Table 1. (Contd.)

Crop	Source
*Limnanthes alba**	USA
*Lotus tenuis**	USA
*Luffa acutangula**	UK
Lycopersicon esculentum	Taiwan, USA
*Macrotyloma uniflorum**	Ethiopia
Manihot sp.*	Brazil
*Manisuris sellona**	USA
Medicago spp.*	Australia, Hungary, USA
Medicus sp.*	USA
Melilotus alba	Taiwan, USSR
*Mentha arvensis**	France, Vietnam
Ocimum spp. *	Germany
*Oryza sativa**	Philippines
Panicum spp.*	USSR
*Paspalum veginatum**	Australia
Pennisetum typhoides	Zimbabwe
Phaseolus aconitifolius	Taiwan, USA
*Piper nigrum**	Indonesia
Pistacia sp. *	Holland
Pisum sativum	France, Netherlands, Sweden, USA
*Plantago maritime**	USSR
Prunus spp. *	Italy, Turkey
Pyrus spp.*	USA
*Psophocarpus tetragonolobus**	Canada
Quinoa sp.*	Nepal
Rosa spp. *	Netherlands
*Rumex acetosa**	France
Sesamum spp.	Israel, Thailand
Setaria sp.*	USSR
*Spinacea oleracea**	USSR
Solanum melongena	Bangladesh, Japan, Sri Lanka, USA
S. tuberosum	Peru
Solanum spp.	Nepal
Sorghum spp.	USA
Stylosanthes spp.*	Brazil, Australia, USA
Trifolium spp.	Australia, USA
Triticum spp.	Italy, Sweden, USA
Vigna spp.	Taiwan, Thailand
V. unguiculata	Australia, Brazil, Italy, Nigeria, Taiwan, USA
Vitis spp.*	South Africa
Zea mays	South Africa, USA
Zucchini sp.*	Israel

* Not reported earlier as seed-borne (Richardson, 1990)

transmission of a soil-borne pathogen can be a potential threat to agriculture if infected seed is sown in uninfected area.

References

Agarwal PC, Dev Usha and Indra Rani (2001) *Fusarium* species intercepted in exotic crop germplasm during 1976-99. *Ind. J. Agric. Research* **71:** 736-739.

CAB International (2003) *Crop Protection Compendium*, Wellingford, UK: CAB International.

Khetarpal RK, Varaprasad KS, Lal A, Agarwal PC and Lal B (2001) Plant quarantine of germplasm under exchange. In: BS Dhillon, KS Varaprasad, K Srinivasan, M Singh, S Archak, U Srivastava and GD Sharma (Eds) *National Bureau of Plant Genetic Resources: A compendium of achievements* (National Bureau of Plant Genetic Resources, New Delhi pp 90-115.

Lima MF and Lopes CA (1998) Virulence variation among isolates of *Fusarium solani* on potato. *Fitopatologia Brasileira* **23:** 121-126.

Richardson MJ (1990) *An Annotated List of Seed-borne Diseases.* Fourth ed. ISTA, Zurich, Switzerland 387p.

Scherm H and Yang XB (1996) Development of sudden death syndrome of soybean in relation to soil, temperature and soil water metric potential. *Phytopath.* **86:** 642-649.

Insect-Pests Intercepted in Introduced Planting Material during Quarantine Processing from 2000-04

Kavita Gupta, Shashi Bhalla, Manju Lata Kapur, Charan Singh, Naresh Kumar, RS Baloda, Meenakshi and Beche Lal

Division of Plant Quarantine, National Bureau of Plant Genetic Resources, New Delhi-110 012

Key Words: Insect-Pests, Quarantine, Interception, Germplasm

The import of exotic planting material, either in bulk or as small samples meant for research in various crop improvement programmes is a potential and inadvertent source of introducing exotic pests into new areas which may severely damage the crop production and economy of a nation. There are glaring examples of various pests and diseases introduced along with imports, which have resulted in enormous crop losses (Khetarpal *et al.*, 2001).

National Bureau of Plant Genetic Resources is the nodal agency to undertake the quarantine processing of germplasm and transgenic material introduced into

the country for research purposes. Several insect pests of great economic significance have been intercepted over the years of which many are not reported from India.

During the five-year period from 2000- 2004, a total of 5,20,596 samples of exotic planting material of various crops were processed for quarantine clearance. All the planting material (both true seed and vegetative propagules) were inspected by naked eye or with the help of magnifiers for the detection of external symptoms of damage i.e. holes, rotting, swelling, deformity, etc. or presence of dead or alive insects/ mites, eggs/ egg shells, immature stages, exuviae or excreta thereof.

Seed samples (12,561) of plant genera were exposed to soft X-rays, at 22 Kv, 3 mA for 15 seconds at a distance of 30 cm to detect hidden infestation (Bhalla *et al.*, 2002). Samples of small seeds (772) difficult to detect through X-ray radiography were subjected to transparency test by heating in lactophenol-acid fuchsin. The infested samples were salvaged using several techniques viz., mechanical cleaning (1685), fumigation (1692), X-ray (974) and pesticidal dip and spray treatment (1028). One thousand six hundred and ninety two infested seed samples were fumigated with ethylene dichloride-carbon tetrachloride (EDCT) mixture @ 320 mg/ l for 48 or 640 mg/ l for 24 hrs. at 30°C in an airtight container at normal air pressure and 1,028 infested samples of vegetative material were given dip/ spray treatment with an acaricide, Kelthane @ 0.035% and insecticide, Malathion @ 0.05% or a combination of both.

The insects were retrieved from the seeds and vegetative propagules either by detention or soaking and were identified on the basis of identification keys and reference collection at NBPGR. The various pests intercepted are listed in Table 1.

Visual examination revealed insect infestation in 1,685 samples. The important interceptions include *Araecerus* sp.; *Cryptolestes* sp.; *Lasioderma serricorne*; *Rhizopertha dominica*; *Sitophilus granarius*; *S. oryzae; S. zeamais*; *Sitotroga cerealella*; *Systole coriandri* and *Tribolium castaneum* in the crops and countries as listed. Apart from these, unidentified aphids, immature insect stages, mealy bugs, mites, scale insects and staphylinid beetles were also detected in several crop species.

Araecerus sp. intercepted in *Zea mays* is a cosmopolitan stored grain pest with a wide host range and reported from several tropical and subtropical countries including India. *Cryptolestes* sp., intercepted from *Pennisetum typhoides* has only one of its species *C. pusillus* reported from India. The difficulty in identifying *Cryptolestes* at the species level accounts for it not being reported from many countries. *L. serricorne* is cosmopolitan but is most abundant in the tropics. *Sitophilus granarius* is distributed throughout the temperate region and is rare in the tropics limited only to cool upland areas and is reported from India. *S. oryzae* and *S. zeamais* are found in all warm and tropical countries and have a high ability to establish anywhere with favourable moisture and temperature. *Sitotroga cerealella* has a wide host range and is widespread in India. The seed damage caused by *S. cerealella* is similar to that caused by the rice weevil *Sitophilus oryzae* but can be distinguished by the adult emergence holes on the infested seeds and adult feeding damage in case of *S. oryzae*.

X-ray radiography revealed infestation in 974 samples. The major interceptions were *Acanthoscelides obtectus, Bruchidius atrolineatus, Bruchophagus gibbus, Bruchus dentipes, B. lentis, B. pisorum, Callosobruchus analis, C. chinensis* and *C. maculatus* in plant species and countries as in Table 1. *A. obtectus* originated in tropical South America, but has spread to other warm regions, including one unconfirmed report from India. *Bruchidius* sp. has been reported on a wide range of hosts from all over the world. *B. atrolineatus* intercepted in *V. unguiculata* from Nigeria has yet not been reported from India and is a serious pest of *Vigna* spp. and *Lens* spp. from several African countries.

Bruchophagus gibbus, a chalcidoid reported on lucerne and purple clover from Australia, China, Germany and USA has yet not been reported from India. *B. roddi* has been reported only on *Medicago sativa* with unconfirmed reports of being present in northern India. It has been reported to cause a damage of 5- 53 % to seeds of leucerne and red clover. *B. mellipes,* has been reported only on *Sesbania* spp. with unconfirmed reports of being present in India.

Bruchus dentipes is a pest specific to *Vicia faba* causing upto 76% damage is reported from countries like Greece, Syria, Turkey and Australia, and is yet not reported from India. *B. ervi* intercepted from Syria and several other countries has unconfirmed records of being present in Central Asia and Australia. *B. pisorum* intercepted from *P. sativum,* reported to have a wide host range, has a limited distribution in India confined only to the pea growing northern India. *B. lentis* has

Table 1. Insect Pests Intercepted in introduced material during 2000- 04

Pest	Host	Source
* ' Acanthoscelides obtectus	*Phaseolus vulgaris*	Colombia, Mexico, Peru, USA
Araecerus sp.	*Zea mays*	USA
' Bootanomyia sp.	*Eucalyptus* sp.	Australia
' *Bruchidius* sp.	*Trifolium alexandrium*	Egypt
	Trifolium spp.	Egypt, Ethiopia, UK
* ' *Bruchidius atrolineatus*	*Vigna unguiculata*	Nigeria
* ' *Bruchophagus gibbus*	*Medicago sativa*	USA
' *B.mellipes*	*Sesbania rostrata*	Philippines
	Sesbania sp.	Brazil, Ethiopia
' *Bruchophagus roddi*	*M. sativa*	USA
' *Bruchophagus* sp.	*Sesbania* sp.	Brazil, Ethiopia
* ' *Bruchus dentipes*	*Vicia faba*	ICARDA (Syria)
* ' *B. ervi*	*Lens* spp.	ICARDA (Syria)
	L. culinaris	Syria, Chile, Germany, Greece, Iran, Italy, Lebanon, Morocco, Turkey, Russian Federation
' *B. emarginatus*	*Pisum* spp.	Russia
' *B. pisorum*	*P. sativum*	Bulgaria, Eritrea, Russia
' *B. lentis*	*L. culinaris*	Afghanistan, Azerbaijan, ICARDA (Syria), Spain
	V. faba	Afghanistan, Canada, Ethiopia, Pakistan, Ukraine, Yemen
' *B. nubilis*	*V. faba*	Ukraine
' *Callosobruchus analis*	*Vigna unguiculata*	Nigeria, USA
' *C. chinensis*	*L. culinaris*	ICARDA (Syria)
	Vicia faba	Eritrea
	Vigna unguiculata	Nigeria, USA
' *C. maculatus*	*V. unguiculata*	Nigeria, USA
Cryptolestes sp.	*Sesamum indicum*	Uganda
	Pennisetum typhoides	Nigeria
Lasioderma serricorne	*Hordeum vulgare*	ICARDA (Syria)
* ' *Quadrastichodella eucalyptii*	*Eucalyptus camendulensis*	Australia
Rhizopertha dominica	*H. vulgare*	ICARDA (Syria), Mexico
	Oryza sativa	Malaysia
	Triticum aestivum	Australia, Azerbaijan, ICARDA (Syria), Mexico
	Triticale	Mexico
* *Sitophilus granarius*	*T. aestivum*	USA
S. oryzae	*O. sativa*	Malaysia, Philippines, Thailand, USA
	Sorghum bicolor	Brazil, Philippines, USA
	T. aestivum	Nepal
	Z. mays	CIMMYT (Mexico), Thailand
S. zeamais	*Z. mays*	CIMMYT (Mexico), Indonesia, Philippines, Thailand, USA
Sitotroga cerealella	*O. sativa*	Nepal
	Z. mays	Bolivia
Systole coriandri	*Coriandrum sativum*	Russia
Tribolium castaneum	*Gypsophylla.*spp	Israel
	P. typhoides, T. aestivum	Nepal
	Sesamum spp.	USA
	Sorghum bicolor	Canada
	Z. mays	Thailand, USA

* Pests not yet reported from India; ' Pests detected through X-ray radiography

been recorded as a serious pest in Algeria, Iran, Lebanon and Turkey with infestation level reaching 80% with complete loss of germination. It is a univoltine species and overwinters in seeds posing higher quarantine risk.

Quadrastichodella eucalyptii in *Eucalyptus* sp., a pest not yet reported from India, has been reported as a seed-destroying pest of Eucalyptus from Australia, Japan, Malaysia and New Zealand. *Systole coriandri,* a chalcidoid reported on *Angelica* and coriander from Chile, Hungary and Russia has been reported from India only from endemic pockets (CAB *International*, 2003).

Pests like *Callosobruchus analis, C. chinensis, C. maculatus, R. dominica* and *Sitophilus oryzae* although reported from India pose a quarantine risk during import due to their high economic significance and possibility of presence of new biotypes/strains having greater physiological adaptability (Wadhi, 1980). Both the species *C. maculatus* and *C. chinensis,* known to occur widely in tropical/subtropical conditions, possess biological strains. The introduction of a mutant strain in a new climatically suitable environment could lead to population explosion.

The importance of effective implementation of plant quarantine is clearly indicated by the interception of several economically important pests not yet reported from India. Quarantine risk is much higher due to the hidden nature of infestation and their being repeatedly intercepted.

References

Bhalla Shashi, ML Kapur, B Lal, BR Verma and Singh C (2002) Quarantine risk associated with exchange of plant genera carrying hidden infestation. *Indian J. of Pl. Genet. Res.*. **15(2):** 160-163

CAB *International* (2003) Crop Protection Compendium. CABI Biosciences, UK.

Khetarpal RK, KS Varaprasad, A Lal, PC Agarwal and B Lal (2001) Plant quarantine of germplasm under exchange. In: BS Dhillon KS Varaprasad, Kalyani Srinivasan, Mahendra Singh, Sunil Archak, Umesh Srivastava and GD Sharma (Eds.) *National Bureau of Plant Genetic Resources: A Compendium of Achievements*. NBPGR, New Delhi, p. 90-115.

Wadhi SR (ed) (1980) Plant Quarantine Activity at the National Bureau of Plant Genetic Resources. *NBPGR Sci. Monogr.* No 2, p. 99.

Pathogenic Fungi and Bacteria in Phytosanitary Isssues-Current Trends and Future Directions

SK Chakrabarty, K Anitha, RDVJ Prasada Rao and KS Varaprasad

National Bureau of Plant Genetic Resources Regional Station, Rajendranagar, Hyderabad- 500 030, Andhra Pradesh

Key Words: Quarantine, Phytosanitary, Fungi, Bacteria, Pest Risk Analysis

The latest Global Agreement on "Sanitary and Phytosanitary Measures" (SPS Agreement) deals with phytosanitary issues among the member countries of World Trade Organisation (WTO). SPS has the major implication on food safety, animal and plant health in relation to trade. As the main purpose of WTO is trade flow with equal treatment, there is an increase in the dissemination of dangerous fungi, bacteria, viruses, nematodes and insects. To combat such threat, Government of India enforced plant Quarantine (Regulation of Import into India) Order, 2003 to regulate exchange of plant/ plant material for sowing, planting, propagation with general and specific conditions for import. Regulation of import to prevent introduction of destructive fungi and bacteria is highlighted in three schedules in the order. Importation of banana, rubber, and date palm is prohibited due to *Ralstonia solanacearum, Microcyclus ulei* and *Fusarium oxysporum* f. sp. *albedinis*, respectively (Schedule IV). Several plant species like cassava, citrus, cocoa, cotton, groundnut, rice and tobacco can be imported with additional declarations (Schedule V). Specific post-entry quarantine measures and treatments are imposed to prevent exotic fungi and bacteria in *Allium* spp., barley, beans, carrot, chickpea, grape, maize, peas, sorghum and soybean. (Schedule VI).

NBPGR Regional station, Hyderabad is discharging quarantine requirements of ICAR institutes, State Agricultural Universities, Private Companies and International institute (ICRISAT) located in South India. Suitable detection techniques are used to detect plant pathogens like fungi and bacteria on exotic germplasm. Few of the quarantine significant pathogens intercepted at this Regional Station were *Peronospora manshurica* on soybean from USA; *Ralstonia solanacearum* on groundnut from Australia, Brazil, Cyprus, Malawi, Niger, Sudan, USA and Zimbabwe; *Xanthomonas campestris* pv. *holcicola* and *Ralstonia andropogoni* on sorghum from PDR Yemen.

Soybean downy mildew caused by *P. manshurica* is not known to occur in India. This pathogen was intercepted on soybean from USA. Oospores of the pathogen were detected by visual examination and sedimentation test. However, at NBPGR, New Delhi, the pathogen was intercepted in 1535 samples from 15 countries (Agarwal and Singh, 1998). Thirty physiological races were reported from USA alone (Dunleavy, 1997). The oospore can retain viability upto eight years (Pathak *et al.*, 1978). Bacterial leaf streak (*X. campestris* pv *holcicola*) and leaf stripe (*R. andropogoni*) were identified during the rainy season of 1987 on sorghum. Dot-immunobinding assay was used to identify both these bacteria (Prasada Rao *et al.*, 1990). There is no authentic evidence on the detection of these two pathogens in India, hence they are categorised