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PATHWAY-INITIATED PEST RISK ANALYSIS ON ONION BULBS (Allium cepa) FROM ARGENTINA TO JAMAICA

Version 1

Ministry of Agriculture & Fisheries
Pest Risk Analysis Unit,
Plant Quarantine/ Produce Branch
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IMPORT RISK ANALYSIS:

Onion bulbs from Argentina

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Prepared for

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Executive Summary

This pest risk analysis documents the phytosanitary risks associated with importing *Allium cepa (*onions) from Argentina into Jamaica, intended for human consumption. It also provides risk management propose phytosanitary measures necessary to manage the risks posed by regulated pests on the pathway.

Information on organisms associated with onions in Argentina reveals that pests of quarantine importance exist. Without mitigation, these pests could be introduced into Jamaica through importation of commercially produced onions. Pests of quarantine importance include the insect *Nacpactus leucoloma* (White fringe beetle); the nematode *Ditylenchus dipsaci* (the stem and root nematode); the mite *Aceria tulipae* K.; the virus Onion Dwarf Yellow Virus (ODYV) and the following pathogens: The bacterium, *Burkholderia cepacia*; five pathogenic fungi, *Botryotina fuckeliana*, *Sclerotium cepivorum*, *Colletotrichum circinans*, *Peronospora destructor*, *Phytophthora cryptogea* and *Pythium irregulare*.

The Likelihood and Consequence of Introduction of each pest were assessed individually, and risk ratings for each estimated. The Likelihood of Introduction value was estimated by assessing the quantity of the commodity to be imported annually and the potential for pest entry and establishment. The Consequence of Introduction value was estimated by assessing five elements that reflect the biology and ecology of the pests: the Host range, Climate-Host Interaction, Dispersal Potential, Economic and Environmental Impacts. The two values were summed to estimate an overall Pest Risk Potential, which is an estimation of risk in the absence of mitigation.

Based on the low risk potential, the fungus *P. destructor* does not require specific mitigative measures, except for port-of- entry inspection. The bacterium, mite, nematode and the remaining fungi may require phytosanitary measures to manage the risk of introduction into Jamaica. The insect, *Naupactus leucoloma* has a high risk potential and phytosanitary measures are strongly recommended to provide sufficient phytosanitary security to Jamaica.

Recommended phytosanitray measures to manage the risk of regulated pests on the import pathway include the use of pre-and post-harvest pest control activities, operational systems and phytosanitary inspection and certification.

Other risk management measures will be assessed as equivalent, when supporting evidence is provided in accordance with ISPM 24: *Guidelines for the Determination and Recognition of Equivalence of Phytosanitary Measures* (IPPC 2005)

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Argentina's regulatory framework for onion exports

The National Service of Agrifood Health and Quality (Spanish: *Servicio Nacional de Sanidad y Calidad Agroalimentaria*, SENASA), is the main sanitary entity in Argentina., Its main objective is the control and certification of products and by-products of animal and plant origin, their inputs and agrochemical residues, as well as the prevention, eradication and control of animal diseases, including those transmissible to man, and of plant pests that affect the agricultural production of Argentina.

To implement and promote sanitary and phytosanitary action, it draws up regulations and controls their compliance, ensuring the application of the Argentina Codex standards according to international requirements.

SENASA plans, organizes and executes specific plans and programs that regulate production, orienting it to the production of food that is safe for human and animal consumption.

SENASA is a dependency of the Secretariat of Agriculture, Livestock, Fisheries and Food division of the Ministry of Economy.

Actions performed by SENASA

To achieve a guarantee of quality, which includes safety and efficacy of animal and plant health, SENASA carries out the following actions:

It controls and certifies the quality of the products used for the diagnosis, prevention and treatment of diseases and/or pests that affect the health and quality of animals and plants, and also controls and determines how to prevent and treat effluents and residues caused by their production.

It establishes epidemiological borders and limits, adopts and executes appropriate technical measures, including the use of sanitary rifle animal slaughter and destruction of plants, to safeguard Argentina's animal and plant heritage.

It registers, authorizes, closes and controls the processing, manufacturing, storing, transport and marketing of all products within its competence.

SENASA controls federal traffic, imports and exports of products, byproducts and derivatives of animal or plant origin, agrifood goods, veterinary pharmaceutical and agrochemical products, fertilizers and amendments.

SENASA registers, authorizes of forbids agrochemical products.

National Direction of Plant Protection (ONPF)

In plant health, it is the primary responsibility of SENASA to manage phytosanitary protection, and also all aspects related to plants, their products, byproducts and derivatives, specific inputs and food, and to draw up the regulations related to these matters that must be complied with by all physical or legal entities, public or private organizations and institutions.

All planning, programming, organization, execution and supervision of plans and programs for the surveillance, monitoring, control, prevention and eradication of pests affecting plants and their products, especially those requiring a quarantine, are within the area of competence of SENASA.

Actions

Propose phytosanitary regulations for agricultural production, and imports, exports, processing, brokerage, packaging, shipment and trade of plants, their products and byproducts, according to national policies.

Draw up regulations that must be complied with by physical and legal entities, public and private organizations and institutions to further the application of national phytosanitary policies.

Formulate and coordinate plans and programs for phytosanitary protection in all Argentina to prevent the introduction of pests and diseases that require quarantine.

Intervene in any phytosanitary emergencies that may arise, coordinating any action with national, provincial, municipal and private organizations, and participating in any action these organizations may decide on.

Propose and coordinate the creation and regulation of advisory technical committees in the area of its competence.

Draw up and propose cooperation agreements with governments, national and international public and private organizations on phytosanitary issues and plant quarantine.

Participate, when necessary, in regional, hemispheric and global organizations, both at home and abroad, and in events related to its specific role.

Formulate and coordinate a surveillance and detection system for pests and diseases that affect the crops of major economic importance.

To comply with this SENASA implements and maintains a National Phytosanitary Surveillance System whose aim is to provide updated information on the situation of any pests that may affect plantations in the territory of Argentina.

INTRODUCTION

This pest risk analysis was prepared by the Pest Risk Analysis Unit of the Plant Quarantine/Produce Inspection Branch of the Ministry of Agriculture and Fisheries, to examine the pest risk associated with the importation of onion, *Allium cepa*, from Argentina into Jamaica, intended for human consumption. Estimates of the risks are expressed qualitatively, using terms of high, medium and low. This risk assessment is 'pathway- initiated' in that it is based on the potential pest risks associated with the onions along the pathway from the fields in Argentina to consumers in Jamaica.

Pest risk analysis (PRA) is the process used by NPPOs to provide technical justification for phytosanitary measures. PRA is defined by the IPPC as "the process of evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated and the strength of any phytosanitary measures to be taken against it." The process requires a risk assessment to characterize the risk and risk management to determine appropriate measures.

The International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO) provides guidance for conducting pest risk analyses. The methods used to initiate, conduct, and report this pest risk analysis are consistent with guidelines provided by the FAO (IPPC, 1996a). Biological and phytosanitary terms (e.g., introduction, quarantine pest) conform to those outlined in International Standards for Phytosanitary Measures Publication No. 5, *Glossary of Phytosanitary Terms* (IPPC, 2002a).

Details of the methodology and rating criteria used in this document can be found in the publication: "Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02" (USDA, 2000)

ONIONS

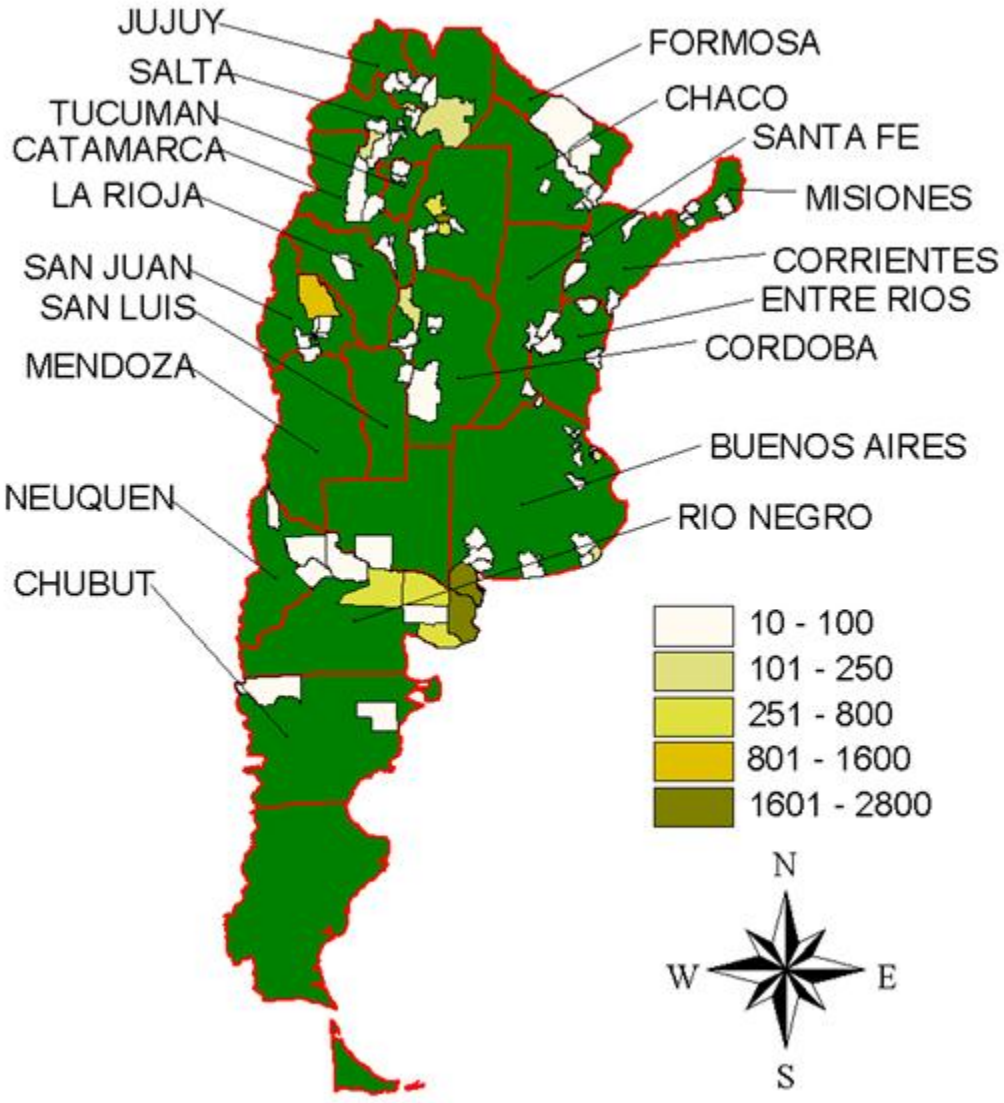
Onion is believed to be indigenous to Asia and is thought to have originated in areas of Iran and West Pakistan. Onions were cultivated in the Middle East and India from as early as 320-2780 BC. The cultivation of onions in the new world is thought to have begun as early as 1629 (Databank and Evaluation Division- Jamaica Ministry of Agriculture & Fisheries, 2008)

About 19,000 hectares of onion are cultivated in Argentina, with a production of over 500,000 tons. The area sown to onion grew around 70% in the last decade and average yield increased 18%. About 47% of the cultivated area is in the south of Argentina (Province of Buenos Aires and mid and lower valley of the Río Negro), 25 % in Cuyo (Mendoza and San Juan), 14 % in Santiago del Estero, and the remaining 14% in different Argentine provinces (MAI-Argentina).

Onions have been grown in Jamaica on a limited scale. Onions are grown mainly in the parish of St. Elizabeth in the Pedro Plains area, with this parish generally producing over 90% of the Island's total output. High volumes of onion imports have remained relatively consistent over the

years with imports of onion increasing in recent years. As much as 90% of the onions imported in Jamaica are brought from the Netherlands.

A Map of the Principal Onion Producing Provinces in Argentina



Source: Argentina Market Access Information

1 INITIATION

1.1 Initiating Event: Proposed Action

This is a pathway-initiated pest risk assessment, done in response to a request by Argentina to export onions to Jamaica. This Pest Risk Analysis was warranted in order to examine the potential phytosanitary risks associated with the importation of onion into Jamaica and would play a major role in the decision making process as to whether this product will be allowed into the country.

The PRA area is the entire Island of Jamaica.

1.2 Previous Risk Analysis, Current Status and Pest Interceptions

There is no previous risk analysis for onions entering Jamaica from Argentina. A risk assessment was however done for onions (Allium *cepa)* from Costa Rica, which included consideration of one of the pests also included in this assessment.

2 PEST RISK ASSESSMENT

2.1 Pest Categorization – Identification of Quarantine Pests

Pests associated with onion in Argentina are listed in Table 1.1. The table details the presence or absence of these pests in Jamaica, their quarantine status, the likelihood of these pests being traded or transported on the commodity (onion), potential economic impact and pertinent citation for pests bionomics and distribution.

Pests not considered for further assessment were determined by their quarantine status, their absence from the pathway or they are unlikely to enter and/or be established in Jamaica

Table1.1 Showing the Pests/Diseases in Argentina Associated with Onion

Pest	**Common Name**	**Present in Importing Country (Jamaica)**	**[1]Quarantine Status in Jamaica**	**Present on Pathway**	**References**
Burkholderia cepacia	sour skin of onion	Not Present	QP	YES	CPC, 2006
Erwinia carotovora subsp. atroseptica	potato blackleg disease	Not Present	NQP	YES	CPC, 2006
Erwinia carotovora subsp. carotovora	bacterial root rot of sweet potato	Not Present	NQP	YES	CPC, 2006
Pseudomonas marginalis pv. marginalis	lettuce marginal leaf blight	Not Present	QP	YES	CPC, 2006
Pseudomonas syringae pv. syringae	bacterial canker or blast (stone and pom	Not Present	QP	NO	CPC,2006
Pseudomonas viridiflava	bacterial leaf blight of tomato	Not Present	QP	NO	CPC,2006

Pest	**Common Name**	**Present in Importing Country (Jamaica)**	**[1]Quarantine Status in Jamaica**	**Present on Pathway**	**References**
Rhizobium radiobacter	crown gall	Present	NQP	?	CPC,2006
Pest	Common Name	Present in Importing Country (Jamaica)	[1]Quarantine Status in Jamaica	Present on Pathway	References
Alternaria alternata	alternaria leaf spot	Present	NQP	NO	CPC,2006
Alternaria porri	purple blotch	Present	NQP	YES	CPC,2006
Aspergillus fumigatus		Not Present	QP	?	CPC,2006
Aspergillus niger	Black mold	Present	NQP	YES	CPC,2006
Botryotinia fuckeliana	grey mould-rot	Not Present	QP	YES	CPC,2006
Botrytis allii	neck rot	Present	QP	YES	MAI-Argentina
Botrytis squamous	leaf blight	Not Present	QP	NO	MAI- Argentina
Botrytis tulipae	tulip fire	Not Present	NQP	YES	CPC,2006
Cladosporium allii	leaf blotch	Not Present	QP	NO	MAI-Argentina/CPRA
Colletotrichum circinans	onion smudge	Not Present	QP	YES	CPC, 2006
Colletotrichum dematium	leaf spot	Not Present	QP	?	CPC, 2006
Corticium rolfsii	sclerotium rot	Present	NQP	YES	CPC, 2006
Gibberella intricans	damping-off of safflower	Not Present	QP	?	CPC, 2006

Pest	**Common Name**	**Present in Importing Country (Jamaica)**	**[1]Quarantine Status in Jamaica**	**Present on Pathway**	**References**
Pest	Common Name	Present in Importing Country (Jamaica)	[1]Quarantine Status in Jamaica	Present on Pathway	References
Glomerella cingulata	anthracnose	Present	NQP	NO	CPC, 2006
Macrophomina phaseolina	charcoal rot of bean/tobacco	Present	NQP	YES	CPC, 2006
Nectria haematococca	dry rot of potato	Present	NQP	YES	CPC, 2006
Penicillium digitatum	green mould	Not Present	QP	NO	CPC, 2006
Penicillium italicum	blue mould	Not Present	QP	NO	CPC, 2006
Peronospora destructor	downy mildew of onion	Not Present	QP	YES	CPC, 2006
Phomopsis longicolla	pod and stem blight	Not Present	QP	NO	CPC, 2006
Phytophthora cryptogea	tomato foot rot	Not Present	QP	YES	CPC, 2006
Puccinia allii	rust of Allium spp	Not Present	QP	YES	CPC, 2006
Pyrenochaeta terrestris	pink root rot	Not Present	QP	NO	MAI-Argentina/CPRA
Pythium irregulare	dieback: carrot	Not Present	QP	YES	CPC, 2006
Sclerotinia sclerotiorum	cottony soft rot	Present	NQP	YES	CPC, 2006, (Pathologist)

Pest	**Common Name**	**Present in Importing Country (Jamaica)**	**[1]Quarantine Status in Jamaica**	**Present on Pathway**	**References**
Sclerotium cepivorum	white rot of onion)	Not Present	QP	YES	CPC, 2006
Pest	Common Name	Present in Importing Country (Jamaica)	[1]Quarantine Status in Jamaica	Present on Pathway	References
Stemphylium botryosin	leaf mould	Present	NQP	NO	MAI-Argentina/CPRA
Acromyrmex lundi	Black ant	Not Present	QP	NO	MAI-Argentina
Agrotis bilitura	Potato cutworm	Present	NQP	NO	MAI-Argentina
Agrotis ipsilon	black cutworm	Present	NQP	NO	CPC, 2006
Agrotis malefida	Pale-sided cutworm	Present	NQP	NO	MAI-Argentina
Atherigona orientalis	pepper fruit fly	Present	NQP	NO	CPC, 2006
Conoderus scalaris	Wireworm	Not Present	QP	?	MAI-Argentina
Delia antiqua	Onion Fly	Present	NQP	YES	MAI-Argentina
Delia platura	bean seed fly	Present	NQP	YES	CPC, 2006
Frankliniella occidentalis	western flower thrips	Present	NQP	NO	CPC/CPRA
Liriomyza	serpentine	Present	NQP	NO	CPC, 2006

Pest	**Common Name**	**Present in Importing Country (Jamaica)**	**[1]Quarantine Status in Jamaica**	**Present on Pathway**	**References**
huidobrensis	leafminer				/CPRA
Liriomyza trifolii	American serpentine leafminer	Present	NQP	NO	CPC, 2006
Pest	Common Name	Present in Importing Country (Jamaica)	[1]Quarantine Status in Jamaica	Present on Pathway	References
Listroderes costirostris	vegetable weevil	Not Present	QP	NO	CPC, 2006
Naupactus leucoloma	whitefringed weevil	Not Present	QP	YES	CPC, 2006
Peridroma saucia	pearly underwing moth	Present	NQP	NO	CPC, 2006
Spodoptera eridania	southern armyworm	Present	NQP	NO	CPC, 2006
Spodoptera frugiperda	fall armyworm	Present	NQP	NO	CPC, 2006
Thrips tabaci	potato thrips	Present	NQP	NO	CPC, 2006
Trichoplusia ni	cabbage looper	Present	NQP	NO	CPC, 2006
Ditylenchus dipsaci	stem and bulb nematode	Not Present	QP	YES	CPC, 2006
Meloidogyne hapla	root knot	Present	NQP	YES	CPC, 2006

Pest	**Common Name**	**Present in Importing Country (Jamaica)**	**[1]Quarantine Status in Jamaica**	**Present on Pathway**	**References**
	nematode				
Meloidogyne incognita	root knot nematode	Present	NQP	YES	MAI-Argentina
Paratrichodorus minor	stubby root nematode	Not Present	QP	NO	CPC, 2006
Pratylenchus penetrans	northern root lesion	Present	NQP	YES	CPC, 2006
Pest	Common Name	Present in Importing Country (Jamaica)	[1]Quarantine Status in Jamaica	Present on Pathway	References
Pratylenchus thornei		Present	[2]NQP	YES	CPC, 2006
Pratylenchus zeae	root lesion nematode	Present	NQP	YES	CPC, 2006
Trichodorus	stubby root nematodes	Present	NQP	NO	CPC, 2006
Aceria tulipae Keifer	Dry bulb mite	Not Present	QP	YES	MAI- Argentina
Rhizoglyphus echinopus	bulb mite	Not Present	QP	NO	MAI- Argentina
Tetranychus urticae	Two-spotted spider mite	Present	NQP	NO	MAI- Argentina
Helix aspersa	common snail	Present	NQP	YES	CPC, 2006, IOJ
Plasmodiophora brassicae	cabbage club root	Not Present	QP	NO	CPC, 2006
Onion yellow dwarf virus	onion yellow dwarf	Not Present	QP	YES	CPC, 2006

[1]Quarantine status was justified on the basis that the pest is absent from the importing country (Jamaica) and has the potential to cause economic impact.
[2] NQP- Not a Quarantine Pest because it is present in the importing country (Jamaica)
[3]QP – Quarantine Pest based on absence of the pest from the country and the potential economic impact
[4]CPC- Crop Protection Compendium (see references)
[5]MAI-Argentina – Market Access Information received from Argentina.
[6]IOJ- Institute of Jamaica

Table 1.2 Quarantine Pests Selected for Further Analysis.

Category of Pests	**Scientific name**	**Common Name**
BACTERIA		
	Burkholderia cepacia	Sour skin of onion
FUNGI		
	Botryotinia fuckeliana	Grey mould rot
	Colletotrichum circinans	Onion smudge
	Peronospora destructor	Downy mildew of onions
	Phytophthora cryptogea	Tomato foot rot
	Pythium irregulare	Dieback
	Sclerotium cepivorum	Cottony soft rot
INSECT		
	Naupactus leucoloma	White fringed beetle
NEMATODES		
	Ditylenchus dipsaci	Stem and bulb nematode
MITES		
	Aceria tulipae K.	Dry bulb mite
VIRUS		
	Onion yellow dwarf virus	Onion yellow dwarf

2.2 PROBABILITY OF INTRODUCTION

2.2.1 Likelihood of Introduction for the Pathogens, Nematode and Mite

The likelihood of introduction is a function of the quantity of the commodity to be imported as well as the opportunity provided for the quarantine pests to survive post-harvest handling. The pest opportunity is defined by five criteria that consider the potential for the pest to survival along the pathway. These include the pests' ability to survive postharvest treatment and shipment, the possibility of avoiding detection at port of entry and the potential to find suitable host

Quantity Imported Annually

The rating for the Quantity Imported Annually is usually based on the amount reported by the exporting country. For qualitative risk assessments, the amount of the commodity imported is estimated in units of standard 40-foot long shipping containers. A low rating is assigned if less than 10 containers are imported annually, 10 to 100 containers is assigned a medium rating and above 100, the rating is high. The risk values of 1, 2, and 3 are assigned to the ratings respectively.

Onion forms a major part of the spice diets of Jamaicans, however local production has seen a decline with only 455 tonnes produced in 2008 and even less in previous years. Consequently there has been a consistent high volume of onion imports over the years peaking at up to 10609 tonnes in 2001. The quantity of onions to be exported annually from Argentina to Jamaica is currently unknown. However if the amount to be imported is estimated at a quarter of that imported by Jamaica in 2008 (8626 tonnes), then approximately 80 40-foot shipping containers would be used. **The rating for quantity imported annually is therefore Medium (2).**

Criteria for rating	**Risk Rating**	**Risk Value**
Bacteria		
Burkholderia cepacia	**Medium**	**2**
Fungi		
Botryotinia fuckeliana	**Medium**	**2**
Sclerotium cepivorum	**Medium**	**2**
Colletotrichum circinans	**Medium**	**2**
Phytophthora cryptogea	**Medium**	**2**
Pythium irregulare	**Medium**	**2**
Peronospora destructor	**Medium**	**2**
Nematodes		

Ditylenchus dipsaci	**Medium**	**2**
Mite		
Aceria tulipae K.	**Medium**	**2**
Virus		
Onion Yellow Dwarf Virus	**Medium**	**2**

Survive Post-harvest Treatment

This refers to any manipulation, handling or specific phytosanitary treatment to which the commodity is subjected and that will have an effect on the pest. These may include culling, washing, chemical treatment, cold storage etc

Criteria for rating	**Risk Rating**	**Risk Value**
BACTERIA		
Burkholderia cepacia *B. cepacia* infects onion leaves and bulbs only when they are wounded. The bacterium can infect onion bulbs through succulent tissue of the neck wound created by the topping procedure at postharvest. Argentina reports that topping using sharps utensils (scissors and knives) is widely practiced during post- harvest treatment especially with delicate varieties of onion. The risk of wounding and subsequent infection is therefore high, however during the selection process, any lacerated onions are deselected (MAI-2007).	**Medium**	**2**
FUNGI		
Botryotinia fuckeliana This fungus can attack all parts of the host plants at any stage of growth, but usually attacks at or near harvest time, when the application of chemicals is likely to leave toxic residues. The fungal mycelium can cause latent infections in stored fruits and vegetables, as well as in bulbs and corms (CABI, 2006). The quality criteria reported by Argentina does not stipulate the specific phytosanitary measures that will be applied in Argentina nor their efficacy. Because of this uncertainty as well as the risk associated with chemical control of the fungus at certain stages of the plant growth and the likelihood that latent infection may go undetected, the fungus is estimated to have a high probability of surviving postharvest treatments.	**High**	**3**
Colletotrichum circinans Onion smudge may appear at all growth stages but it is more common on bulbs approaching maturity and during storage. Under favourable conditions of high moisture and temperature, which occur during harvesting in wet weather and storage under wet conditions, the fungus spreads and grows into underlying scales where it produces spots surrounded by yellowish borders. In severe cases, infection can penetrate the entire bulb causing shrinkage and complete collapse of the fleshy	**High**	**3**

scales. The disease increases onion susceptibility to other rotting agents (CABI, 2006). Some onion producing regions in Argentina do have prevailing wet climatic conditions which encourages infection by this pathogen		
Sclerotium cepivorum If bulbs infected by *S. cepivorum* survive long enough to be placed into storage, the pathogen may continue to decay the bulbs if there is high humidity and low temperatures. If the bulbs are stored under dry conditions then the disease may not spread but bulbs infected in the field will continue to decay (Cherry, 2008) This means that bulb curing won't inhibit fungal growth if prior infection occurred in the field and storage at 0^oC and between 65-70% humidity, as is reported by Argentina, will further encourage multiplication. The possibility of surviving postharvest treatment will be therefore be high	**High**	**3**
Pythium irregulare The fungus favours moist condition (high humidity) for spread. It therefore means that relative humidity during postharvest treatment will influence its spread.	**High**	**3**
Peronospora destructor The downy mildew fungus can rest in perennial varieties and in infected onion bulbs left in the field and in cull piles. Argentina indicates cultural practices as well as preventative chemical spraying in the field is used to control this pathogen, however onions stored in the field is still at risk since the pathogen is dispersed by wind.	**Medium**	**2**
Phytophthora cryptogea *P. cryptogea* is said to cause internal discoloration, soft rot and mould growth on vegetative organs (CABI, 2006). It is expected that during post-harvest treatment procedure as stipulated by Argentina, onions with such symptoms will be discarded. Despite this, onions going through the pathogen latent period, may not show symptoms and will go undetected during post-harvest treatments. The risk therefore remains relatively high	**Medium**	**2**
NEMATODE		
Ditylenchus dipsaci *D. dipsaci* favours wet conditions and mild temperatures ($15\text{-}20^oC$) and are adversely affected by dry conditions and temperatures below 10^oC and above 22^oC. Under these conditions the nematode survives as a quiescent fourth stage juvenile in seeds, bulbs, and tubers and can be spread passively for long distances with these propagative plant organs or in reused irrigation water. There is therefore a high risk of the nematode surviving postharvest treatment of onions at any temperature. However with obvious damage to plants and onion bulbs (split scale leaves, dehydrated bulbs or rot bulbs), it is expected that these onion will be deselected during Argentina's onion selection process for exports.	**Medium**	**2**
MITE		

***Aceria tulipae* K.** The mite can be established in the protected environments of *Allium* storage facilities. The mite requires high humidity to thrive. The eggs, nymphs and adults are able to survive in bulbs for extended periods in storage, and are the main source of infestation of the annually cultivated crops, where this pest is present (MacLeod, 2007). Chemical treatment in the field is inadequate since bulbs would be difficult to access. The risk of mites surviving postharvest treatment is therefore high.	**High**	**3**
VIRUS		
Onion Yellow Dwarf Virus(OYDV) The virus results in reduced size of bulbs. In the packaging process of onions in Argentina, bulbs are sized, it is however unclear as to whether bulbs of certain sizes which indicates viral infection would be discarded. The risk of these bulbs being imported into Jamaica is therefore high	**High**	**3**

Survive Shipment

The element estimates the pest likelihood of surviving the standard transit temperature and relative humidity for onion. Using the USDA recommended temperature and relative humidity and approximate transit and storage life for fruits and vegetables, the standard shipping conditions for dehydrated onion should be kept at 10^{o}C and 50% RH.

Criteria for rating	Risk Rating	Risk Value
BACTERIA		
Burkholderia cepacia The likelihood of *B. cepacia* to survive shipment is uncertain due to lack of pertinent scientific information; however, the CABI compendium reports that the pathogen is liable to be carried in the bulbs both internally and externally during trade and transport (CABI, 2006). Because of the uncertainty, the risk rating is high	**High**	**3**
FUNGI		
Botryotinia fuckeliana Temperature affects the rate of sporulation of *B. fuckeliana*. The optimum temperature for spore formation was found to be 15°C while it was 20°C for mycelial growth. At temperatures below 15°C, the rate of sporulation falls sharply and at 10°C it is only 10% of the sporulation at 15°C or even less. The optimum relative humidity for spore production is about 90%, and most spores are produced during the night, provided the temperature is sufficiently high.	**Medium**	**2**
Colletotrichum circinans Fairly humid conditions are essential for the production of abundant sporulation of this pathogen. Good spore germination occurs from 13 to 25°C with an optimum at 20°C. Infection however takes place and the disease develops from about 10 to 32°C with an optimum about 26°C	**Medium**	**2**

Sclerotium cepivorum Temperature relationships for *S. cepivorum* sclerotial germination vary according to the temperature history of the sclerotia. Once sclerotia germinate and infect plants/plant part, time for symptom development decreases with increasing temperature. Infection symptoms took five times as long to be seen at 6°C as at 24°C (CABI, 2006).	**Low**	**1**
Pythium irregulare *P. irregulare* can overwinter in soil as an oospore, suggesting that it can survive low temperatures	**High**	**3**
Peronospora destructor This fungus overwinters in the field as thick-walled resting spores (oospores) on dead leaves and stems of infected plants. During mild winters, the fungus also can survive as a threadlike growth within infected bulb and plant tissues. Thin-walled spores (conidia) appear on infected plants during the next growing season when humidity is high and temperatures range between 4°Cand 25° C. These spores are produced most rapidly at about 13° C, and are spread easily on air currents to new plants in nearby fields. The innate ability of the fungus to survive low temperatures means it is highly likely to survive shipment (Johnson et al).	**High**	**3**
Phytophthora cryptogea The minimum temperature at which this fungus will survive is below 1°C, optimum temperature range lies between 22–25°C, maximum temperature is between 31–33°C. It is therefore likely for the fungus to survive shipment conditions.	**High**	**3**
NEMATODES		
Ditylenchus dipsaci During cold storage of bulbs and tubers, *D. dipsaci* and rotting may continue to develop. Maximum activity and invasive ability is generally between 10 and 20°C	**High**	**3**
MITE		
Aceria tulipae K. Eggs, nymphs and adults of this mite are able to survive in the bulbs for extended periods both in the soil over winter and in storage,	**High**	**3**
VIRUS		
Onion Yellow Dwarf Virus The thermal inactivation point for OYDV is between 60-65^{o}C, this suggest that the virus will be able to survive shipment conditions.	**High**	**3**

Detection at Port-of- Entry

This estimates the potential for the pest to escape detection based on its association with the commodity. If there is no inspection at port of entry or the presence of the pests is not readily visible (such as the pest being internal with no external manifestation), the risk rating is high.

Criteria for rating	Risk Rating	Risk Value
BACTERIA		
Burkholderia cepacia Symptoms are generally expressed only at harvest time or in storage and affected bulbs frequently produce a sour or vinegar-like odour (CPC, 2006). Generally a yellow-brown discoloration of scales is produced and, externally, the bulb may appear firm. Symptoms may only be visible at the neck region after the leaves have collapsed, which is soft when pressed. Any such damage should be detectable at inpsection	**Low**	**1**
FUNGI		
Botryotinia fuckeliana The fungus produces a soft rot (grey mould), blight or brown lesions of immature, fleshy or senescent tissues. *B. fuckeliana* may also cause rot of stored vegetables such as onion. Early infestation may however go unnoticed.	**Medium**	**2**
Colletotrichum circinans The disease affects the scales and lower portions of the unthickened leaves, which constitute the neck of the bulb. On the outer bulb scales, over the surface of the bulb, masses of minute stromata form beneath the cuticle. These bodies, dark green at first, blackening with age, are sometimes scattered over the surface of the bulb but are more frequently concentrated in smudge-like spots, roughly circular, or arranged in concentric rings 1-2 cm diameter or more.	**Low**	**1**
Sclerotium cepivorum In commercial crops, the first signs of the disease may appear as a small patch more yellow than the surrounding onions, which could be mistaken for nutrient deficiency (CPC, 2006). The signs of the disease may be masked by other conditions as well as by the natural colour of the bulb which may also be white	**High**	**3**
Pythium irregulare Low to moderate infections are often inconspicuous (CPC, 2006). Symptoms of *P. irregulare* may be confused with symptoms of rot unless the commodity is detained for microscopic detailing during post-entry quarantine.	**High**	**3**
Peronospora destructor *P. destructor* is borne internally, however symptoms are visible.	**Low**	**1**

After a period of storage of onion bulb, the outer fleshy scale becomes amber, wrinkled and watery.		
Phytophthora cryptogea It is impossible to detect *P. cryptogea* on crops since the symptoms are often similar to those caused by other species of *Phytophthora*. When disease symptoms are discovered, the pathogen must be isolated for positive identification (CPC, 2006)	**High**	**3**
NEMATODES		
Ditylenchus dipsaci Scales on older infected bulbs often split and appear swollen or bloated. The outer layers of scales of the infected bulbs are split allowing the inner layers to bulge through. Symptoms frequently look similar to damage caused by onion maggot. Infected bulbs are also very susceptible to secondary infections by bacteria and fungi.	**Low**	**1**
MITE		
Aceria tulipae K. The mite is very small and difficult to see with the naked eye. Identification with certainty requires examining properly cleared and slide-mounted specimens under high magnification.	**High**	**3**
VIRUS		
Onion Yellow Dwarf Virus The virus causes deterioration during storage and premature sprouting of onion bulbs (Source: Description of plant viruses). This is expected to be visible upon detection, though positive identification would require post entry quarantine testings.	**Low**	**1**

Potential to move to suitable Host

This considers the geographical location of likely markets and the proportion of the commodity that is likely to move to locations suitable for pest survival. As a small Island, if infested commodity enters the Jamaica, all final destinations will have suitable climatic conditions for pest survival.

Criteria for rating (Bacteria)	**Risk Rating**	**Risk value**
Burkholderia cepacia Imported Onions will be for consumption and are expected to be sold throughout the island in markets and supermarket. It is expected that both locally produced and imported onions will be stored and sold together and any slight damage to our local onion will provide suitable environment for the bacteria to infect and multiply in already harvested onions. Cultivation of onions, is however mainly propagated from seedlings	**Low**	**1**

transported from nurseries and seedbeds in Jamaica (Nelson, 1997) and any possible infection arising will likely to be from irrigation water contaminated bacterial cells.		
FUNGI		
Botryotinia fuckeliana The role of wind-blown and rain-splashed plant debris containing mycelia as dispersal propagules is probably underestimated. Infected petals and senescent flowers are dispersed by wind and rain and provide a large, saprophytically-based inoculum. Mycelia can also be important in latent infections in stored fruits and vegetables, as well as in bulbs and corms. The pathogen is also transmitted by insects example *Drosophilia melanogaster* (CABI, 2006), which is prevalent in Jamaica. Combined with the diverse host range, the pathogen's ability to move to suitable host is high, however the climate tolerance of the pathogen (see climate-host interaction) may reduce such possibility	**Medium**	**2**
Colletotrichum circinans Damaged or inedible parts of an onion will be discarded rather than consumed, thereby creating a potential pathway for introduction of this organism. Warm, wet weather is essential for the development and spread of the smudge (CABI, 2006), which is consistent with the climatic conditions in Jamaica.	**High**	**3**
Sclerotium cepivorum Unless the imported onion intended for consumption is used as planting stock, the fungus is not expected to be transferred and affect local production. Its survival is also limited as it requires an optimum temperature of 10 -20 °C. The growth of this fungus is restricted by higher temperatures, which is seen year round in Jamaica.	**Low**	**1**
Pythium irregulare *P. irregulare* survives in soil and in infected plant debris as oospores and hyphal swellings. If the commodity is discarded or planted in backyard gardens, there exist a possibility that the pathogen may survive especially because of it large host range (200 species of plant). However spread may be restricted because it requires contaminated water to spread and infect mainly low temperatures (Katawczik, 2008).	**Low**	**1**
Peronospora destructor Downy mildew overwinters as mycelium on bulbs left in the field after harvest and in cull piles. Mycelium can survive for long periods on immature bulbs and set onions used for plantings. Once established, the pathogen can complete its life cycle in as few as 11-15 days under ideal environmental conditions of cool and wet weather. Dry, hot weather is unfavourable for the pathogen to spread and slows the disease progress (Delahaut et.al 2009).	**Low**	**1**
Phytophthora cryptogea The pathogen can survive on dead and decayed matter (saprobic) and	**High**	**3**

at similar temperatures as experienced in Jamaica. The onion will be widely distributed throughout the island and infected bulbs may be discarded causing soil infestation, which can then invade several host plants.		
NEMATODES		
Ditylenchus dipsaci The race of *D. dipsaci* that breeds on onions seems to be polyphagous and can also infest several other crops. Some of its hosts include other *Allium* species, sugar beet, beans, peas, potato, maize, sweet potato (CPC, 2006). Even if infested onion is discarded or grown, the climatic conditions in Jamaica will not be conducive for development.	**Low**	**1**
MITES		
Aceria tulipae Based on the current known distribution of *A. tulipae*, the mite is likely to be able to establish outdoors in Jamaica. Infested bulbs planted in Jamaica could support *A. tulipae*. The mite show optimum development at 25^{o}C, which coincide with the temperatures in Jamaica year round.	**High**	**3**
VIRUS		
Onion Yellow Dwarf Virus Virus is transmitted by an arthropod vector, particularly by insects. *Myzus persicae*, the green peach aphid is one of the primary vectors, and is widely distributed in Jamaica (CABI, 2006). The virus has an inactivation temperature of above 65^{o}C, and is transmitted in a non-persistent manner that is, aphids may transmit the virus when briefly probing the plant in passing. Acquisition and inoculation of the virus is in short feeding times and aphid infectivity is rapidly lost (DPD)	**High**	**3**

2.2.2 Likelihood of Introduction: Insect (Naupactus leucoloma)

Quantity Imported Annually

The rating for the Quantity Imported Annually is usually based on the amount reported by the exporting country; the quantity of onion to be imported annually from Argentina by Jamaica is currently unknown. The common type of container used for exporting onions is net bags that weigh approximately 20-25 kg when full, since approximately 91% (Data bank & Evaluation Division, 2009) of the onions consumed in Jamaica within the last 10 years have been imported the estimated risk rating for quantity to be imported is **High (3).**

Survive Post Harvest Treatments

Once *N. leucoloma* is established on outdoor crops, little can be done to control infestations.

N. leucoloma has spread from its native South America to South Africa, Australia, New Zealand and the USA. Despite phytosanitary measures in the USA, it has spread from Florida to states further north and west. *N. leucoloma* damages many important crop plants, particularly potato and forage plants, and can survive on a great variety of other hosts. In countries where it has been introduced, it usually becomes a pest (Lanteri & Marvaldi, 1995). Methyl isothiocyanate was found to be the most active of several fumigants against *N. leucoloma* (Matthiessen *et al*., 1996). However there was no fumigation mentioned in the post-harvest treatment of onion from Argentina, therefore putting the estimated risk rating to **High (3).**

Survive Shipment

N. leucoloma is likely to survive shipment as the larvae are generally found buried in the onion bulb leaves where they are protected. It is however expected that the cold temperature at which Argentina reports that onion are stored (0^{o}C) will have some impact on the survival of the larvae, therefore the risk rating may be estimated at **Medium (2).**

Detection at Port-of- Entry

Onions intended for import are expected to be subjected to point of entry inspection. Estimating the risk that this pest will not be detected at a port of entry therefore involves consideration of the degree of concealment of the pest in the commodity. Since the pest generally borrows into the onion bulb, where it is difficult to detect, the rating is determined to be **Medium (2).**

Potential to move to suitable Host

Onions forms a major part of the spice diet for Jamaicans and is therefore sold island wide. Approximately 91% of the onion consumed in Jamaica over the last ten years is imported. It is therefore expected that onion imported from Argentina will be distributed to markets and supermarkets all over the island (Databank & Evaluation). Consumers of the commodity is likely to discard or plant onion bulbs deemed not fit for consumption; this pose a threat to commercially grown onion farms especially since *N. leucoloma* has been documented to survive in tropical climate similar to Jamaica (Florida), the risk is therefore **High (3)**.

Cumulative Summary: Likelihood of Introduction of the Pathogens

Table: Cumulative Risk Summary for the Likelihood of Introduction of the pests from Argentina

Pest	Quantity Imported Annually	Survive post-harvest treatment	Survive Shipment	Detection at port-of-entry	Potential to move to suitable host	Cumulative Risk Rating
Insect						
Naupactus leucoloma	2	3	2	2	3	12
Bacteria						
Burkholderia cepacia	2	2	3	1	1	9
Fungi						
Botryotinia fuckeliana	2	3	2	2	2	11
Sclerotium cepivorum	2	3	3	3	1	12
Colletrichum circinans	2	3	2	1	3	11
Peronospora destructor	2	2	3	1	1	9
Phytophthora cryptogea	2	2	3	3	3	11
Pythium irregulare	2	3	3	3	1	12
Nematode						
Ditylenchus dipsaci	2	2	3	1	1	9
Mite						
Aceria tulipae K.	2	3	3	3	3	14
Virus						
Onion Yellow Dwarf Virus	2	3	3	1	3	12

2.3 CONSEQUENCE OF INTRODUCTION

2.3.1 Consequences of Introduction of Quarantine Pathogens

This assess the undesirable outcomes being considered resulting from the introduction of quarantine pests. The potential consequences of introduction are rated using five risk elements: host ranges, climate-host interaction, dispersal potential, economic and the environmental impact. The biology/ecology of the pests is reflected in this section. The risk elements are assigned a value (low, medium, or high), and then a cumulative risk rating is calculated by summing all risk elements value.

Morphology and Biology

Criteria for rating
BACTERIA
Burkholderia cepacia *B. cepacia* is an aerobic, gram-negative rod, motile bacteria with a polar tuft of flagella. It is non-fluorescent, producing a yellowish or greenish pigment on a variety of media (CPC, 2006). It is a versatile organism found as an inhabitant of soil and water or as a pathogen of plants and animals. The bacterial cells are rods that measure 1.6–3.2 × 0.8–1.0 µm, they occur singly or in pairs (Schwartz & Mohan 1965).
FUNGI
Botryotinia fuckeliana *B. fuckeliana* is a pleomorphic fungus with different anamorphs. The anatomy and morphology of the mycelium of *B. fuckeliana* are typical of the class Ascomycetes. The fungus is septated with septae being perforated by a simple pore. The fungus reproduces using conidia, sclerotium, microconidia and ascospores (CABI, 2006).
Colletotrichum circinans The fungus has a septated branching mycelium that varies in colour and size depending on the age of the mycelium. It also shows hyaline structural features with few septa when young, turning dark green and thickening with age. Reproduction occurs via conidia (CABI, 2006).
Sclerotium cepivorum This fungus forms black, near-spherical sclerotia that are 200-500 µm in diameter. It can also form large sclerotial bodies of irregular shape with lengths varying between 0.5 and 1.5 cm (6). The sclerotia can be found on the mycelium.
Pythium irregulare *P. irregulare* is an Oomycete of the family Pythiaceae. Hyphae are typically 5 um in diameter and can have limoniform swellings. Sporangia are asexual structures and in *P. irregulare* are spherical and can be terminal or intercalary and produce zoospores which are about 7-10 µm when encysted. Antherida and oogonia are the sexual structures. The antheridia are monoclinous or hypogynous, are stalked one to three per oogonium and can be branched. Oogonia are spherical, smooth walled or may have a number of irregular projections (1-5) and can be intercalary or terminal. Oospores are the end result of an oogina fertilized by antheridia and are

mostly aplerotic.
Peronospora destructor The fungus exists as aseptate sporangiophores, with length of 122-150 µm and basal width of 7-17 µm.
Phytophthora cryptogea The hyphae of *P. cryptogea* are very uneven in width, with hyphae showing width of up to 8 µm. Hyphae tend to exhibit groups of angular swellings giving a 'net-like' appearance in water cultures. Sporangiophore proliferates through empty sporangium or developing sympodially from below. Sporangia are regularly ovoid or obpyriform, 37–40 (–55) × 23 (–30) µm, and are produced only in liquid media, non-papillate, without obvious apical thickening, often with a conspicuous central vacuole. Oogonia rarely formed in single cultures but develop promptly and abundantly on pairing isolates of opposite compatibility types, 20–32 (–38) µm diam., wall smoth, becoming yellow but not much thicker with age. Antheridia spherical and 10 (–16) µm diam. or occasionally oval or short cylindrical. Oospore nearly filling the oogonium, wall 3·5 µm thick (CABI, 2006).
NEMATODES
Ditylenchus dipsaci These are round, slender transparent worms. The adults are about 1.2 mm long; some race can be up to 2mm long with a moderately developed head skeleton. The tail terminus sharply pointed in both male and female with a post-vulval sac extending about half-way to the anus (EPPO and CABI).
MITE
Aceria tulipae The mite has a vermiform body ranging from 200-250µm length. The dorsal side is covered with a shield (37-39 µm) which bears a longitudinal striation as well a pair of long posterior-directed, divergent dorsal setae near the posterior edge. The two pairs of legs have distinctive claw-like structures located terminally on the tarsi, with seven pairs of rays.
VIRUS
Onion Yellow Dwarf Virus (OYDV) The onion yellow dwarf virus is a Potyvirus belonging to the family Potyviridae. OYDV exist as a non-enveloped filamentous particle comprising of a nucleic acid surrounded by a hollow protein cylinder or capsid, which is helical in structure with a mass of 34kDa. The modal length is 772 and 823 nm (CABI, 2006)

Host Range

This element looks at the pest's ability to establish a viable reproductive population and its potential for causing plant damage. The risk is simply rated on the host range of each pest. A low risk rating means that the pest only attacks a single species or multiple species within a single genus; a medium rating is assigned when the pest attacks multiple species in a single family. However the risk rating is high when multiple species from multiple families are attacked

Criteria for rating	**Risk Rating**	**Risk Value**
BACTERIA		
Burkholderia cepacia	**Low**	**1**

The primary host is onion and problems do occur, albeit to a lesser extent, on garlic. Other minor hosts are listed and appear in the literature however; in general, these reports remain to be confirmed. Some of the minor host includes potato, maize, lettuce, cotton (CABI, 2006). The risk rating for *B. cepacia* will be based on the confirmed hosts only.		
FUNGI		
Botryotinia fuckeliana The host range of *B. fuckeliana* is very wide. The pathogen is considered as a non-specific pathogen with 235 hosts (CABI, 2006) including vegetables, ornamentals, field crops, fruits and forest tree seedling.	**High**	**3**
Colletotrichum circinans This fungus primarily affects the *Allium* species (CABI, 2006)	**Low**	**1**
Sclerotium cepivorum *S. cepivorum* is a pest primarily of the *Allium* species (CABI, 2006).	**Low**	**1**
Pythium irregulare *P. irregulare* infects a wide range of plants including herbaceous and woody plants, and both monocots and dicots (CABI, 2006). The pathogen has been identified on over 200 host species. In the United States it has been found across the country on pineapple, cereals, grasses, celery, pepper, tobacco, pecan trees, citrus trees, strawberries, lentils, corn, soybean, cucumber, onion, and carrot (Katawczik, 2008).	**High**	**3**
Peronospora destructor *Peronospora destructor* is a destructive disease of onion and other alliums including garlic, leeks shallot etc (CABI, 2006).	**Low**	**1**
Phytophthora cryptogea *P. cryptogea* has a wide host range attacking plants from at least 23 families, especially from the Compositae (Asteraceae) and Gesneriaceae. Some of the hosts include tomato, ornamentals (including petunia, aster, and chrysanthemum), potato, chicory, spinach, bean, onion, cucurbits, eggplant, hop, sunflower, safflower, lucerne, chestnut and others (CABI, 2006).	**High**	**3**
NEMATODES		
Ditylenchus dipsaci *D. dipsaci* is known to attack over 450 different plant species, including many weeds. However, it occurs in more than 20 biological races, some of which have a limited host range. The races that breed on rye, oats and onions seem to be polyphagous and can also infest several other crops.	**High**	**3**
MITE		
***Aceria tulipae* K.** *Aceria tulipae* has hosts in the families Alliaceae and Liliaceae.	**High**	**3**

These include Allium species such as *A. ampeloprasum* (leek), *A. ascalonicum*(shallot), *A. cepa* (onion), *A. sativum* (garlic), *A. schoenoprasum* (chives), and *Tulipa* (tulip). *Allium chinense* (rakkyo) is a secondary host (MacLeod, 2007).		
VIRUS		
***Onion Yellow Dwarf Virus* (OYDV)** OYDV infects members of the genus *Allium*, reports of the virus infecting Chinese sacred lily have not been confirmed (CABI, 2006).	**Low**	**1**

Climate –Host Interaction

Pests are expected to behave as they do in their native areas when introduced into new areas provided that the hosts plants and climate are similar. The ecological zonation and the interactions of the pests with their biotic and abiotic environments are considered. Estimates are are based on availability of both host material and suitable climate conditions.

Criteria for rating	Risk Rating	Risk Value
BACTERIA		
Burkholderia cepacia *B. cepacia* is primarily a pest of the *Allium* genus; onions in particular and garlic to a lesser extent. The optimum growth temperature for the bacterium is between 30–35°C. Infection by *B. cepacia* generally occurs through a wound when free water from rain, overhead irrigation, or flooding causes contamination of the host tissue. The temperature condition required for optimum multiplication of this bacterium is consistent with that experience in Jamaica	**Medium**	**2**
FUNGI		
Botryotinia fuckeliana Temperature affects the rate of sporulation, the optimum temperature for spore formation was found to be 15°C while it was 20°C for mycelial growth. Once sclerotia germinate and infect plants, time for symptom development decreases with increasing temperature. Epidemics caused by *B. fuckeliana* occur in cool, wet and humid weather, conditions that favour sporulation and infection. The severity of grey mould is closely related to environmental conditions and is especially dependent on temperature and relative humidity (CABI, 2006).	**Low**	**1**
Colletotrichum circinans Infection takes place and the disease develops from about 10 to 32°C with an optimum of about 26°C. Fairly humid conditions are essential for the production of conidiomata and abundant sporulation. Good spore germination occurs from 13 to 25°C	**Medium**	**2**

with an optimum at 20°C. In warm, wet weather the pathogen may complete a life cycle from infection to conidiomata (reproductive spore) eruptions in 5-6 days. Very hot, dry weather checks the progress of the pathogen. *C. circinans* is a soilborne pathogen. In the absence of the host it can survive in the soil for several years, at least two (2 years). The climatic conditions in Jamaica may not be conducive for pathogen optimal survival but establishment remains possible.		
Sclerotium cepivorum Temperature relationships for sclerotial germination vary according to the temperature history of the sclerotia and the isolate under study (Gerbrandy, 1992). The fungus infects plants in the *Allium* genus, which includes onion, garlic, and leeks. The disease can occur in any location where *Allium* spp. are grown, as long as part of the crop growth occurs during a cool season. Cool weather is also needed for germination of sclerotia and hyphal growth.	**Medium**	**2**
Pythium irregulare *P. irregulare* is a widespread fungus of species in the genera Brassicae, Beta and Fabaecae. The fungus has a worldwide distribution. Its optimum temperature for growth is about 30°C (CPC, 2006). *P. irregulare* prefers conditions of high moisture for root colonization and 50% saturation capacity of soil for infection (Katawiczk, 2008)	**High**	**3**
Peronospora destructor The pathogen is found in the Americas, North, East and South Africa, West, South, and East Asia, Europe, Australia, and New Zealand. *P. destructor* is present where temperatures are cool. In the tropics it attacks mainly onions planted in the mountain regions. The pathogen fails to sporulate on onion plants kept in continuous light or darkness. The range of temperature between 4 and 26°C is favourable for sporulation, but a nearly saturated atmosphere (>95% RH) or >90% RH, according to Yarwood (1943), is also required (CPC, 2006). The major onion cultivation sites are in the low altitude southern regions of Jamaica.	**Low**	**1**
Phytophthora cryptogea *P. cryptogea* is primarily a soil-borne plant pathogen in the temperate regions but it also exists in nature as a saprobic fresh-water fungus (Sparrow, 1960). It is most active at temperatures between 10 and 20°C (Erwin and Ribeiro, 1996), infecting the roots, stem bases, bulbs and corms by mycelia, (CPC, 2006). The minimum temperature for *P. cryptogea* is below 1°C, optimum 22–25°C and a maximum of 31–33°C.	**Medium**	**2**

NEMATODES		
Ditylenchus dipsaci *D. dipsaci* occurs locally in most temperate areas of the world (Europe and the Mediterranean region, North and South America, northern and southern Africa, Asia and Oceania) but it does not seem able to establish itself in tropical regions except at higher altitudes that have a temperate climate (CPC, 2006). *D. dipsaci* favours wet conditions and mild temperatures (15-20^{o}C) and are adversely affected by dry conditions and temperatures below 10^{o}C and above 22^{o}C. It was discovered that the nematode is not favoured for establishment in the outdoor climatic conditions of Florida as warm temperatures greater than 22^{o}C will prevent nematode infection and development (Greco et. al. 1991).	**Low**	**1**
MITE		
***Aceria tulipae* K.** Based on the current known distribution of *A. tulipae*, the mite is likely to be able to establish outdoors in the Jamaica Optimum development occurs at around 25°C.	**Medium**	**2**
VIRUS		
Onion Yellow Dwarf Virus The thermal inactivation point for this virus is between 60 and 65°C, which is far above the average temperature in Jamaica. The longevity of the virus in *vitro* is 2-3 days. The virus withstands drying and storage in leaves over $CaCl_2$ at 4°C. Once the virus is carried into the bulb, then the temperature in Jamaica is conducive for transmission (DPD).	**High**	**3**

Dispersal Potential

Pests may disperse after introduction into new areas. The dispersal potential indicates how rapidly and widely the pest's economic and environmental impact may be expressed within the importing country or region. The dispersal potential is related to the pest's reproductive potential, inherent mobility, and dispersal ability. Factors for rating the dispersal potential include: the presence of multiple generations per year or growing season, the relative number of offspring or propagules per generation, any inherent capabilities for rapid movement, the presence of natural barriers or enemies, and dissemination enhanced by wind, water, vectors, or human assistance.

Criteria for rating (Bacteria)	**Risk Rating**	**Risk Value**
Burkholderia cepacia *B. cepacia* is nutritionally diverse, adaptable and has the capacity to propagate as an environmental microbe as well as an opportunistic pathogen. This is due to the unusual genomic	**Medium**	**2**

arrangement. Bacteria spread more rapidly in water-soaked tissue and when temperatures exceed 30°C. Although *B. cepacia* does not appear to survive on dry surfaces for more than 1 week, it can survive for many months in water		
FUNGI		
Botryotinia fuckeliana *B. fuckeliana is* a non-specific parasite which attacks sunflower as well as many other hosts. Under humid conditions, the grey mould produce spreads rapidly. In dry weather, the mycelium produces conidia. The main source of inoculum is conidia, which are wind-borne and are also spread by rain (splash dispersal). Based on the climatic conditions in Jamaica, this pest will be able to reproduce and dispersed rapidly once established	**High**	**3**
Colletotrichum circinans In warm, wet weather, the pathogen may complete a life cycle from infection to conidiomata (spore) eruptions in 5-6 days. Very hot, dry weather slows the progress of the pathogen.	**High**	**3**
Sclerotium cepivorum The fungus is favoured by cool weather and survives in the soil as small, round structures known as sclerotia. These sclerotia can survive in the soil for decades. The sclerotia that form on the decaying host will lay dormant until a host plant's root exudates stimulate germination specifically root exudates that are unique to *Allium* spp. Cool weather is also needed for germination of sclerotia and hyphal growth. Jamaica only experience short bouts of seasonal cool temperatures which are intricate in the fungus growth and development, potential dispersal is therefore low	**Low**	**1**
Pythium irregulare *P. irregulare* has sexual and asexual stages which both end in infection by hyphal germ tubes. Moist conditions favour the spread of this pathogen through zoospores. Zoospores are motile in water and will encyst to form germ tubes. This is why crops in low lying areas with poor drainage or plants in a greenhouse with a contaminated irrigation system are more at risk for infection.	**Medium**	**2**
Peronospora destructor The quantity of spores released into the air from sources depends on wind, solar radiation and relative humidity. Aerial dispersal of spores depends on wind, as demonstrated by some observations made in the field, and on the distribution of diseased plants as it relates to the prevailing wind direction. Increasing temperature also limits spore survival; at 35°C 0%	**Low**	**1**

of spores were still able to germinate after 10 h, irrespective of relative humidity. Spores are also killed rapidly by alternating wet and dry periods, a phenomenon associated with low rates of dew deposition (CPC, 2006). Infected crops growing in proximity to healthy crops are a frequent source of onion mildew spores (CPC, 2006). After the fungus is established, it completes its life cycle in 11 to 15 days; new spores can then infect new plants or leaves. As the upper portion of the onion leaf is killed, the fungus can infect the next lower part of the leaf. The entire leaf may thus become infected and die. During favorable environmental conditions the infection may result in a severe epidemic. During dry weather, the spores usually disappear and the number of lesions declines. However, the disease cycle recommences when wet, cool weather recurs (Global Crop Pest website). Downy mildew can develop from an initial infection by airborne spores into an epidemic very quickly if humidity and temperature conditions (1.5 to 7 hours of leaf wetness and 43° to 80°F) are favorable. Spores can travel long distances in moist air, but are quickly killed by dry conditions. Initial sources of disease can be infected bulbs, sets, seeds, and plant debris (Davis 2008).		
Phytophthora cryptogea Studies done on *P. cryptogea* demonstrated that flagella activity and water movement greatly increase the dispersal of zoospores which are attracted to and accumulate on root surface where they encyst and germinate to penetrate the epidermis of host plants. The incidence of infection of plants is directly related to the concentration of motile zoospores per plant .The sporangia in soil are tolerant of moderate desiccation for 4-24 hours without losing their ability to release zoospores. Zoospores or cysts of *P. cryptogea* are commonly spread by irrigation water and the fungus was frequently isolated from contaminated (CPC, 2006)	**Medium**	**2**
NEMATODES		
Ditylenchus dipsaci In onion plants at 15°C, the life-cycle takes about 20 days. Females lay 200 to 500 eggs each.	**Medium**	**2**
MITE		
Aceria tulipae K. If infested bulbs were planted out the mite could transfer to suitable hosts via aerial dispersal, as is common amongst other eriophyids, although Conijn *et al*., (1996) indicate that the spread of this mite outdoors is limited. If *A. tulipae* was carried	**Low**	**1**

into onion stores, they could survive and transfer to other bulbs (MacLeod, 2007)		
VIRUS		
Onion Yellow Dwarf Virus The virus survives in bulbs and sets and therefore can be transmitted during vegetative reproduction (Davis et. al 2009). The onions intended for import are for consumption, however if sprouting occurs and onion is planted, then the fact that the vector is prevalent in Jamaica, would increase the chance of the pest being spread from plant to plant. Additionally some 60 species of aphid is known to transmit the virus non-persistently in nature and is said to be responsible for the epidemics of the virus.Although the virus is not spread to the seed, seed from infected plants is of poor quality. Jamaica primarily cultivates onion from seedlings.	**High**	**3**

Economic Impact

Introduced pests cause a variety of direct and indirect economic impacts such as reduced yield, reduced commodity value, loss of foreign or domestic markets, and non-crop impacts. Factors considered during the ranking process included whether the pest would: affect yield or commodity quality, cause plant mortality, act as a disease vector, increase costs of production including pest control costs, lower market prices, affect market availability, increase research or extension costs, or reduce recreational land use or aesthetic value.

Criteria for rating	**Risk Rating**	**Risk value**
Bacteria		
Burkholderia cepacia In general, *B. cepacia* is not considered to be a serious pathogen of onion or other crops. Whilst yield losses of 5-50% have been noted in individual fields, the disease is sporadic particularly in maturing bulbs or in storage (CPC, 2006). Such damage would result in reduced value of the crop and loss of domestic markets due to presence of this pathogen.	**High**	**3**
FUNGI		
Botryotinia fuckeliana *B. fuckeliana* infects a very wide range of plants including field-grown crops such as grapes and greenhouse-grown vegetables, flowers and fruits. It causes yield losses in the field and during postharvest storage and transport. It is difficult to assess the damage caused by *B. fuckeliana*. Economic losses of greater than 50% may occur in many crops, depending on the prevailing environmental conditions. Intensive use of fungicides is needed to control grey mould. In Europe, 25-30%	**Medium**	**2**

of vineyards (3.7 million hectares) were treated with fungicides in 1992 and 1993; the costs of fungicide applications were estimated to be 20-50 million EU dollars.		
Colletotrichums circinans Assessments of economic impact are problematic due to prior confusion with *Colletotrichum acutatum*. More recent anecdotal evidence suggests that *C. acutatum* is the primary cause of *Colletotrichum* disease of strawberry even in the areas of North America where *C. fragariae* is known to occur. This uncertainty results in the rating being high	**High**	**3**
Sclerotium cepivorum On a worldwide basis, Allium white rot is probably the most serious threat to Allium crop production of any disease (CABI, 2006). In a number of regions, the disease has been responsible for the complete collapse of the Allium production industry (Cherry online). The pathogen cause losses from 1 to 100% and has caused great damage in diverse regions of Europe, Asia, Africa, North, Central, and South America, Australia and New Zealand (Ulacio-Osario et. al 2006).	**High**	**3**
Pythium irregulare The economic impact of diseases caused by *P. irregulare* depends on the relative importance of the affected crop to the production area. *P. irregulare*, along with other species of *Pythium* genus causes significant loss of greenhouse crops and those in hydroponic production systems by causing damping-off and root rot. Cavity spots and dieback of carrots caused by *P. irregulare* and other *Pythium* species significantly reduce yield and value (Liddell et al., 1989; Guerin et al., 1994).-(extracted from CPC, 2006)	**Medium**	**2**
Peronospora destructor Downy mildew caused by the fungus is a destructive disease of onions and other alliums (garlic, leeks etc) reducing the yield and bulb quality. The infection seldom kills plants, but reduces bulb size and leaves the bulb tissues especially the neck spongy and open to invasion by storage decay organisms (Delahaut et. al 2009)**.** This disease is one of the most destructive of onion seed production world-wide (Global Crop pest website)	**High**	**3**
Phytophthora cryptogea *P. cryptogea* is a serious plant pathogen in many countries, causing great damage especially to tomato and ornamentals grown in nurseries, greenhouses and under hydroponics (CABI, 2006). The yield lost and value reduction of this fungus on onion in unknown.	**Low**	**1**
NEMATODES		

Ditylenchus dipsaci *D. dipsaci* is one of the most devastating plant parasitic nematodes, especially in temperate regions. Without control, it can cause complete failure of host crops, including onions, garlic, legumes and especially flower bud.	**High**	**3**
MITE		
Aceria tulipae K. *A. tulipae* feeds on the foliage of hosts and between the layers in bulbs.Feeding causes stunting, twisting, curling and discoloration of foliage and scarification and drying of bulb tissue. There is scant information quantifying the impact of this pest. However, what data there is, suggests that when bulbs are severely infested, losses could be significant, for example approximately 30% losses have been reported from onions. In field trials, Larrain (1986) measured yield losses of 23% in garlic due to *A. tulipae*. The mite can transmit Onion Mite-borne Latent virus and Shallot Mite borne Latent virus. Vectoring these viruses would not significantly increase any impact resulting from feeding damage caused by the mite since virus symptoms and damage resulting from mite feeding is very similar (MacLeod, 2007).	**High**	**3**
VIRUS		
Onion Yellow Dwarf Virus OYDV especially damages onion seed crops since infected plants neither flower nor bear seeds. The damage level depends on the number of infected plants. Vegetable yield of OYDV-infected plants in annual crops may be reduced by 25% whereas potential seed yield losses may be reduced by 50-70% (CABI, 2006)	**Medium**	**2**

Environmental Impact

The potential pests to cause environmental damage is considered by evaluating the following factors: ecological disruptions, biodiversity threat or reduction, and chemical or biological control plans adoption. The environmental impact reflects the potential for these quarantine pests to adversely affect native species outside the onion agroecosystem (PPQ).

Criteria for rating	**Risk Rating**	**Risk Value**
BACTERIA		
Burkholderia cepacia The pathogen is not expected to stimulate biological or chemical control programmes since infections usually occurs at or near maturity as a rot of bulb scales, and sometimes in storage. Contaminated irrigation water has been implicated in the spread of the pathogen, the use of recycled or irrigation runoff water could just be avoided (Schwartz & Mohan 1965). The bacterium does not appear to be strongly invasive,	**Medium**	**2**

attacking only plants that are damaged or weakened. *B. cepacia* can however infect other crops outside the Allium species;		
FUNGI		
Botryotinia fuckeliana Control of the pathogen is difficult to achieve because the fungus can attack all parts of the host plants at any stage of growth, often at or near harvest time, thus preventing the application of chemicals that leave toxic residues. Furthermore, the fungus has been shown to easily develop resistance to intensively-used fungicides. The introduction of this pest into Jamaica will therefore stimulate chemical or biological control programme.	**Medium**	**2**
Colletotrichums circinans The potential environmental impact is uncertain, therefore the risk rating assumes a high value	**High**	**3**
Pythium irregulare The potential environmental impact is uncertain, therefore the risk rating assumes a high value	**High**	**3**
Sclerotium cepivorum Sclerotia of *S. cepivorum* are stimulated to germinate specifically by root exudates of the genus *Allium* and the natural host range is limited to this genus. Chemical treatment is among the more effective short-term solutions to Allium white rot, but cannot be relied upon in the long term. Biological and using resistant varities would have to be employed.	**Medium**	**2**
Peronospora destructor *P. destructor* can cause severe yield losses if weather conditions stay within a favourable range for each of the disease stages. Therefore, control of downy mildew is always necessary to guarantee crop health: good management of cultural factors alone is not sufficient (CBAI, 2009). As such an integrated management strategy would have had to be employed	**Medium**	**2**
Phytophthora cryptogea *P. cryptogea* has a wide host range attacking plants from at least 23 families. Whereas differences in host ranges existed among isolates from different hosts, the isolates from chicory were non-specific. The control of plant diseases caused by soil-borne pathogens is difficult and requires integrated approach to reduce fungal growth. (CPC, 2006).	**Medium**	**2**
NEMATODES		
Ditylenchus dipsaci In most countries regulatory measures such as certification schemes are applied to minimize spread of *D. dipsaci.*	**Medium**	**2**
MITE		
Aceria tulipae	**Medium**	**2**

Aceria tulipae has hosts in the families Alliaceae and Liliaceae. Control of *A. tulipae* has focused on treatment of bulbs with chemicals or low temperatures to attempt to eradicate mite infestations prior to storage or planting.		
VIRUS		
Onion Yellow Dwarf Virus OYDV is a pest of the *Allium* species.	**Medium**	**2**

Animal/Human Transmission

This looks at the virulence of the pests with respect to animal and humans, the human to human contact, and the severity of the disease caused.

Criteria for rating (Bacteria)	**Risk Rating**	**Risk Value**
Burkholderia cepacia Although sporadic human infection due to *Burkholderia cepacia* has been reported for many years, it has been only during the past few decades that species within the *B. cepacia* complex have emerged as significant opportunistic human pathogens (LiPume, 2003). *B. cepacia* is inherently resistant to multiple antibiotics, can metabolize diverse substrates, and is found in soil and in moist environments. The organism has a particular predilection for the lung in patients with cystic fibrosis (CF) and has emerged as an important opportunistic human pathogen in hospitalized and immunocompromised patients. *B. cepacia* was first reported as a human pathogen causing endocarditis in the 1950s, since then the organism has caused numerous catheter-associated urinary tract infections, wound infections, and intravenous catheter associated bacteremias (Holmes, A et al. 1998). A study done by Jacob J.L, et al. revealed that multiple *B. cepacia* complex species colonize the onion rhizosphere and have the potential to cause sour skin rot disease of onion. In addition, the onion rhizosphere is a natural habitat and a potential environmental source of *B. cenocepacia*, which is implicated in the human infection by the bacterium.	**High**	**3**

2.3.2 Consequences of Introduction of the insect- Nacpactus leucoloma

Synonyms: *Graphognathus leucoloma* Buchanan
Pantomorus leucoloma Boheman

Common names: White-fringed weevil (English)
White-fringed beetle (English)

The adult female of this species is the only sex found outside of South America (EPPO datasheet). The adult female is 8mm-12 mm in length and 4 mm wide across the abdomen. It has a short snout and is oval in general shape. It is dark grey, with a lighter band along the outer margin of its wing covers and two paler longitudinal lines on each side of the head and thorax one above and one below the eye. The abdomen is densely covered with short pale hairs which become longer towards the tips of the elytra. The inner margins of the elytra are fused together, and the adults cannot fly. Males are shorter, about 8.5 mm long, and narrower with longer antennae and legs.

Males are rare and have only been found in South America (EPPO). Outside South America, only parthenogenic females are found. Five to 25 days after emerging, mature females begin to lay up to 1500 eggs in groups of 20-60 over a two-month period. Eggs hatch in 11-30 days, the larval stage has 11 larval instars, the first of which does not feed (EPPO datasheet). The fully grown legless larva is about 13 mm long and 6 mm wide, it has a small, round pale-brown head, which is tucked back into the prothorax with only the black mandibles protruding. The body is yellowish-white, fleshy, curved and sparsely covered with hair. It consists of 12 segments interrupted by 2 sublateral longitudinal grooves extending the length of the body.

The entire larval stage is spent in the soil at a depth of 1-15 cm, but some may burrow deeper. The larval stage usually overwinters, although eggs can also overwinter. It is the damage caused by larval feeding that makes *N. leucoloma* a pest.

Host Range

Naupactus leucoloma is a highly polyphagous pest (CSL, 1999), with the ability to feed on a very wide range of plant species totaling up to 385 species of plant showing significant damages to some plants. It causes severe damage on the following crops: *Brassica* spp., *Daucus carota* (carrot), *Fragaria xananassa*, *Medicago sativa*, *Pisum sativum*, *Rubus* spp., *Solanum tuberosum* (potato), *Trifolium* spp. and *Zea mays* (corn). EPPO reports that this pest can seriously caused damage to carrot and potato which are crops of economically importance to Jamaica. This rating is therefore **High (3).**

Climate –Host Interaction

The climate in Argentina varies due to its large territory, with four climatic conditions existing: warm, moderate, arid and cold. The warm climates shows both tropical and subtropical conditions and the province Santiago del Estero, which exports 14% (third largest producing province) of Argentina's onion having a tropical temperature similar to that of Jamaica.
Buenos Aires, Argentina's largest onion producing province (producing 36% of Argentina's onion for export) shows moderate temperate due to the oceanic influence. The climates in these areas correspond to those in Jamaica. Additionally, the pest has been able to establish in Florida which experience similar climatic conditions to Jamaica. The rating is therefore **High (3).**

Dispersal Potential

Adults cannot fly but they actively crawl and climb. Females can crawl 0.4-1.2 km during their 2-5-month adult life (Metcalf & Metcalf, 1993). Adults cling to hay, other crops and to vehicles and agricultural equipment being transported, and can thus be carried in trade. Since eggs are laid on many parts of host plants and remain viable for more than 7 months, they can also be transported in trade (Chadwick, 1978). As females are parthenogenetic laying upto 1500 eggs in groups of 20-60 over a two-month period, the chance of small populations colonizing new region is high (EPPO datasheet). The dispersal potential of this insect is therefore considered to be **High (3).**

Economic and Environmental Impact

Very low population densities of *N. leucoloma* can cause economic damage. A density of only one larva m^{-1} row of potatoes (equivalent to about 1 larva 1.5 m^{-2}) resulted in a loss of 9% of average gross return (Learmouth, 1993). As larvae feed on roots, the damage they cause is noticed when plants begin to show stress by becoming yellow or stunted. Larvae often sever a plant's main root while feeding. In potatoes, damage is more spectacular, as larvae tunnel inside the tubers. In New Zealand, the nitrogen fixation rate of *Trifolium repens* was reduced by 92% by *N. leucoloma* larval feeding (Hardwick & Prestidge, 1996). Larvae hatching from eggs in early or late summer reach sufficient size to damage sweet potato roots before the autumn harvest (Zehnder, 1997). Adults feed on leaves, but the resulting damage is very minor except at high population densities. Metcalf & Metcalf (1993) stated that "entomologists who have studied the insect feel that it may become a serious pest in many regions of the United States" and hence, the USA has internal phytosanitary regulations to limit its spread.
Naupactus leucoloma is highly polyphagous pests, and is able to feed on a very wide range of plant species, with crops such as sweet potato, carrot and Irish potato which are of economic importance to Jamaica being susceptible. This pest threatens crop yield, value and loss to domestic and foreign market. **The risk rating is therefore High (3)**

Cumulative Risk Summary: Consequences of Introduction

Table: Cumulative Risk Summary for the Consequences of Introduction of the pests from Argentina

Pest	Host Range	Climate/Host Interaction	Dispersal potential	Economic Impact	Environmental Impact	Animal/ Human Interaction	Cumulative Risk Rating
Insect							
Naupactus leucoloma	3	3	3	3	3	-	15
Bacteria							
Burkholderia cepacia	1	2	2	3	2	3	13
Fungi							
Botryotinia fuckeliana	3	1	3	2	2	-	11
Sclerotium cepivorum	1	2	1	3	2	-	9
Colletrichum circinans	1	2	3	3	3	-	12
Peronospora destructor	1	1	1	3	2	-	8
Phytophthora cryptogea	3	2	2	1	2	-	10
Pythium irregulare	3	3	2	2	3	-	13
Nematode							
Ditylenchus dipsaci	3	1	2	3	2	-	11
Mite							
Aceria tulipae K.	3	2	1	3	2	-	11
Virus							
Onion Yellow Dwarf Virus	1	3	3	2	2	-	11

3 CONCLUSION:

Pest Risk Potential and Pests Requiring Phytosanitary Measures

To estimate the pest risk potential for each pest, the cumulative risk rating for the consequences of introduction and likelihood of introduction is summed. The risk potential ratings are assigned as follows:

Low: 11-18 points
Medium: 19-26 points
High: 27-33 points

Table: The overall Pest Risk Potential Rating

Pests	Consequences of Introduction	Likelihood of Introduction	Pest Risk Potential	Risk Ratings
Insect				
Naupactus leucoloma	15	12	**27**	**High**
Bacteria				
Burkholderia cepacia	13	9	**22**	**Medium**
Fungi				
Botryotinia fuckeliana	11	11	**22**	**Medium**
Sclerotium cepivorum	9	12	**21**	**Medium**
Colletrichum circinans	12	11	**23**	**Medium**
Peronospora destructor	8	9	**17**	**Low**
Phytophthora cryptogea	10	11	**21**	**Medium**
Pythium irregulare	13	12	**25**	**Medium**
Nematode				
Ditylenchus dipsaci	11	9	**20**	**Medium**
Mite				
Aceria tulipae K.	11	14	**25**	**Medium**
Virus				
Onion Yellow Dwarf Virus	11	12	**23**	**Medium**

Based on the risk potential, the fungus *P. destructor* doesn't require specific mitigative measures, excepting port-of- entry inspection. The bacterium, mite, nematode and the remaining fungi may require phytosanitary measures. The insect, *Naupactus leucoloma* has a high risk potential and phytosanitary measures are strongly recommended to provide sufficient phytosanitary security to Jamaica.

Additionally, it is concluded that if any of the pests with the exception of *Phytophthora cryptogea* move from private gardens or areas where onion is discarded to commercial growing areas or the wider environment, they could cause moderate to high economic and environmental consequences to Jamaica. The bacterium, *Burkholderia cepacia* may have a human health consequence.

Assessment of uncertainty

The greatest and most significant area of uncertainty in this risk analysis is related to our lack of knowledge of the onion food-waste disposal patterns and the percentage home gardening in Jamaica. There is also considerable uncertainty in terms of the definite pre and post-harvest management strategies employed for onion bulbs in Argentina. As such, the risk assessment may be reviewed once further relevant information becomes available.

4 RISK MANAGEMENT

For each organism classified as a potential quarantine pest, risk management identifies the options available for managing the risk. Feedback is sought from stakeholders on these options through consultations. The risk analysis is then finalized following consultations and will present options, refined if appropriate, for the phytosanitary measures to be considered. Measures are recommended to the Chief Plant Quarantine Officer for decision once the measures are deemed to be appropriate.

4.1 Risk Mitigation Options

4.1.1 Generally Applicable Phytosanitary Measures Options

The following phytosanitary options are generally applicable for pests potentially associated with imported goods.

Pest Free Areas (PFA)

The International Standards for Phytosanitary Measures (ISPM) No 4, *Requirements for the establishment of pest free areas,* describes the requirements for the establishment and use of PFAs as a risk management option. It is accepted that pests that have never been detected in, or that have been detected and eradicated from an area should not be considered present in an area if there have been sufficient opportunity for them to have been detected. When sufficient information is available to support a PFA declaration, this phytosanitary measure is usually considered to provide a very high level of protection.

Pest free place of production (PFPP)

ISPM 10 *Requirements for the establishment of pest free places of production and pest free production sites*) describes the requirements for the establishment and use of pest free places of production as a risk management option for meeting phytosanitary requirements for the import of plants. A pest free place of production is defined in the standard as a "place of production in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period

When sufficient information is available to support a PFPP declaration, this phytosanitary measure is usually considered to provide a high level of protection depending on the epidemiological characteristics of the pest under considerations.

4.1.2 Specific Phytosanitary Measures that may be Applicable to the Import of Onions from Argentina

Pests associated with the crop can be reduced through the application of pesticides and fungicides as well as integrated pest management activities. Field inspections prior to harvesting can confirm that pest or disease rates are suitably low and, if combined with other phytosanitary measures such as processing or treatment, can ensure adequate levels of mitigation are achieved.

Integrated pest management (IPM) strategies to manage pest of concern in Argentina could include:

Pre-Harvest Management

- **Cultural Control**

1. Use pest free planting stock
2. Use of resistant or tolerant cultivar to reduce damage
3. Sanitation and farm hygiene; avoid the use of contaminated water.
4. Avoid dense planting of onions or planting near weeds and dense barriers because these help to maintain dew on the onion leaves which aids in disease infection and dissemination.
5. Remove un-harvested plant parts and decaying infected plant tissues
6. Destroy volunteer onion plants and crop debris as soon as the crop is harvested.

- **Chemical Control**

1. Use of pesticides should be applied when appropriate

Post-Harvest Management

- **Harvesting, Sanitization, Curing and Drying**

1. It is expected that large clumps or clods of soil and other foreign materials should be removed and badly affected or damaged produce discarded.
2. Onions must be sorted and only onions free from all impurities which may materially alter the appearance or eating quality should be sent to the exported consignment.
3. A standard sanitizing wash using sodium hypochlorite (NaClO) is recommended after the bulbs have been cleaned from soil and or decaying plant material to protect onion bulbs from bacterial or fungal infection during storage and transport
4. Visual inspection of bulbs for pests or symptoms of disease either immediately after harvesting or during processing for export should also be integrated into post-harvest management
5. It is important that no root material is left on the base of the bulb and the stalk at the top of the bulb is trimmed back to within a few millimetres of the bulb surface.
6. Onions must be mature, clean, firm, free from diseases, dry cured and free from bottle necks

7. Heat treatment using temperatures above 45^{o}C is suggested to reduce infestations by *Peronospora destructor* and *Ditylenchus dipsaci*.
8. In storage, it is important to maintain relative humidity between 65-70% with adequate air circulation at 0ºC (32ºF) to prevent splitting, sprouting and disease infestation.

- **Onion packaging**

Good packaging for onions should meet the following criteria:

1. Strong enough to retain the required weight of onions under the conditions of transport and storage
2. Allow sufficient ventilation for the air around the bulbs to maintain relative humidity in the required range
3. In many circumstances, provide a means of displaying legally required and Commercially necessary information

- **Onion Storage**

The objectives of onion storage are to extend the period of availability of crop, maintain optimum bulb quality and minimise losses from physical, physiological, and pathological agents.

1. Bulbs selected for storage should be firm and the neck dry and thin.
2. Skin colour should be typical of the cultivar.
3. Microbial infections such as *Aspergillus niger* occur during production of onions but these will only develop on the bulbs during storage where the storage environment is conducive for their growth.
4. Prior to storage, crop must be cleaned and graded, and all damaged or diseased bulbs removed. Careful harvest and pre-storage treatments with minimal mechanical loads are important to achieve a long storage period.
5. Storeroom temperature, relative humidity, and atmospheric composition affect the length of storage that can be achieved.

- **Fumigation**

In keeping with, risk potential guidelines, specific phytosanitary measures are strongly recommended to provide sufficient phytosanitary security to Jamaica. With reference to the insect, *Naupactus leucoloma* which borrows internally in onion bulb; the USDA treatment manual (see section T101-q-2 of the treatment schedule for fruits, vegetables and nuts) provides a methyl bromide fumigation schedule for insects that are “internal feeders” of onion bulbs.

Methyl bromide fumigation schedule for internal feeders (and leafminers) in onion bulbs. Treatment: **T101-q-2** MB at NAP—tarpaulin or chamber (extracted from treatment schedule for fruits, vegetables and nuts)

5 RISK MANAGEMENT PROPOSAL

Summary of Risk

The pest risk assessment identified 10 organisms of quarantine importance to Jamaica that are likely to follow the pathway of onions bulbs from Argentina into Jamaica. These include the insect *Nacpactus leucoloma*; the nematode *Ditylenchus dipsaci*; the mite *Aceria tulipae* K.; the virus Onion Dwarf Yellow Virus (ODYV): the bacterium, *Burkholderia cepacia*; five pathogenic fungi, *Botryotina fuckeliana, Sclerotium cepivorum, Colletotrichum circinans, Peronospora destructor, Phytophthora cryptogea* and *Pythium irregular.*

The likelihood of introduction of these pests and the consequences were they to be introduced were assessed in the section on risk assessment and risk ratings applied. Specific phytosanitary measure are deemed necessary to mitigate the threat to Jamaica posed by the potential introduction of those pests rated as having an overall risk potential of medium or high. Based on the risk potential, the fungus *P. destructor* doesn't require specific mitigative measures, excepting at port-of- entry inspection.

The following section proposes measures that Jamaica believes will effectively manage known phytosanitary risks associated with the importation of fresh onion bulbs for human consumption from the Argentine Republic in a way that is consistent with international obligations.

5.1 Proposed Requirements

Phytosanitary measures to manage the risk of the regulated pests on the pathway include the use of pre-and post-harvest pest control activities, regulatory/official activities and phytosanitary inspection and certificate

Import Permit

A Jamaica plant quarantine import permit is required for the importation of onions from Argentina

Pre-Harvest Activities

(i) **In-field pest control**

a) All registered farms implement pest management activities outlined in an integrated pest management (IPM) and monitoring programme.

b) An efficacious insecticide is applied if necessary, to manage the risk of *Nacpactus leucoloma* infestation. Application of an efficacious preventative fungicide for *Botryotina fuckeliana, Sclerotium cepivorum, Colletotrichum circinans,*

Peronospora destructor, *Phytophthora cryptogea* and *Pythium irregular i* is utilised. Records of control measures are retained

(ii) **Monitoring**

a) Production sites must be monitored by a SENASA personnel trained in detection and recognition of pathogens of concern to Jamaica. Onion bulbs from production sites where disease symptoms are found are not eligible for export to Jamaica.

Post-Harvest Activities

(i) **Cleaning**: Physical cleaning is expected to reduce the presence of regulated pests

a. Onion bulbs for export to Jamaica must be cleaned, manicured and graded during processing at a SENESA registered packing house. Cleaning, manicuring and grading includes the removal of soil and foreign material, removal of fibrous roots leaving each onion bulb with minimal root material and the removal of the loose outer skin to ensure no soil remains.

b. Onion bulbs showing signs of damage, pest infestation, symptoms of disease, contamination or growth of sprouts or roots, are removed and labelled for disposal during the physical cleaning process.

(ii) **Visual Inspection and Remedial Action** is expected to reduce the presence of regulated pests

a) During the growing season and at the pre-harvest, SENESA crop inspection and monitoring activities should be conducted for arthropods or for signs and symptoms of disease associated with the above ground onion plant parts. Following harvest all onion bulbs are to be inspected for all life stages of regulated pests. Damaged bulbs may have noticeable secondary infection, arthropods or nematodes associated with them.

b) Detection of any regulated pest of concern to Jamaica should result in the application of an appropriate treatment or exclusion of the onion lot from the Jamaican export pathway.

Regulatory/Official Activities

The following operational, phytosanitary maintenance and verification system ensures the proposed risk management measures have been met and are maintained.

(i) **Farm registration**

The designated NPPO for Argentina (SENESA) registers all commercial farms. Only commercially produced onion bulbs from registered farms may be imported into Jamaica. Registration is required to ensure approved production procedures are followed and provide product traceability along the export pathway.

(ii) **b) Packing house/ storage facility registration**

SENESA registers all packing and storage facilities processing onion bulbs for export to Jamaica verifying that packing and storage facilities are compliant with agreed packing house operations, and sanitation procedures. Packing house and storage facility registration is expected to limit the presence of hitchhiker pests and allow trace-back information in the event of non-compliance.

(iii)**Phytosanitary inspection and certification**

All consignments must be sampled and visually inspected for pests prior to issuance of a phytosanitary certificate by SENESA. When no pests or diseases are found and all requirements of the import have been met, a phytosanitary certificate should be issued.

a) Inspection on Arrival

- The Plant Quarantine Inspectors will check the accompanying documentation on arrival to confirm that it reconciles with the actual consignment.

- If regulated pests are intercepted or detected on the commodity, or associated with packaging, the following actions will be undertaken as appropriate:

    - Re-export (where possible) of the consignment at the importer's risk.
    - Destruction of the consignment at importers expense.
    - The suspension of trade, until the cause of the non-compliance is investigated, identified and rectified.

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