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SHORT COMMUNICATION

PLANT PATHOGENS INTRODUCED TO SRI LANKA THROUGH IMPORTED SEED POTATO (*Solanum tuberosum* L.)

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INTRODUCTION

Sri Lanka imports 25% of the total seed potato requirement from Holland, Germany, France, Poland, Australia, New Zealand and United Kingdom. De Silva *et al.* (2002) reported that many fungi and bacteria that are potential pathogens on local crops are introduced to the country through imported fruits. Consequently it is possible that many plant pathogens, insect and weed species enter through seed potato. The importation of 5000 to 6000 t every year and subsequent direct planting in the soil will aggravate this situation. The Plant Quarantine Act No. 35 of Sri Lanka has been introduced to prevent the entry of such alien species to the country through imported commodities. Quarantine restrictions are imposed on seed potato imports considering the danger of introducing certain pathogens (Anon., 1999). This paper reports the pathogens detected in seed potato lots imported to the country during the period 2003 to 2006, with a view to draw the attention of scientists on the contaminated flora in imported commodities.

MATERIALS AND METHODS

Sampling

Samples were collected from seed potato lots of different varieties imported into the country through seaport. Ten percent of the boxes/bags of seed potato were randomly collected from each lot and the condition of the tubers visually examined. Sample of 300 tubers was randomly collected from each box/bag and all samples mixed and finally 100 tubers collected randomly for further studies. Each sample was dispatched to the laboratory for detection of pathogens by laboratory and greenhouse studies. Another sample of 100 tubers was collected for field studies conducted at the post quarantine unit in Sita Eliya.

Laboratory investigation

Hundred tubers collected from each sample were checked for pathogens and disease symptoms visually and microscopically. Some tubers were kept in humid chambers and incubated for 2 - 4 days to observe microscopically the associated pathogens of the tubers. Laboratory tests were conducted for the detection of fungi, bacteria and viruses associated with the peel and internal tissues of tubers. Pieces of periderm and internal tissues of 25 tubers were cultured on Potato Dextrose Agar (PDA), PDA + 1% Streptomycin and Malt Extract Agar and incubated for 4 - 5 days at room temperature. Fungal pathogens were identified by comparison of morphological characteristics and microscopic observations of fungi with published data (Hooker, 1981). Bacteria were distinguished by comparison of disease symptoms, colony characters on media, staining and microscopic observations with published data (Hooker, 1981).

Greenhouse studies

Randomly selected tubers of seed potato lots were planted under greenhouse conditions to detect any disease development due to latent infection of pathogens including viruses. Shoots of plants were used to detect potato virus X, S, Y, M, and leaf roll virus by enzymes linked immunosorbent assay (ELISA).

Field studies

Hundred tubers were grown in the field at post quarantine unit, Sita Eliya to observe performance of potato varieties and detection of disease development due to latent infection.

RESULTS AND DISCUSSION

Diseases on tubers were basically identified by comparison of visual observations of disease symptoms, culture characters on artificial media and microscopic observations of pathogen morphology (Table 1) with published data (Hooker, 1981). Some samples of seed potato lots, imported each year had no fungal or bacterial disease symptoms on surface or in internal tissues. However, most of seed potato lots frequently showed symptoms of fungal diseases such as black scurf caused by *Rhizoctonia solani*, silver scurf caused by *Helminthosporium solani*, dry rot caused by *Fusarium* species and actinomycetes diseases such as common and netted scab caused by *Streptomyces* species (Tables 2 and 3). Fungal disease viz. rubbery rot caused by *Geotrichum candidum* was rarely observed in seed potato lots in year 2003. However, imported seed lots were highly infected with *Geotrichum candidum* in the recent past (Table 2). Another severe disease *i.e.* bacterial soft rot

caused by *Erwinia carotovora* was detected in some imported seed lots (Table 2). *Erwinia* survives in potato tubers as latent infections and as a result soft rot epidemics can occur in the potato cultivation (Hooker, 1981), and such epidemics were reported in potato cultivations of imported varieties Kondor and Granola in Mandaram Nuwara and Keppetipola area in years 2004 and 2005, respectively.

Table 1. Disease symptoms and characteristics of major fungal pathogens associated with imported seed potato.

Disease	*Disease symptoms*	*Morphology and Culture characters of pathogen*	*Associated pathogen*
Black scurf	Black colour sclerotia develop superficially on surface.	Mycelium septate, dark brown and hyphae large (7-10 µ in diameter). Mycelia show right angle branching.	*Rhizoctonia solani*
Silver scurf	Small brown localized spots. Affected areas have silvery sheen if the surface is wet.	Mycelia hyaline, septate, branched and turn brown with age. Un-branched conidiophores are septate. Conidia have 2-8 septa and length 20 – 50 µ, colour dark brown.	*Helminthosporium solani*
Fusarium dry rot	Periderm wrinkling over rotted tissues and in internal cavities. Cavities lined with white gray mycelia.	Mycelia septate and branched. Colony colour; white, pink, purple or brown according to species. Conidia produced openly within hyphae. Conidia two types. Macro conidia - sickle shaped, 3-6 cells, larger in size, length 25-60 µ. Micro conidia - abundant, cylindrical, 1-2 cells, smaller	*Fusarium* species
Common scabs	Angular corky scabs appear on the surface.	Gray colour filamenteus mycelia, size about 1µ. Black pigmentation surrounding the colony. Spore size about 0. 5µ. Gram staining - ve.	*Streptomyces scabies*
Netted Scabs	Brown lesions have net like structures on the surface	Colourless filamenteus mycelia produce spores, spore size about 0.5µ. Gram staining + ve.	*Streptomyces species*

Table 2. Diseases observed in internal tissues and on periderm of tubers and their frequency in seed potato lots.

Disease and pathogen	*Disease frequency of lots in each year**				*% variation of disease infected tubers of lots in each year*			
	2003	*2004*	*2005*	*2006*	*2003*	*2004*	*2005*	*2006*
Black scurf caused by *Rhizoctonia solani*	96	96	102	81	1-24	1-24	1-60	1-23
Silver scurf caused by *Helminthosporium solani*	94	91	97	84	3-75	1-100	2-100	1-68
Dry rot caused by *Fusarium* species	53	64	34	21	1-9	1-44	1-60	1-9
Rubbery rot caused by *Geotrichum candidum*	1	3	9	15	2	1-21	1-22	1-100
Common and netted scab Caused by *Streptomyces* spp.	75	92	155	79	1-76	1-100	1-100	1-74
Bacterial soft rot caused by *Erwinia carotovora*	2	5	1	3	1-3	1-33	57	1-6

* No. of tested seed potato lots =244

Morphological and cultural characteristics on media and microscopic observations of pathogens indicated that although there were no disease symptoms on tubers, many fungi and *Streptomyces* spp. were associated with periderm of potato tubers as surface contaminants. Some fungi viz. *Rhizoctonia solani*, *Helminthosporium solani*. *Fusarium* spp., *Alternaria* spp., *Geotrichum candidum*, *Aspergillus* spp. and actinomycetes viz. *Streptomyces* spp. were frequently observed on tubers of tested seed lots (Table 3).

Some seed potato lots were not released for cultivation when disease incidences mentioned in quarantine regulation exceeded the permitted limits or due to other diseases that were severely damaging the tubers. Among the varieties imported to the country, over 60% included varieties like Granola and Desiree. Imported seed potato variety Desiree frequently showed scab symptoms, while Granola and Lyra showed high incidence of silver scurf, black scurf and dry rot. For example, of 1028 t. of total imports of variety Desiree, 343 t. of seed were refused release for cultivation in year 2005 due to high incidence of scab disease which exceeded permit limits of scab disease. Even though diseases were present on or inside tubers, most of the seed potato lots were released for cultivation in each year because their disease incidences did not exceed permit limits or they were not considered as important quarantine diseases.

Table 3. Organisms isolated on periderm tissues and internal tissues when cultured on different media and frequency of isolation of each pathogen from seed potato lots in years 2004 and 2006.

Fungi and bacteria isolated from tissues	*Frequency of pathogen found in lots* *	
	*Year 2004 (244)**	*Year 2006 (229)**
Rhizoctonia solani	187	163
Helminthosporium solani	160	97
Fusarium species, *F. solani* and *F. roseum*	203	70
Alternaria alternata and *A. solani*	102	16
Stemphylium species	19	3
Sclerotium species	28	2
Botrytis species	9	4
Macrophomina species	44	2
Geotrichum candidum	41	48
Aspergillus species	88	186
Pennicilium species	24	2
Trichoderma species	26	23
Pythium species	6	2
Colletotrichum species	9	7
Rhizopus species	4	-
Streptomyces species	144	116

* No. of tested seed potato lots

It took 3-4 weeks for virus indexing of each seed potato lot by ELISA but they need to be released within 5 days after inspection. Therefore, virus standard of phytosanitary certificates issued by authorities of producing countries were considered to grant permission for cultivation. However, virus indexing was done at HORDI to re-check and compare virus incidences in seed lots. This indicated that there were one or more harmful viruses such as potato viruses X, S, Y, M and leaf roll virus in tubers of most of the imported seed potato lots (Table 4). These viruses cause severe crop losses in some crops of family Solanaceae, Chenopodiaceae, Compositae, Asteraceae and Fabaceae (Agrios, 1997; Hooker, 1981). It has been reported that diseases such as potato mop-top virus and powdery scabs caused by *Spongospora subterranse* are not tested in local laboratories, but occur in seed potato producing countries especially in Europe. Field observations indicated that out of 244 lots, 40 lots had virus symptoms under the field conditions (Table 5). These results indicate that, it is possible many fungi, bacteria and viruses such as *Rhizoctonia solani*, *Helminthosporium solani*. *Fusarium* spp., *Alternaria* spp. *Stemphylium* spp., *Sclerotium* spp., *Phoma* sp., *Botrytis* sp., *Macrophomina* sp., *Geotrichum candidum*, *Pythium* spp., *Colletotrichum* sp., are introduced to the country through imported seed potatoes even though foreign authorities certify that these seed potato lots are free from pathogens or within permitted limits of quarantine regulations of Sri Lanka.

Table 4. Viruses detected by ELISA of imported seed potato lots in years 2003, 2004, 2005 and 2006.

Virus detected in shoots	*Disease frequency in seed potato lots*			
	*Year 2003 (53)**	*Year 2004 (207) **	*Year 2005 (195)**	*Year 2006 (227)**
Potato virus X	11	41	41	74
Potato virus S	3	40	60	12
Potato virus Y	1	38	47	20
Potato virus M	6	33	66	20
Potato leaf roll virus	14	51	33	32

* Number of tested seed potato lots

Table 5. Visual observation of diseases on growing plants of different seed potato lots under field conditions at Sita Eliya in year 2004.

Disease observed	*Frequency of disease of seed potato lots*	*Disease severity of lots*	
		No. of severe lots	*No. of mild lots*
Fusarium wilt	4	-	4
Black leg	1	-	1
Mosaic symptoms (virus)	33	11	22
Leaf roll symptoms (virus)	7	1	6

* No.of tested seed potato lots =244

Streptomyces species (actinomycetes), bacteria and viruses detected in tubers were recognized as pathogens on potato as well as many other crops (Hooker, 1981). For example, *Geotrichum candidum*, the causal agent of sour rot of oranges and other fruits can infect several crops (Holliday, 1980). Leaf spots and leaf blight caused by *Alternaria solani* and *Botrytis* species were common diseases responsible for the considerable yield reduction in the vegetables such as tomato, leeks and *Capsicum* in up-country regions (Anon., 1990). Nursery disease damping-off and root rot can be caused by *Rhizoctonia solani*, *Sclerotium* spp., *Fusarium solani* and other Fusarium species can cause serious diseases of solanaceae and fabaceae crops and it has been reported severe crop losses occur in most of the areas in rainy seasons. Bacterial pathogen, *Erwinia carotovora* causes soft rot to more than 44 species including cabbage and carrot (Shekhawat and Chakrabarti, 2000) and may severely damage cultivation in up and mid country areas. It was reported that *Streptomyces* spp. (actinomycetes) is pathogenic on carrot, beet and radish and fungal pathogens such as *Aspergillus* spp., and *Penicillium* spp., pathogenic mainly on fruits such as papaya and grains of pulses (Agrios, 1997; Shekhawat and Gadewar, 2000). In the tropical countries, disease development and such losses due to diseases may be higher because of the favourable weather conditions for the microorganisms throughout the year (Holliday, 1980). Since these pathogens are recorded in the country but importation of large quantities of disease infected seed potatoes may increase in inoculum density of pathogens in the local soil and cause diseases of crops.

Therefore, it is necessary to pay attention to avoid invasion of unwanted pathogens into the country through imported seed potatoes.

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