

Generic Pest Risk Analysis for Potato in Nepal

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ABSTRACT

Pest Risk Analysis (PRA) is the process of evaluation for biological and economic evidences in order to determine whether a pest should be regulated under phyto-sanitary measures. The present mini review highlights the potential potato pathogen list recorded in Nepal harmful for potato production and productivity. At global scale altogether 135 potential quarantine pests (PQP) for potato has been recorded, while in Nepal only 92 PQP were recorded. Out of those 52, 13 and 27 were fungi, bacteria and viruses respectively. Among the 92 PQP, 34, 30 and 13 were considered at high, medium and lower risk type pathogens for potato. There was no information available on other 15 PQP.

Keywords: Pest Risk Analysis, Potential Quarantine Pest, Pathogen, Pest risk assessment

सारांश

शत्रुजीव जोखिम विश्लेषण (PRA) एउटा वैज्ञानिक प्रक्रिया हो। जसमा शत्रुजीवको जैविक तथा आर्थिक तथ्यको आधारमा बाहिरी देशबाट आफ्नो देशमा भित्राउन विरुवा स्वस्थता सम्बन्धी नियमन गर्नु पर्ने हो होइन निक्यौल गरिन्छ। प्रस्तुत सक्षिप्त आलेखमा नेपालमा आलुबालीका सभाव्य जोखिमपूर्ण जीवाणुहरूको विवेचनात्मक सूची प्रस्तुत गरिएको छ। संसारभरि आलु बालीमा लाग्ने १३५ थरि रोगका जीवाणुहरू (Pathogens/Pests) सूचीकृत छन्। विश्वव्यापीरूपमा १३५ थरिका जीवाणुहरूलाई सम्भाव्य जोखिमयुक्त मानिएका छन्। तथापि, यी रोगका जीवाणुहरूको नेपाली सन्दर्भमा आर्थिक विश्लेषण गर्दा ९२ वटा जीवाणुहरूलाई सम्भाव्य शत्रुजीव (Potential Quarantine Pest, PQP) को रूपमा लिन सकिन्छ। ९२ वटा (PQP) मध्ये ५२, १३ र २७ वटा दुई, विषाणु तथा जीवाणु क्रमशः रहेका छन्। यी ९२ वटा शत्रुजीव (Pathogen) मध्ये ३४ थरिलाई उच्च, ३० मध्यम, १३ लाई सामान्य जोखिमयुक्त शत्रुजीव मानिएका पाइए। बाँकी १५ वटा शत्रुजीवको जोखिम विश्लेषण सम्बन्धी जानकारी उपलब्ध छैन।

INTRODUCTION

According to the World Trade Organization (WTO)'s sanitary and quarantine (SPS) agreement on the sharing of the material under Pest Risk Analysis (PRA) is important (Jha et al 2006, Ullah 2016). Sanitary and Phytosanitary (SPS) Agreement of the World Trade Organization (WTO) suggested to implement a Pest Risk Analysis (PRA) while sharing genetic materials, because, it is necessary to develop a comprehensive PRA in international trade and commerce brought out for crops export and import (MoAD 2013). Food and Agriculture Organization (FAO) has taken the initiative to strengthen the plant quarantine and institutional capacity of quality quarantine services in Nepal. Pest risk analysis involves the merging of scientific assessment, ongoing consultation and practical pest management. Nepal being a member of World Trade Organization (WTO) needs to declare the prevailing diseases (pest) status of crops, which has been a major international concern for trade promotion. Pest risk assessment is a process of identifying plant pests as potential hazards and characterizing their risk (MoAD 2013). Risk characterization is risk assessment process of estimating the likelihood or probability of experiencing the adverse effects of pests.

Risk assessment provides the scientific basis for analyses. Its emphasis is on biology, but it also includes a description of economic implications (Ullah 2016). Since the PRA is a recent requirement and obligation to reduce the impact of pathogen. Therefore, the purpose of the paper is to elucidate on potential quarantine pests (PQP) such as fungi, bacteria, viruses and risk of entry, spread, damage etc.

MATERIALS AND METHODS

To perform generic pest risk analysis (PRA) Crop Protection Compendium (CPC 2006) provides reference for information on global pathogens (pests) list. The relevant literature was reviewed and the lists of pathogens (disease) have been prepared. Several magazines, journals, proceedings, research report and books with a description of the work performed in Nepal have been consulted. The information gathered has been further upgraded.

Guidelines for rating entry

Rating= low: The probability of entry is low given the combination of factors including the distribution of the pest source, management practices, low commodity volume, low probability of pest survival in transit, or low probability of contact with susceptible hosts given the intended use. The probability of entry is low but clearly possible given the expected combination of factors.

Rating = medium: Pest entry into in an area is likely given the combination of factors described above.

Rating =high: Pest entry is very likely or certain given the combination of factors described above.

Table 1. List of global, Nepal and Potential Quarantine Pest (PQP) for Nepal

SN	Global list on potato pathogen (Fungi, bacteria, phytoplasma & viruses)	Updated Nepal pest list (Fungi, bacteria and viruses)	Potential Quarantine Pest (PQP) (Fungi, bacteria and viruses)
1.	<i>Acididium cantense</i> (Acididium potato rust)	<i>Alternaria alternata</i> (alternaria leaf spot)	<i>Acididium cantense</i> (Acididium potato rust)
2.	<i>Alternaria alternata</i> (alternaria leaf spot)	<i>Alternaria solani</i>	<i>Alternaria radicina</i> (black rot of carrots)
3.	<i>Alternaria radicina</i> (black rot of carrots)	<i>Alternaria tenuissima</i>	<i>Arthrinium phaeospermum</i>
4.	<i>Alternaria solani</i> (early blight of potato and tomato)	<i>Cercospora solanica</i>	<i>Bacillus polymyxa</i> (bacterial fruit rot)
5.	<i>Arthrinium phaeospermum</i>	<i>Cladosporium tenuissimum</i>	<i>Belicobasidium purpureum</i> Pat.
6.	<i>Aspergillus niger</i> (Aspergillus ear rot)	<i>Phytophthora infestans</i>	<i>Botryotinia fuckeliana</i> (Botrytis rot)
7.	<i>Bacillus polymyxa</i> (bacterial fruit rot)	<i>Synchytrium endobioticum</i>	<i>Burkholderia cepacia</i> (slippery skin of onion)
8.	<i>Belicobasidium purpureum</i> Pat.	<i>Thanatephorus cucumeris</i> (Frank) Donk	<i>Burkholderia gladioli</i> pv. <i>Gladioli</i> (corn scab)
9.	<i>Botryotinia fuckeliana</i> (Botrytis rot)	<i>Rhizoctonia solani</i>	<i>Chalara elegans</i> (black root rot)
10.	<i>Burkholderia cepacia</i> (slippery skin of onion)	<i>Aspergillus niger</i> (Aspergillus ear rot)	<i>Choanephora cucurbitarum</i> (Choanephora blossom blight)
11.	<i>Burkholderia gladioli</i> pv. <i>Gladioli</i> (corn scab)	<i>Corticium rolfsii</i> (collar rot)	<i>Cochliobolus australiensis</i>
12.	<i>Cercospora solanica</i>	<i>Fusarium coeruleum</i> (dry rot: potato)	<i>Cochliobolus hawaiiensis</i> (leaf spot: maize)
13.	<i>Chalara elegans</i> (black root rot)	<i>Cercospora solani-tuberosi</i>	<i>Coleosporium tussilaginis</i> f.sp. <i>senecionis-sylvati</i>
14.	<i>Choanephora cucurbitarum</i> (Choanephora blossom blight)	<i>Cercospora concors</i>	<i>Colletotrichum coccodes</i> (anthracnose of tomato)
15.	<i>Cladosporium tenuissimum</i>	<i>Spongospora subterranean</i>	<i>Didymella bryoniae</i> (gummy stem blight)
16.	<i>Clavibacter michiganensis</i> subsp. <i>Sepedonicus</i> (Potato ring rot)	<i>Cochliobolus lunatus</i> (Cabage, Rice)	<i>Didymella lycopersici</i> (canker of tomato)
17.	<i>Cochliobolus australiensis</i>	<i>Sclerotinia sclerotiorum</i> (collar rot) Lentil	<i>Erwinia carotovora</i> subsp. <i>Carotovora</i> (bacterial root rot of sweet potato)
18.	<i>Cochliobolus hawaiiensis</i> (leaf spot: maize)	<i>Colletotrichum capsici</i> (leaf spot of peppers)	<i>Erwinia chrysanthemi</i>
19.	<i>Cochliobolus lunatus</i> (black kernel of rice)	<i>Septoria lycopersici</i> (leaf spot of tomato) Tomato	<i>Erwinia chrysanthemi</i> pv. <i>Chrysanthemi</i> (bacterial maize stalk rot)
20.	<i>Coleosporium tussilaginis</i> f.sp. <i>senecionis-sylvati</i>	<i>Erwinia chrysanthemi</i> pv. <i>Zeae</i> (bacterial stalk rot) Maize	<i>Erysiphe orontii</i> (powdery mildew)
21.	<i>Colletotrichum capsici</i> (leaf spot of peppers)	<i>Pythium aphanidermatum</i> (damping-off) Maize	<i>Fusarium</i>
22.	<i>Colletotrichum coccodes</i> (anthracnose of tomato)	<i>Macrophomina phaseolina</i> (ashy stem blight) Mango	<i>Fusarium culmorum</i> (culm rot: cereals)
23.	<i>Corticium rolfsii</i> (collar rot)	<i>Clavibacter michiganensis</i> subsp. <i>Sepedonicus</i>	<i>Fusarium oxysporum</i> f.sp. <i>tuberosi</i>
24.	<i>Didymella bryoniae</i> (gummy stem blight)	<i>Erwinia carotovora</i> subsp. <i>Atroseptica</i>	<i>Geotrichum candidum</i> (sour rot: Citrus spp.)
25.	<i>Didymella lycopersici</i> (canker of tomato)	<i>Ralstonia solanacearum</i>	<i>Gibberella avenacea</i> (bud rot)
26.	<i>Erwinia carotovora</i>	<i>Streptomyces scabiei</i>	<i>Gibberella baccata</i> (biocontrol: velvetleaf)
27.	<i>Erwinia carotovora</i> subsp. <i>Atroseptica</i> (potato blackleg disease)	<i>Potato virus M</i>	<i>Gibberella zeae</i> (cobweb disease)
28.	<i>Erwinia carotovora</i> subsp. <i>Carotovora</i> (bacterial root rot of sweet potato)	<i>Potato virus S</i>	<i>Helminthosporium solani</i> (silver scurf)
29.	<i>Erwinia chrysanthemi</i>	<i>Potato virus X</i> (potato interveinal mosaic)	<i>Hypocrea rufa</i> (fruit rot: Citrus spp.)
30.	<i>Erwinia chrysanthemi</i> pv. <i>Chrysanthemi</i> (bacterial maize stalk rot)	<i>Potato virus Y</i> (potato mottle)	<i>Levellula taurica</i>
31.	<i>Erwinia chrysanthemi</i> pv. <i>Zeae</i> (bacterial stalk rot)	<i>Potato virus A</i> (potato mild mosaic)	<i>Melanotus communis</i> (wireworm, common)
32.	<i>Erysiphe orontii</i> (powdery mildew)	<i>Potato aucuba mosaic virus</i>	<i>Nectria haematococca</i> (dry rot of potato)
33.	<i>Fusarium</i>	<i>Potato leafroll virus</i>	<i>Pectobacterium chrysanthemi</i> (slow wilt)
34.	<i>Fusarium coeruleum</i> (dry rot: potato)	<i>Phytophthora capsici</i> (soft rot of cucurbit fruits)	<i>Phaciopycnis tuberivora</i> (dryrot: potato)
35.	<i>Fusarium culmorum</i> (culm rot: cereals)	<i>Levellula taurica</i> (In onion)	<i>Phialophora parasitica</i> (wilt: date palm)
36.	<i>Fusarium oxysporum</i> f.sp. <i>tuberosi</i>	<i>Erwinia chrysanthemi</i> (in onion)	<i>Phoma andigena</i> (black blight of potatoes)
37.	<i>Geotrichum candidum</i> (sour rot: Citrus spp.)	<i>Tomato spotted wilt virus</i> (tomato spotted wilt) in lentil	<i>Phoma eupyrena</i>
38.	<i>Gibberella avenacea</i> (bud rot)	<i>Ralstonia solanacearum</i> race 1 (in tomato)	<i>Phoma exigua</i> var. <i>exigua</i> (leaf blotch)
39.	<i>Gibberella baccata</i> (biocontrol: velvetleaf)	<i>Ralstonia solanacearum</i> race 3 (in tomato)	<i>Phoma foveata</i> (potato gangrene)
40.	<i>Gibberella zeae</i> (cobweb disease)	<i>Tomato mosaic virus</i> (tomato mosaic) in tomato	<i>Phytophthora citrophthora</i> (brown rot of citrus fruit)
41.	<i>Helminthosporium solani</i> (silver scurf)	<i>Cucumber mosaic virus</i> (cucumber mosaic) in pea	<i>Phytophthora cryptogea</i> (tomato foot rot)
42.	<i>Hypocrea rufa</i> (fruit rot: Citrus spp.)	<i>Pseudomonas syringae</i> (It come with other sp showacpc)	<i>Phytophthora drechsleri</i> (watermelon fruit rot)
43.	<i>Levellula taurica</i>	<i>Alfalfa mosaic virus</i> (alfalfa yellow spot)	<i>Phytophthora erythroseptica</i> var. <i>erythroseptica</i> (pink rot)
44.	<i>Macrophomina phaseolina</i> (ashy stem blight)	<i>Citrus exocortis viroid</i> (citrus exocortis)	<i>Phytophthora megasperma</i> (apoplexy)
45.	<i>Melanotus communis</i> (wireworm, common)	<i>Tobacco mosaic virus</i> (tobacco mosaic)	<i>Polyscytulum pustulans</i> (skin spot of potato)
46.	<i>Nectria haematococca</i> (dry rot of potato)		<i>Potato purple-top wilt phytoplasma</i>
47.	<i>Nectria haematococca</i> (dry rot: potato)		<i>Potato stolbur phytoplasma</i>
48.	<i>Pectobacterium chrysanthemi</i> (slow wilt)		<i>Potato witches' broom phytoplasma</i>
49.	<i>Phaciopycnis tuberivora</i> (dryrot: potato)		<i>Pseudomonas fluorescens</i> (biocontrol: Damping off (cotton))
50.	<i>Phialophora parasitica</i> (wilt: date palm)		<i>Pseudomonas marginalis</i> pv. <i>Marginalis</i> (lettuce marginal leaf blight)
51.	<i>Phoma andigena</i> (black blight of potatoes)		<i>Pseudomonas putida</i> (biocontrol: Erwinia spp.)
52.	<i>Phoma eupyrena</i>		<i>Pseudomonas syringae</i> pv. <i>Garcae</i> (bacterial blight of coffee)
53.	<i>Phoma exigua</i> var. <i>exigua</i> (leaf blotch)		<i>Pseudomonas syringae</i> pv. <i>Tabaci</i> (angular leaf spot)
54.	<i>Phoma foveata</i> (potato gangrene)		<i>Puccinia pittieriana</i> (common rust of potato)
55.	<i>Phytophthora capsici</i> (soft rot of cucurbit fruits)		<i>Pythium butleri</i>

SN	Global list on potato pathogen (Fungi, bacteria, phytoplasma & viruses)	Updated Nepal pest list (Fungi, bacteria and viruses)	Potential Quarantine Pest (PQP) (Fungi, bacteria and viruses)
1.	<i>Phytophthora citrophthora</i> (brown rot of citrus fruit)		<i>Pythium ultimum</i>
2.	<i>Phytophthora cryptogea</i> (tomato foot rot)		<i>Pythium vexans</i> (damping off)
3.	<i>Phytophthora drechsleri</i> (watermelon fruit rot)		<i>Ralstonia solanacearum</i> race 1
4.	<i>Phytophthora erythroseptica</i> var. <i>erythroseptica</i> (pink rot)		<i>Ralstonia solanacearum</i> race 3
5.	<i>Phytophthora infestans</i> (blight of potato)		<i>Rhizobium radiobacter</i> (crown gall)
6.	<i>Phytophthora megasperma</i> (apoplexy)		<i>Rhizobium rhizogenes</i> (bacterial gall)
7.	<i>Polyscytalum pustulans</i> (skin spot of potato)		<i>Rosellinia bunodes</i> (black root rot)
8.	Potato purple-top wilt phytoplasma		<i>Rosellinia necatrix</i> (dematophora root rot)
9.	Potato stolbur phytoplasma		<i>Septoria lycopersici</i> var. <i>malagutii</i> (annular leaf spot of potato)
10.	Potato witches' broom phytoplasma		<i>Thecaphora solani</i> (potato smut)
11.	<i>Pseudomonas fluorescens</i> (biocontrol: Damping off (cotton))		<i>Ulocladium atrum</i> (almond mould complex)
12.	<i>Pseudomonas marginalis</i> pv. <i>marginalis</i> (lettuce marginal leaf blight)		<i>Verticillium albo-atrum</i> (verticillium wilt of alfalfa)
13.	<i>Pseudomonas putida</i> (biocontrol: Erwinia spp.)		<i>Verticillium dahliae</i> (verticillium wilt)
14.	<i>Pseudomonas syringae</i>		<i>Verticillium nigrescens</i> (seed reduction: soybean)
15.	<i>Pseudomonas syringae</i> pv. <i>garcae</i> (bacterial blight of coffee)		<i>Verticillium tricorpus</i>
16.	<i>Pseudomonas syringae</i> pv. <i>tabaci</i> (angular leaf spot)		Andean potato latent virus
17.	<i>Puccinia pittieriana</i> (common rust of potato)		Andean potato mottle virus (Andean mottle of potato)
18.	<i>Pythium aphanidermatum</i> (damping-off)		Arracacha virus B
19.	<i>Pythium butleri</i>		Beet curly top virus (curly top)
20.	<i>Pythium ultimum</i>		Pepino mosaic virus
21.	<i>Pythium vexans</i> (damping off)		Potato 14R (?) tobamovirus
22.	<i>Ralstonia solanacearum</i> (bacterial wilt of potato)		Potato Andean latent tymovirus
23.	<i>Ralstonia solanacearum</i> race 1		Potato Andean mottle comovirus
24.	<i>Ralstonia solanacearum</i> race 3		Potato black ringspot virus (calico disease of potato)
25.	<i>Rhizobium radiobacter</i> (crown gall)		Potato deforming mosaic virus (deforming mosaic of potato)
26.	<i>Rhizobium rhizogenes</i> (bacterial gall)		Potato mop-top virus
27.	<i>Rosellinia bunodes</i> (black root rot)		Potato spindle tuber viroid (spindle tuber of potato)
28.	<i>Rosellinia necatrix</i> (dematophora root rot)		Potato virus T
29.	<i>Sclerotinia sclerotiorum</i> (collar rot)		Potato virus V
30.	<i>Septoria lycopersici</i> (leaf spot of tomato)		Potato yellow dwarf virus (yellow dwarf of potato)
31.	<i>Septoria lycopersici</i> var. <i>malagutii</i> (annular leaf spot of potato)		Potato yellow vein virus (yellow vein of potato)
32.	<i>Streptomyces scabiei</i> (potato scab)		Potato yellowing virus
33.	<i>Synchytrium endobioticum</i> (black wart of potato)		<i>Solanum apical leaf curling</i> (?) bigeminivirus
34.	<i>Thanatephorus cucumeris</i> (many names, depending on host)		<i>Solanum yellow luteovirus</i>
35.	<i>Thecaphora solani</i> (potato smut)		Southern potato latent (?) carlavirus
36.	<i>Ulocladium atrum</i> (almond mould complex)		Tobacco necrosis virus
37.	<i>Verticillium albo-atrum</i> (verticillium wilt of alfalfa)		Tobacco rattle virus (spraing of potato)
38.	<i>Verticillium dahliae</i> (verticillium wilt)		Tobacco ringspot virus (annulus tabaci)
39.	<i>Verticillium nigrescens</i> (seed reduction: soybean)		Tobacco streak virus
40.	<i>Verticillium tricorpus</i>		Tomato black ring virus
41.	Alfalfa mosaic virus (alfalfa yellow spot)		Tomato infectious chlorosis virus
42.	Andean potato latent virus		Tomato yellow mosaic virus
43.	Andean potato mottle virus (Andean mottle of potato)		
44.	Arracacha virus B		
45.	Beet curly top virus (curly top)		
46.	<i>Citrus exocortis</i> viroid (citrus exocortis)		
47.	Cucumber mosaic virus (cucumber mosaic)		
48.	Pepino mosaic virus		
49.	Potato 14R (?) tobamovirus		
50.	Potato Andean latent tymovirus		
51.	Potato Andean mottle comovirus		
52.	Potato aucuba mosaic virus		
53.	Potato black ringspot virus (calico disease of potato)		
54.	Potato deforming mosaic virus (deforming mosaic of potato)		
55.	Potato leafroll virus		
56.	Potato mop-top virus		
57.	Potato spindle tuber viroid (spindle tuber of potato)		
58.	Potato virus A (potato mild mosaic)		
59.	Potato virus M		
60.	Potato virus S		
61.	Potato virus T		
62.	Potato virus V		
63.	Potato virus X (potato interveinal mosaic)		
64.	Potato virus Y (potato mottle)		
65.	Potato yellow dwarf virus (yellow dwarf of potato)		
66.	Potato yellow vein virus (yellow vein of potato)		
67.	Potato yellowing virus		
68.	<i>Solanum apical leaf curling</i> (?) bigeminivirus		
69.	<i>Solanum yellow luteovirus</i>		
70.	Southern potato latent (?) carlavirus		
71.	Tobacco mosaic virus (tobacco mosaic)		
72.	Tobacco necrosis virus		
73.	Tobacco rattle virus (spraing of potato)		
74.	Tobacco ringspot virus (annulus tabaci)		
75.	Tobacco streak virus		
76.	Tomato black ring virus		
77.	Tomato infectious chlorosis virus		
78.	Tomato mosaic virus (tomato mosaic)		
79.	Tomato spotted wilt virus (tomato spotted wilt)		
80.	Tomato yellow mosaic virus		

RESULTS

The data showed that all together 92 pathogens (fungi, bacteria and phytoplasma, viruses and viroids) were recorded as potential quarantine pests (PQP) for pest risk analysis (PRA). Out of 92 pathogens, fungi were 52, bacteria and phytoplasma were 13 and virus and viroids were 27 (Table 1). Detail information was not available for 15 pathogens. Among 15 pathogens fungi was 9, phytoplasma 1 and virus and viroids were 5. Out of 92 PQP for pest risk assessment, 34 were at high, 30 were of medium and 13 were of lower risk. Fifteen pests had no information. Risk management revealed that thirty-five pathogens (pests) were in high category, 30 pathogens (pests) in medium, 12 pathogens (pests) in low category (Table 2). Fifteen had no risk information. Out of 92 pests, sixty-one pathogen (pest) required additional declaration, 16 do not require additional declaration while fifteen had no information (Table 2).

DISCUSSION

The common pathogen of potato reported in Nepal are late blight (*Phytophthora infestans*), bacterial wilt (*Pseudomonas solanacearum*), black scurf (*Rhizoctonia solani*) and tuber warts (*Synchytrium endobioticum*). In the last 30 years some recommendations made by Nepal Agricultural Research Council (NARC 1995, 1997) such as crop rotation, use of clean planting materials could control or minimize the bacterial wilt incidences.

Virus is the main reason for the decline in potato crop production. When the seed lot is planted for many years, the yield potential of the variety reduced due to viral diseases. Depending on the type of virus, the yield might drop below 80%. Degradation studies in the eastern terai showed that the virus infection decreases the tuber yield by 3.6% for every 10% increase in the infection (Wells et al 1996, Khairgauli 2054).

Mechanically transmitted virus such as potato virus x (PVX) is more common problem in the hills than in terai. Moreover, aphids spreading virus disease such as PVY is more common in plain areas. Other viruses such as PVM and PVS are found both in hills and plain areas (Shrestha 1997, Lama et al 1996, PRP 2003). The sanitary and phytosanitary (SPS) agreement requires that the disease database is must and the pest risk analysis (PRA) for the exchanged material is mandatory for international trade and commerce (FAO 2003).

But in Nepalese context information on various aspects such as entry, establishment, biology, epidemiology and economic impact is not sufficient for exchange of genetic materials. Crop Protection Compendium (CPC 2006) was used as a reference for information before.

Table 2. List of PQP and their categories, risk assessment, management and additional declaration

SN	Potential Quarantine Pest	Category	Risk Assessment Rating	Risk Management Rating	Additional Declaration
1.	<i>Aecidium cantense</i> (Aecidium potato rust)	Fungi	medium	medium	Not required
2.	<i>Alternaria radicina</i> (black rot of carrots)	Fungi	medium	low	Not required
3.	<i>Arthrinium phaeospermum</i>	Fungi	No information	No information	No information
4.	<i>Belicobasidium purpureum</i> Pat.	Fungi	No information	No information	No information
5.	<i>Botryotinia fuckeliana</i> (Botrytis rot)	Fungi	medium	medium	Not required
6.	<i>Chalara elegans</i> (black root rot)	Fungi	medium	medium	Not required
7.	<i>Choanephora cucurbitarum</i> (Choanephora blossom blight)	Fungi	low	medium	Required
8.	<i>Cochliobolus australiensis</i>	Fungi	medium	medium	Required
9.	<i>Cochliobolus hawaiiensis</i> (leaf spot: maize)	Fungi	medium	medium	Required
10.	<i>Coleosporium tussilaginis</i> f.sp. <i>senecionis-sylvati</i>	Fungi	No information	No information	No information
11.	<i>Colletotrichum coccodes</i> (anthracnose of tomato)	Fungi	No information	No information	No information
12.	<i>Didymella bryoniae</i> (gummy stem blight)	Fungi	medium	High	Required
13.	<i>Didymella lycopersici</i> (canker of tomato)	Fungi	low	medium	Not required
14.	<i>Erysiphe orontii</i> (powdery mildew)	Fungi	high	medium	Required
15.	<i>Fusarium</i>	Fungi	low	low	Not required
16.	<i>Fusarium culmorum</i> (culm rot: cereals)	Fungi	low	medium	Required
17.	<i>Fusarium oxysporum</i> f.sp. <i>tuberosi</i>	Fungi	medium	medium	Required
18.	<i>Geotrichum candidum</i> (sour rot: Citrus spp.)	Fungi	medium	medium	Required
19.	<i>Gibberella avenacea</i> (bud rot)	Fungi	medium	High	Required
20.	<i>Gibberella baccata</i> (biocontrol: velvetleaf)	Fungi	low	low	Not required
21.	<i>Gibberella zeae</i> (cobweb disease)	Fungi	low	low	Not required
22.	<i>Helminthosporium solani</i> (silver scurf)	Fungi	high	High	Required
23.	<i>Hypocrea rufa</i> (fruit rot: Citrus spp.)	Fungi	low	low	Not required
24.	<i>Melanotus communis</i> (wireworm, common)	Fungi	low	low	Not required
25.	<i>Nectria haematococca</i> (dry rot of potato)	Fungi	medium	medium	Not required
26.	<i>Phaciopycnis tuberivora</i> (dryrot: potato)	Fungi	No information	No information	No information
27.	<i>Phialophora parasitica</i> (wilt: date palm)	Fungi	No information	No information	No information
28.	<i>Phoma andigena</i> (black blight of potatoes)	Fungi	medium	medium	required

SN	Potential Quarantine Pest	Category	Risk Assessment Rating	Risk Management Rating	Additional Declaration
1.	<i>Phoma eupyrena</i>	Fungi	medium	medium	Required
2.	<i>Phoma exigua</i> var. <i>exigua</i> (leaf blotch)	Fungi	low	low	Not required
3.	<i>Phoma foveata</i> (potato gangrene)	Fungi	medium	medium	Required
4.	<i>Phytophthora citrophthora</i> (brown rot of citrus fruit)	Fungi	low	low	Not required
5.	<i>Phytophthora cryptogea</i> (tomato foot rot)	Fungi	medium	low	Not required
6.	<i>Phytophthora drechsleri</i> (watermelon fruit rot)	Fungi	high	High	Required
7.	<i>Phytophthora erythroseptica</i> var. <i>erythroseptica</i> (pink rot)	Fungi	high	High	Required
8.	<i>Phytophthora megasperma</i> (apoplexy)	Fungi	high	High	Required
9.	<i>Polyscytalum pustulans</i> (skin spot of potato)	Fungi	high	High	Required
10.	<i>Puccinia pittieriana</i> (common rust of potato)	Fungi	high	High	Required
11.	<i>Pythium butleri</i>	Fungi	high	High	Required
12.	<i>Pythium ultimum</i>	Fungi	high	High	Required
13.	<i>Pythium vexans</i> (damping off)	Fungi	medium	medium	Required
14.	<i>Rhizobium radiobacter</i> (crown gall)	Fungi	high	High	Required
15.	<i>Rhizobium rhizogenes</i> (bacterial gall)	Fungi	high	High	Required
16.	<i>Rosellinia bunodes</i> (black root rot)	Fungi	No information	No information	No information
17.	<i>Rosellinia necatrix</i> (dematophora root rot)	Fungi	medium	medium	Not required
18.	<i>Septoria lycopersici</i> var. <i>malagutii</i> (annular leaf spot of potato)	Fungi	high	High	Required
19.	<i>Thecaphora solani</i> (potato smut)	Fungi	high	High	Required
20.	<i>Ulocladium atrum</i> (almond mould complex)	Fungi	medium	medium	Required
21.	<i>Verticillium albo-atrum</i> (verticillium wilt of alfalfa)	Fungi	high	High	Required
22.	<i>Verticillium dahliae</i> (verticillium wilt)	Fungi	high	High	Required
23.	<i>Verticillium nigrescens</i> (seed reduction: soybean)	Fungi	No information	No information	No information
24.	<i>Verticillium tricorpus</i>	Fungi	No information	No information	No information
25.	<i>Bacillus polymyxa</i> (bacterial fruit rot)	Bacteria	medium	medium	Required
26.	<i>Erwinia carotovora</i> subsp. <i>carotovora</i> (bacterial root rot of sweet potato)	Bacteria	high	High	Required
27.	<i>Erwinia chrysanthemi</i>	Bacteria	medium	medium	Required
28.	<i>Erwinia chrysanthemi</i> pv. <i>chrysanthemi</i> (bacterial maize stalk rot)	Bacteria	medium	medium	Required
29.	<i>Pectobacterium chrysanthemi</i> (slow wilt)	Bacteria	high	High	Required
30.	<i>Pseudomonas fluorescens</i> (biocontrol: Damping off (cotton))	Bacteria	low	low	Not required
31.	<i>Pseudomonas marginalis</i> pv. <i>marginalis</i> (lettuce marginal leaf blight)	Bacteria	medium	medium	Required
32.	<i>Pseudomonas putida</i> (biocontrol: Erwinia spp.)	Bacteria	low	low	Not required
33.	<i>Pseudomonas syringae</i> pv. <i>garcae</i> (bacterial blight of coffee)	Bacteria	medium	medium	Required
34.	<i>Pseudomonas syringae</i> pv. <i>tabaci</i> (angular leaf spot)	Bacteria	medium	medium	Required
35.	Potato purple-top wilt phytoplasma	Phytoplasma	high	High	Required
36.	Potato stolbur phytoplasma	Phytoplasma	No information	No information	No information
37.	Potato witches' broom phytoplasma	Phytoplasma	high	High	Required
38.	Andean potato latent virus	Virus	high	high	required
39.	Andean potato mottle virus (Andean mottle of potato)	Virus	high	high	required
40.	Arracacha virus B	Virus	medium	low	required
41.	Beet curly top virus (curly top)	Virus	medium	medium	required
42.	Pepino mosaic virus	Virus	medium	medium	required
43.	Potato 14R (?) tobamovirus	Virus	no information	no information	no information
44.	Potato Andean latent tymovirus	Virus	high	high	required
45.	Potato Andean mottle comovirus	Virus	high	high	required
46.	Potato black ringspot virus (calico disease of potato)	Virus	high	high	required
47.	Potato deforming mosaic virus (deforming mosaic of potato)	Virus	high	high	required
48.	Potato mop-top virus	Virus	high	high	required
49.	Potato spindle tuber viroid (spindle tuber of potato)	Virus	high	high	required
50.	Potato virus T	Virus	high	high	required
51.	Potato virus V	Virus	no information	no information	no information
52.	Potato yellow dwarf virus (yellow dwarf of potato)	Virus	high	high	required
53.	Potato yellow vein virus (yellow vein of potato)	Virus	high	high	required
54.	Potato yellowing virus	Virus	high	high	required
55.	<i>Solanum</i> apical leaf curling (?) bigeminivirus	Virus	no information	no information	no information
56.	<i>Solanum</i> yellows luteovirus	Virus	no information	no information	no information
57.	Southern potato latent (?) carlavirus	Virus	no information	no information	no information
58.	Tobacco necrosis virus	Virus	medium	medium	required
59.	Tobacco rattle virus (spraying of potato)	Virus	high	high	required
60.	Tobacco ringspot virus (annulus tabaci)	Virus	medium	medium	required
61.	Tobacco streak virus	Virus	medium	medium	required
62.	Tomato black ring virus	Virus	medium	medium	required
63.	Tomato infectious chlorosis virus	Virus	high	high	required
64.	Tomato yellow mosaic virus	Virus	medium	medium	required

CONCLUSION

In generic PRA, a total of ninety-two potential quarantine pests (fungi, bacteria and phytoplasma, viruses and viroids) have been included. However, detail information on 15 pests is unavailable. A PRA should be sufficiently documented, so that when dispute arises, the PRA should clearly help to make decision on phytosanitary measures to be taken.

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