southern part of the country. Crop monitoring was weekly between August and January and monthly between February and June.
2. Phytosanitary status of the crop of 1800 plants (plantation density 3 x 1), composed by O'Neal and Bluejay varieties of 4 years old, was observed with the aim of quantify different problems. Crop was divided in 30 layers (two per row) with 60 plants each one. Observations were made in three levels. First level of systematic observation was performed in 10 plants at random. Second observation level was performed in 10 layers at random, less rigorous than the first. Third level was a general observation of the plot.
3. In all cases samples with symptoms from different plant organs were taken and present arthropods were collected for further diagnostic. Along with that in September a battery of traps consisting in a Jackson and a MacPhail trap was installed in order to detect fruit flies. Phenological stage of the crop was recorded in all visits.

4. Besides observations performed in the pilot crop, two visits were made in October and December to the farms of Mr. Jorge Casella located in Rocha department; Mr. Longo located in Maldonado department; and Irurtia S.A. located in Colonia department. Farm in Rocha department is located in an agriculture-forestry zone where there are apple and pear crops. The farm in Maldonado department, is a Citrus production farm and the farm in Colonia department is located in a grapevine production area.
5. Samples received in the diagnostic clinic of Faculty of Agronomy were also processed, which belonged to crops located in the following departments: Paysandú; Montevideo; San José, as well as samples received in the DGSA diagnostic clinic, mainly from crops of Paysandú and Maldonado departments, which results are considered in this report.
6. Sample processing was made in the Laboratories of the Phytopathology Unit of the Faculty of Agronomy, through techniques differing according the suspected causal agent: isolation in growing media: water agar and potato dextrose agar (PDA) for fungi and nutrient agar dextrose (NAD) for bacteria. Microorganisms were identified by traditional techniques. Laboratory of Mycology of the Faculty of Sciences under the responsibility of Lina Betucci provided support for the identification of *Alternaria alternata* and *Pestalotiopsis guepinii*
7. For insect identification the reference collection of the Entomology Unit of Faculty of Agronomy was checked. Aphids identification was performed by Ing. Agr. Roberto Carballo.

5. Description of phenological cycle of O´Neal and Bluejay varieties.

Blueberry crop (*Vaccinium spp*) under our climatic conditions has a deciduous cycle common to fruit species in temperate zones. This implies a dormant period during winter and a growing and development cycle during spring and autumn. Depending on the variety, bud break in Spring can be more or less early determining flowering and harvest periods.

Varieties evaluated in this Project, O´Neal and Bluejay, are varieties of Southern Highbush type, with low chilling requirements. O´Neal variety is more early, having a long flowering period from middle July to middle September. Harvest concentrated from last week of October to first week of December. For Bluejay variety, reproductive and vegetative bud break is later, and its flowering period is from the end of September to the end of October. Harvest period is from last week of December lasting until last week of January.

6. Survey Results and Disease Quantification

Analyzing the list of found fungi, shown in Table 1, it can be seen that the majority of them have a wide host range with the exception of *Pucciniastrum vaccinii* and *Phyllosticta elongata*.

Fungi with higher incidence were *Botrytis cinerea* and *Botryosphaeria sp.* These results agree with works performed in different blueberry producing countries. Both species are polyphagous which makes highly likely their presence in all producing areas (Ballinton *et al* (1993), Milanca and Ciampi (2002).

TABLE 1: Fungi associated to a symptom and relative importance in the season.

Fungus	Plant part affected	Symptom	Relative Importance (*)
<i>Alternaria alternata</i>	Leaf	Spot	1
<i>Botrytis cinerea</i>	Flower, Branch, Leaf	Blight, Spot	4
<i>Botryosphaeria sp</i>	Branch	Blight	3
<i>Cladosporium sp</i>	Leaf	Spot	1
<i>Pucciniastrum vaccinii</i>	Leaf	Spot	2
<i>Ulocladium sp</i>	Leaf	Spot	1
<i>Epicoccum sp</i>	Leaf	Spot	1
<i>Pestalotiopsis guepinii</i>	Leaf	Spot	1
<i>Phyllosticta elongata</i>	Leaf	Spot	2
<i>Stemphylium botryosum</i>	Leaf	Spot	1
<i>Verticillium sp</i>	Root	Plant death	1

(*) Scale: (1) with low incidence (4) with high incidence

Results show that 75% of symptoms correspond to foliar spots. Among the nine genera we found: *Alternaria alternata*, *Cladosporium sp*, *Ulocladium sp* and *Epicoccum sp.*, which are cited in the bibliography as opportunistic, and not as primary causal agents of these symptoms.

Low incidence observed agrees with the observation performed by blueberry technicians and growers.

In all observations only one genera of bacteria was found: *Agrobacterium tumefaciens* causing root galls. This was registered in the farm located in Colonia department, where crop was not well managed (weedy crop, without organic matter incorporation, minimum pruning).

Table 2 shows affected plant organs, symptoms, associated microorganisms and incidence along the season. It must be considered that when a new crop is introduced into a production zone, pests as well as diseases, at the beginning can be found at low levels (Strong *et al* 1984). This agrees with results obtained for 2004-2005 season when pests as well as diseases were not relevant to the crop.

TABLE 2: Observed symptoms, plant organ affected, associated microorganism found and average percentage of affected plants in the whole season.

<i>Organ</i>	<i>Symptom</i>	<i>Associated Microorganism</i>	<i>Incidence (*)</i>
Branch	Branch end burning with black color	<i>Botrytis cinerea</i> <i>Botryosphaeria sp</i>	32.78
Fruit	Broken corolla, with black mycelium	<i>Alternaria alternata</i> <i>Stemphylium botryosum</i>	24.81
Flower	Blight	<i>Botrytis cinerea</i> <i>Alternaria alternata</i> <i>Stemphylium botryosum</i>	24.05
Leaf	Circular Spot, less than 2 mm of red color with diffuse margin.	<i>Alternaria alternata</i> <i>Stemphylium botryosum</i>	20.37
Leaf	Red circular spot, less than 2 mm surrounded by a chlorotic halo	<i>Alternaria alternata</i> <i>Pucciniastrum vaccinii</i>	10.56
Flower	Corolla turns to black color with white sporulation, flower blight.	<i>Alternaria alternata</i> <i>Cladosporium sp</i>	10.33
Leaf	Burning of leaf distal margin	<i>Alternaria alternata</i> <i>Stemphylium botryosum</i> <i>Ulocladium sp</i> <i>Epicoccum sp</i>	9.44
Leaf	Red spot with intense red margin, well delimited less than 3 mm.	<i>Alternaria alternata</i> <i>Pucciniastrum vaccinii</i>	8.15
Leaf	Spot on the underside of the leaf, red, small, with eruptions	<i>Phyllosticta elongata</i> <i>Pucciniastrum vaccinii</i>	4.00
Leaf	Circular red spot with well defined margin, light center	<i>Pestalotiopsis guepinii</i>	3.52
Leaf	Red spot, bigger, bigger than 5 mm.	<i>Alternaria alternata</i> <i>Stemphylium botryosum</i>	2.67
Plant	Plant death	<i>Botryosphaeria sp</i> <i>Verticillium sp</i>	0.56

(*) Average Incidence observed in the hole season.

Almost all symptoms detailed in Table 2 had low severity, finding very few affected organs in each plant.

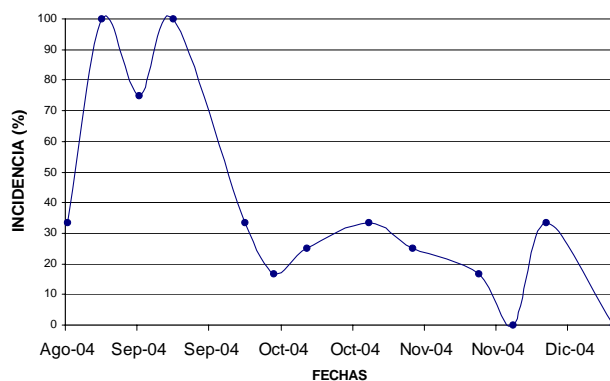


FIGURE 1: Incidence of flower blight along the season

Figure 1 shows incidence of flower blight along the season. Higher incidence is observed during August–September when crop was at flowering stage. Blueberry crop has a long flowering period coinciding with periods when temperature and relative humidity are adequate for *Botrytis cinerea* development, which favors the incidence of this fungus.

Besides fungi observed in this survey, the following were detected in the Diagnostic Clinic of DGSA/MGAP: *Alternaria tenuissima*, *Pestalotia vaccinii* (syn. *Pestalotia guepinii* var. *vaccinii*) and *Phyllosticta vaccini*.

Table 3 shows symptoms that were not associated to any pathogenic agent.

TABLE 3. Symptoms found, plant organ affected and average percentage of affected plants during the whole season.

<i>Organ</i>	<i>Symptom</i>	<i>Incidence</i> (*)
Fruit	Wart in the skin, with chlorotic halo of corky texture	24.81
Leaf	Over growth, deformation, "dent"	16.44
Plant	Dwarfism, rosetted, little development of fruits.	11.85
Leaf	Yellow spot bigger than 5 mm, circular, diffuse, center turns reddish.	11.11
Fruit	Crack or dehydration, caused by lack or excess of water	10.56
Leaf	Spot on the underside, diffuse, black color.	9.44
Branch	Brown to black canker, with lighter center, circular.	2.04

7. Survey Results and Arthropod Quantification

Table 4 shows the list of found insects, which were identified by traditional methodology.

TABLE 4: Surveyed insects

Specie	Plant part attacked	Trophic Group (*)	Relative Importance (**)
<i>Aphis gossypi</i>	Leaf	Polyphagous	2
<i>Diabrotica speciosa</i>	Leaf	Polyphagous	1
<i>Mallocephala deserticola</i>	Leaf	Polyphagous	1
<i>Oiketicus platensis</i>	Leaf	Polyphagous	1
<i>Trialeurodes vaporariorum</i>	Leaf	Polyphagous	1

(*) According to Gómez-Bustillo (1979) (**) Scale: (1) with low incidence (4) with high incidence

All species found are polyphagous, cited in a wide host range. These results agree with that found by Molina (1998) in Spain. At present are of low economic importance, because blueberry is a crop of recent introduction and the quantified populations are minimum. Strong *et al.* (1984) mention that plants in order to serve as insect food require of metabolic adjustments. The introduction of blueberry to food spectrum can vary insect populations in the following seasons.

Blueberry from Uruguay

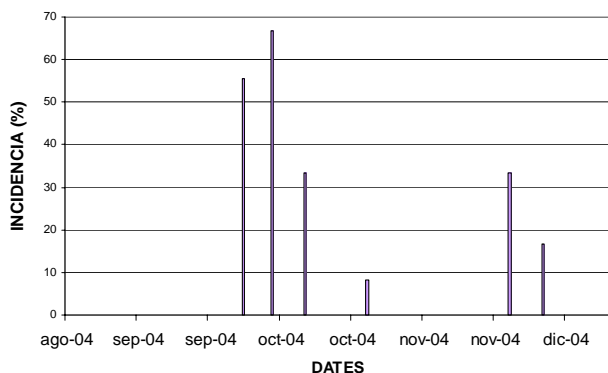


FIGURE 2. Percentage of plants with presence of *Aphis gossypi*.

Aphis gossypi was observed with certain frequency as it is observed in Figure 2. They appear with higher frequency at the beginning of Spring, reducing their presence at the end of the season.

Traps installed to detect fruit flies, did not register presence during the evaluated period.

The following insects were identified in the samples analyzed in the DGSA/MGAP Diagnostic Clinic: *Agrotis ipsilon*, *Rachiplusia nu* and *Leptoglossus impictus*.

8. Conclusions

1. Microorganisms found were: *Alternaria alternata*; *Alternaria tenuissima*; *Botrytis cinerea*; *Botryosphaeria sp*; *Cladosporium sp*; *Pucciniastrum vaccinii*; *Ulocladium sp*; *Epicoccun sp*; *Pestalotiopsis guepinii*; *Pestalotia vaccinii*; *Phyllosticta elongata*; *Phyllosticta vaccinii*; *Stemphylium botryosum* and *Verticillium sp*. and the bacteria *Agrobacterium tumefaciens*.
2. Diseases with higher incidence in the evaluated year were *Botrytis cinerea* and *Botryosphaeria sp*.
3. Identified insects were: *Mallocephala deserticola*; *Trialeurodes vaporariorum*; *Oiketicus platensis*; *Diabrotica speciosa*; *Aphis gossypi*; *Agrotis ipsilon*, *Rachiplusia nu* and *Leptoglossus impictus* .
4. There were not detected pests of economic importance. All pests are polyphagous, occasional and defoliating.
5. It was not registered presence of fruit flies in the evaluated period.

9. Bibliography

BALLINGTON, J; ROOKS, D; MILHOLLAND, R; CLINE, W; MEYERS, J. 1993. Breeding Blueberries for Pest Resistance In North Carolina. *Acta Hort.* 346:87-94

CARUSO, F; RAMSDELL, D. 1995. Compendium of Blueberry and Cranberry Diseases. APS Press. St. Paul, MN. 87 p.

MENDEZ, H. 2004. Asociación Nacional de Productores de arándanos de Uruguay (ANPAU). Com. Pers.

MILANCA, J.; CIAMPI, L. (2002) Estudio del desarrollo de *Botrytis cinerea*, en plantas de arandano cv. O'neal y Patriot, y su relación con algunos factores ambientales. *Fitopatología* v.37 (1): 67-108

MOLINA, J. 1998. Lepidopteros asociados al cultivo de Arándano en Andalucía Occidental. *Boletín de Sanidad Vegetal. Plagas.* Volumen 24 N 4 763-772

OREGON STATE UNIVERSITY (2005) Blueberry Diseases – Overview
<http://berrygrape.oregonstate.edu/fruitgrowing/berrycrops/blueberry/dintro.htm>

STRONG, D; LAWTON, J; SOUTHWOOD, R. 1984. Insects on Plant. Community Patterns and Mechanisms. Blackwell Scientific Publications. Oxford. UK 313. Pp.

SUMMARY

Survey of pests and diseases in blueberry crop (*Vaccinium* spp.) in Uruguay

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6. Implantation of commercial blueberry crops in Uruguay is very recent. Older plants are in their fourth growing cycle. For 2005 it is expected to have 200 has of blueberry plantations in response to the search of alternate crops intended for export. Because is a crop of recent introduction, there is not knowledge about the phytosanitary behavior under our conditions. This work was made within the framework of the Agreement signed between the General Direction of Agricultural Services and the Faculty of Agronomy. The objective was to perform a survey of pests and diseases present in the crop during the whole phenological cycle in the southern part of Uruguay. Phytopathology analysis were made and the isolated microorganisms were identified by traditional techniques. Pests were identified by traditional methodology. The following microorganisms were identified: *Alternaria alternata*; *Alternaria tenuissima*; *Botrytis cinerea*; *Botryosphaeria* sp; *Cladosporium* sp; *Pucciniastrum vaccinii*; *Ulocladium* sp; *Epicoccun* sp; *Pestalotiopsis guepinii*; *Pestalotia vaccinii*; *Phyllosticta elongata*; *Phyllosticta vaccinii*; *Stemphylium botryosum* and *Verticillium* sp. and *Agrobacterium tumefaciens*. Identified insects were: *Mallocephala deserticola*; *Trialeurodes vaporariorum*; *Oiketicus platensis*; *Diabrotica speciosa*; *Aphis gossypi*; *Agrotis ipsilon*, *Rachiplusia nu* and *Leptoglossus impictus* .

ANNEX 1

Symptoms of Fungi of Higher Incidence:

Botrytis cinerea



Fruit and Flower Blight. Photos show signs of fungus (gray mold).

Botryosphaeria spp.



Stem Blight. Dead branches with attached leaves. There is no leaf wilting or premature leaf fall.



Vascular tissue affected on the basis of the branch. Brown or tan discoloration on affected tissues colonized by the fungus.

Pucciniastrum vaccinii



Circular, brown spots on the upper surface of the leaf. Orange spots on the lower side beneath spots on the upper side (pustules), which are the fungus uredospores.

Pestalotiopsis guepinii



Spot with well-defined border of reddish color. The spot's center is lighter with black points; these black points correspond to the fungus acervuli, asexual fungal fruiting body.

Conidia of *Pestalotiopsis* under microscopy.

Appendix B. Risk mitigation options

Introduction

According to the IPPC's standard on principles of plant quarantine, countries have the sovereign right to use risk mitigation strategies that minimize pest risks to a scientifically justified level (IPPC, 1996). The appropriate level of protection for an imported commodity can be achieved by the application of a single phytosanitary measure, such as inspection or a quarantine treatment, or a combination of measures through a systems approach (IPPC, 2002). Specific mitigations may be selected from a range of pre-harvest and post-harvest options, and may include other safeguarding measures. While developing these strategies, it is important to understand that risk can never be eliminated, but it can be reduced and managed. Selection of the appropriate risk management options must consider not only the efficacy of the various risk management strategies, but also the potential impact that such strategies would have to both the importing and exporting countries. Risk management strategies must also minimize impacts on the international movement of people, commodities and conveyances (IPPC, 1996). IPPC standards outline two steps in risk management: 1) identification of risk management options and 2) analysis of the efficacy and impact of the different options (IPPC, 1996). This appendix provides the first step in risk management, i.e., the identification of phytosanitary options.

Phytosanitary Options

The pest risk assessment for fresh blueberries (*Vaccinium corymbosum* and *V. virgatum*) for consumption from Uruguay identified two fruit flies, *Anastrepha fraterculus* and *Ceratitis capitata* as quarantine pests likely to follow the pathway. Further analysis indicated these pests represent a high risk potential to the [continental] United States. Numerous different treatments have been developed to kill fruit infestations of fruit flies, but only four of these may be effective in blueberries without adversely affecting the fruit. These options are briefly discussed below.

Pest Free Sites of Production. Maintenance of pest free areas and/or pest free sites of production is a mitigation option recognized by the IPPC (IPPC, 1999). *Ceratitis capitata* is present in Uruguay (CPC, 2004); however, evidence indicates it may be possible to establish pest free sites of production. For the 2004-2005 crop seasons, Uruguay conducted a national survey for pests and pathogens of blueberries to inform and develop management strategies. The survey explicitly installed traps in blueberry fields to detect fruit flies, but none were ever detected (Appendix A) (Gonzalez *et al.*, 2005). Blueberry fruit were also sampled to detect fruit fly larvae, but again, they were not detected (MGAP, 2005a). Thus, it may be possible to establish pest free sites of production as a mitigation option (IPPC, 1999).

Methyl bromide fumigation. Methyl bromide (CH₃Br) is a colorless, odorless fumigant with relatively low solubility in water (USDA-APHIS, 2006). It is very effective at treating a wide variety of pests on a variety of different hosts. It can also be used to devitalize plants at higher concentrations. Methyl bromide fumigation involves exposing the commodity to the fumigant in a somewhat enclosed space over a relatively short period of time (e.g., a few hours). Following treatment, sufficient time must be given to allow the fumigant to diffuse from the commodity. APHIS has already developed and approved a particular treatment schedule for *C. capitata* on blueberries (USDA-APHIS, 2006); a similar schedule should be effective against *A. fraterculus*.

Irradiation. Irradiation consists of exposing the commodity to gamma-emitting isotopes (such as Cobalt-60 or Cesium-137) or to electron beams produced by linear accelerators (USDA-APHIS, 1997). Irradiation has been demonstrated to be effective in killing or devitalizing organisms that may contaminate commodities and yet pose no significant danger to human health or the environment (USDA-APHIS, 1997). APHIS has approved irradiation as a treatment for *Ceratitits capitata* infestations in fruit (USDA-APHIS, 2006), however, it is unknown how irradiation treatment would affect the quality of blueberries.

Cold Treatment. Cold treatment for medfly, which involves maintaining fruit near freezing conditions for an extended period, has been developed for various fruit commodities (USDA-APHIS, 2006) and has recently been approved for blueberries (Klag, 2006). The optimum condition for blueberry storage is between -0.5 and 0 °C, with 90 – 95% humidity (Blatt *et al.*, 1989). Under these conditions, blueberries have an acceptable storage life of 2 – 4 weeks (Blatt *et al.*, 1989). Thus, cold treatment should prove effective in destroying *C. capitata* larvae in blueberries.

Table Ab1. Mitigation options for two fruit fly pests (*Anastrepha fraterculus* and *Ceratitits capitata*) of blueberries (*Vaccinium* spp.) from Uruguay.

Mitigation Option	Pests	Efficacy													
Pest Freedom and Areas of Low Pest Prevalence															
Pest free production sites or places of production	Fruit flies	Both <i>Ceratitits capitata</i> and <i>Anastrepha fraterculus</i> are present in Uruguay (CPC, 2005); yet a pest survey of a blueberry production site did not reveal any fruit flies (Gonzalez <i>et al.</i> , 2005). Thus, establishment of a pest free production site or place of production may be efficacious with appropriate routine surveys and control programs. Such a mitigation option satisfies requirements for appropriate level of protection													
Quarantine Treatments															
Methyl Bromide	<i>C. capitata</i>	<p>Methyl bromide treatment is approved for <i>C. capitata</i> on blueberries (T101-i-1-1) (USDA-APHIS, 2006).</p> <p>Treatment: T101-i-1-1 MB at NAP—tarpaulin or chamber</p> <table border="1"> <thead> <tr> <th rowspan="2">Temperature</th> <th rowspan="2">Dosage Rate (lb/1,000 ft³)</th> <th colspan="3">Minimum Concentration Readings (ounces) At:</th> </tr> <tr> <th>0.5 hr</th> <th>2 hrs</th> <th>3.5 hrs</th> </tr> </thead> <tbody> <tr> <td>70 °F or above</td> <td>2 lbs</td> <td>26</td> <td>22</td> <td>21</td> </tr> </tbody> </table>	Temperature	Dosage Rate (lb/1,000 ft ³)	Minimum Concentration Readings (ounces) At:			0.5 hr	2 hrs	3.5 hrs	70 °F or above	2 lbs	26	22	21
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0.5 hr			2 hrs	3.5 hrs											
70 °F or above	2 lbs	26	22	21											
	<i>A. fraterculus</i>	A methyl bromide treatment for <i>A. fraterculus</i> on blueberries has not been approved, however, a schedule, similar to the one for <i>C. capitata</i> , should be effective.													
Irradiation	<i>A. fraterculus</i> & <i>C. capitata</i>	Irradiation is already approved for use on these two fruit flies at 150 Gy (USDA-APHIS, 2006).													
Cold Treatment	<i>A. fraterculus</i> & <i>C. capitata</i>	Cold treatments for <i>Ceratitits capitata</i> and <i>Anastrepha fraterculus</i> on various commodities have been approved by APHIS (T107-a-1; USDA-APHIS, 2006). Specific research for the optimal treatment schedule for these flies in blueberries is required.													

Conclusions

Four risk mitigations options for medfly in blueberries were identified. A detailed examination and choice of appropriate phytosanitary measures to mitigate pest risk is undertaken as part of the pest risk management phase in consultation with the exporting country and is not discussed in this document. The specification and implementation of phytosanitary measures, as would be present in an operational work plan, is beyond the scope of this document.