GENERIC PEST RISK ANALYSIS: IMPORT OF TRANSGENIC RICE

Editors

Baleshwar Singh
Kavita Gupta
Z Khan
Shashi Bhalla
V Celia Chalam
SC Dubey

National Bureau of Plant Genetic Resources
New Delhi 110 012, INDIA

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Introduction

Rice (*Oryza sativa* L.) is one of the world's most important cereals food crop in tropical and subtropical regions of the world for human consumption. Major Rice growing countries include India, China, Bangladesh, Thailand, Myanmar, Philippines, Japan, Pakistan, USA, Indonesia, Korea and Vietnam. India and China produce 50% of rice in the world. Rice cultivation has grown up to 158 ha out of which 90% production is being carried out in developing countries. China tops the list of top 10 rice producing nations with a production of 144,560 million tons and India in the second spot as the country produces 104,800 million tons during February 2016 (https://www.worldriceproduction.com/). Yield enhancement to increase rice production is one of the essential strategies to meet the demand for food of the growing population.

Both abiotic and biotic features limit adversely the productivity of rice growing areas. Upto 50% of the agricultural productivity is lost due to abiotic stresses, while biotic stresses accounts for nearly 10-20% comparably (Vats *et al*., 2016). Biotic stress is a stress that occurs as a result of harm done to crops by living organisms such as insect/pests, diseases and weeds. The relationship between biotic stress and yield of crops affects decisions of the growers, quality of the produce and profitability. In a study conducted by the International Rice Research Institute (IRRI), it was found that, on average, farmers lose 37% of their rice yield to pests and diseases, and that these losses can range between 24% and 41% depending on the production situation. (http://irri.org/rice-today/where-rice-pests-and-diseases-do-the-most-damage-). The plant genetic resources including transgenic has played the key role to overcome such problems. The germplasm of transgenics with desirable traits is being imported into the country for various research programmes. Movement of planting material poses the risk of inadvertent introduction of exotic pests hitherto not known to occur in India, or new virulent strains of the ones already reported, may prove more dangerous in the new environment.

Of the major pests affecting rice, 45 are fungal, 10 bacterial, 15 viral, and 75 insect-pests and nematodes (http://www.fao.org/docrep/003/x6905e/x6905e04.htm). Realizing the economic losses caused by them, efforts have been directed to understand the genetic basis of resistance and susceptibility. The studies directed to understand the host-plant interaction in rice have given rise to specialized breeding programs for resistance to diseases and insect-pests. Ten major have been identified in rice (Ou, 1985). The major bacterial diseases causing economic losses in any rice growing country are bacterial blight, bacterial leaf streak, and bacterial sheath rot. Many of the serious fungal diseases of rice like blast, sheath blight, brown spot, narrow brown leaf spot, sheath rot and leaf scald are of economic significance in many rice growing countries of the world. Twelve virus diseases of rice have also been identified but the important ones are tungro, grassy stunt, ragged stunt, orange leaf (in Asia), hoja blanca (America), stripe and dwarf virus (in temperate Asia). Brown plant hoppers, stem borers and gall midges are among the major insect-pests in rice production.

The ICAR-National Bureau of Plant Genetic Resources (ICAR-NBPGR), New Delhi, India is the nodal institute for the management of plant genetic resources including transgenics. The institute issue import permit for import of transgenic planting material after getting import clearance from Department of Biotechnology, CGo Complex, Ministry of Science & Technology, Government of India, New Delhi- 110 003. The institute also undertakes the activity of germplasm exchange and its quarantine processing.

A large number of pests are known to be seed-borne/ seed-transmitted in rice. Some of the pests of quarantine significance have been intercepted at NBPGR included **Insects-** *Cryptolestes ferrugineus, C. pusillus, Liposcelides* spp., *Rhizopertha dominica, Sitophilus oryzae, Sitotroga cerealella, Tribolium castaneum* from Philippines, *C. ferrugineus, R. dominica, S. cerealella, T. castaneum* from China; **Nematode-** *Aphelenchoides besseyi* from Singapore; **Pathogens**- *Alternaria padwickii* from China, Philippines; *Bipolaris oryzae (=Drechslera oryzae=Cochliobolus miyabeanus* from Australia, Belgium, China, France, Philippines, Singapore, UK and USA; *B. sorokiniana* from Belgium; *Fusarium verticillioides* from Australia, Belgium, China, France, Philippines, Singapore, UK and USA; *Nigrospora oryzae* from Vietnam; *Phoma sorghina* from Belgium and USA; *Rhizoctonia solani = Thanatephorus cucumeris* from Belgium, Philippines and USA; *Verticillium cinnabarinum* from Vietnam (Bhalla *et al.,* 2008 and Singh *et al*., 2003, 2014). If not intercepted, they could have got introduced into our country and played havoc with our rice production. The Division of Plant Quarantine has envisaged in bringing out a series of publications on the potential quarantine pests (PQPs) in various crop groups. PQPs were short-listed based on the pests: i) not reported from India, ii) having limited distribution, iii) having wide host-range, iv) causing economic losses and v) presence of physiological races. This data has been linked with the pests listed under the Schedules V, VI and VII of Plant Quarantine (Regulation of Import into India) Order, 2003 dealing with the lists of (a) plants and plant material for restricted import only by authorized institutions and special conditions (b) plant/ plant materials permitted import with additional declarations and (c) where imports are possible on the basis of phytosanitary.

Phytosanitary measures are extremely important to facilitate safe import of plants and plant products for protecting our agriculture from the ravages of destructive exotic pests. The increased awareness in recent years regarding the dissemination of plant pests by seeds as well as agricultural commodities during exchange and trade has been primarily due to liberalization of trade under WTO regime. The Agreement on Application of Sanitary and Phytosanitary Measures, under it requires member countries to have uniform phytosanitary standards. The International Plant Protection Convention (IPPC) has developed International Standards for Phytosanitary Measures (ISPM) and so far 37 standards have been brought out. Of these the standards on pest risk analysis (PRA) are given in ISPM-2 (guidelines for PRA), ISPM-11 (PRA for quarantine pests) and ISPM-21 (PRA for regulated non quarantine pests). The preparation of PRA is divided into three main stages viz., process initiation, pest risk assessment and pest risk management. The PRA should be fully documented so that in the event of any review or dispute the information can be used in decision making. In fact, the first step is very crucial to start a PRA and requires both a list of pests reported to occur and a list of those not known to occur in the country.

Under the PQ Order 2003 and its amendments, planting material of rice is restricted and permissible only by Approval of Department of Agriculture and Cooperation, Ministry of Agriculture as per provisions of New Policy on Seed Development (NPSD), 1988 and subject to the recommendation, supervision, monitoring and testing by Director, NBPGR, New Delhi/Director, National Rice Research Institute (Earlier Directorate of Rice Research), Hyderabad with special conditions under the Schedule V for Freedom of seeds for sowing from: (a) Granary weevil (*Sitophilus granarius*) (b) Sheath brown rot (*Pseudomonas fuscovaginae*) (c) Seedling rot (*Pseudomonas glumae*) (d) Bacterial halo blight (*Pseudomonas syringae* pv. *oryzae* (e) Quarantine Weed Seeds.

SCHEDULE-V: List of plants and plant materials restricted import permissible only with the recommendation of authorized institutions with additional declarations and special conditions

Plant species/ variety	Category of plants & plant material	Additional declarations required to be incorporated into PSC	Special conditions of import	Responsibility of authorized Institutions
Rice (*Oryza sativa*)	(i) Seeds for sowing	Freedom from: (a) Granary weevil (*Sitophilus granarius*) (b) Sheath brown rot (*Pseudomonas fuscovaginae*) (c) Seedling rot (*Pseudomonas glumae*) (d) Bacterial halo blight (*Pseudomonas syringae* pv. *Oryzae* (e) Quarantine Weed Seeds	Seed soaking overnight and hot water treatment at 52^0C for 30 minutes.	(a) Approval of Department of Agriculture and Cooperation, Ministry of Agriculture as per provisions of New Policy on Seed Development (NPSD), 1988. (b) Subject to the recommendation, supervision, monitoring and testing by Director, NBPGR, New Delhi/Director, Directorate of Rice Research, Hyderabad.

SCHEDULE– VI: List of plants/ plant materials permitted to be imported with additional declarations and special conditions

Plant species	Category of plant material	Country of Origin	Additional declarations required to be incorporated into Phytosanitary Certificate	Special conditions of import
Oryza sativa (Rice)	(i) Grains for consumption	Any Country	Free from Granary weevil (*Sitophilus granarius*)	Fumigation with Methyl bromide @ 32 g/cu. m at 21^0C and above for 24 h under NAP and the treatment to be endorsed on phytosanitary certificate or by any other fumigant/ substance in the manner approved by the Plant Protection Adviser for this purpose.
	(ii) Fortified rice	China	Free from: (a) *Trogoderma variabile*	Fumigation with Methyl bromide @ 32gram per cubic

	kernel for consumption		(grain dermestid) (b) *Typhaea stercorea* (hairy fungus beetle) (c) *Monographella nivalis* (foot rot of cereals)	meter at 21°C and above for 24 hours under normal atmospheric temperature (NAP) and the treatment to be endorsed on phytosanitary certificate.

Many pests have not yet been reported on rice in India. Therefore, there is risk of introducing pests of quarantine significance along with import of rice from different countries viz., **Insects-** *Ahasversus advena (*Foreign grain beetle), *Haplothrips aculeatus* (Cereal thrips), *Sitophilus granaries* (Grain weevil), *Trogoderma variabile* (Grain dermestid), **Fungus-** *Monographella nivalis* (Snow mold, Fusarium leaf blotch, head blight), **Bacteria-** *Burkholderia glumae* (Bacterial grain rot), *Pseudomonas fuscovaginae* (Sheath brown rot) and *Pseudomonas syringae pv. oryzae* (Halo blight). Therefore, utmost care and all precautions need to be taken up while processing the exotic material for quarantine so as to minimize this risk. Plant quarantine is a government endeavour enforced through legislative measures to regulate the introduction of planting materials, plant products, soil, living organisms, etc. in order to prevent inadvertent introduction of arthropod pests, pathogens, nematodes and weeds harmful to the agriculture of a country/ state/ region and if introduced, prevent their establishment and further spread.

In this context an attempt has been made to prepare a document on the PQPs of transgenic rice**.** Various parameters taken into account were pests of rice, their synonym(s), disease caused or the common name, host range, pathway of introduction, geographical distribution, economic impact and phytosanitary risk involved. The information on various seed-borne and seed-transmitted pests is scattered in different research journals, periodicals, books and other publications. Therefore, it was considered important to compile and consolidate the information on potential quarantine pests of rice and its wild relatives which will be helpful in detection of associated pests with imported transgenic rice.

Table 1: Potential Quarantine Pests of Rice for India

Scientific Name Synonyms and Classification	Common Name	Pathway of Introduction	Host-range	Geographical Distribution	Remarks
Insect pests					
Ahasverus a dvena (Waltl) Synonyms: *Cathartus advena* Waltl, *Silvanus advena* Waltl Order: Coleoptera Family: Silvanidae	Foreign grain beetle	Seed, stored products	*Avena sativa*, *Coffea* sp., *Hordeum vulgare*, ***Oryza sativa,*** *Theobroma cacao, Triticum aestivum*, *Zea mays*	Bangladesh, Canada, Dominican Republic, Ecuador, Ethiopia, Jamaica, Lesotho, Malawi, Nigeria, Philippines, Puerto Rico, Singapore, Solomon Islands, Sri Lanka, Suriname, Tonga, Trinidad and Tobago, UK, USA	Contamination with insect bodies and frass results in loss of market value. Feeds on damaged seeds, abundant only when they are mouldy. Immature stages small and invisible as these are similar in colour to the host.
Cryptolestes ferrugineus (Stephens) [I] Synonyms: *Cucujus ferrugineus* Stephens, *Laemophloeus ferrugineus* Stephens Order: Coleoptera Family: Cucujidae	Rusty grain beetle, rust-red grain beetle	Seed, stored products, as contaminant	*Avena sativa, Hordeum vulgare, Nicotiana tabacum*, ***Oryza sativa***, *Sorghum bicolor, Triticum* spp., *T. aestivum*, *T. spelta*, *Zea mays*	Australia, Austria, Bangladesh, Belgium, Brazil, Canada, China, Denmark, Ethiopia, Germany, Greece, Guyana, Italy, Japan, Kenya, Korea (Republic), Russian Federation, Saudi Arabia, Somalia, Sudan, Sri Lanka, Taiwan, UK, USA, Vietnam, Zimbabwe	Important secondary pest of various stored products including flour. Eggs are laid singly on or amongst the commodity. Often overlooked because of very small size. Can survive in sub-zero temperature (Lee *et al.*,

					1992).
***Sesamia nonagrioides** (Lefebvre) Synonyms: *Sesamia botanephaga* Tams and Bowden, *Sesamia vuteria* nec Stoll Order: Lepidoptera Family: Noctuidae	Mediterranean corn stalk borer, pink maize stalk borer	Seed, as contaminant	*Carex* sp., *Diospyros kaki*, *Gladiolus* hybrids, *Musa* sp., ***Oryza sativa***, *Saccharum officinarum, Solanum melongena*, *Sorghum* sp., *Strelitzia* sp., *Zea mays*	Burundi, Cape Verde, Congo, Côte d'Ivoire, Cyprus, France, Ghana, Greece, Iran, Israel, Italy, Kenya, Mali, Morocco, Nigeria, Portugal, Rwanda, Spain, Sudan, Tanzania, Togo, Turkey, Uganda	Causes serious damage in wheat and rice i.e. breaking of stem and inflorescence and considered an important pest of maize in Europe and North Africa. Can be transported as live eggs, larvae and/ or pupae on plants and plant products.
# Sitophilus granarius Linnaeus [I] Synonyms: *Calandra granaria* Linnaeus, *Curculio granarius* Linnaeus Order: Coleoptera Family: Dryophthoridae	Grain weevil, granary weevil	Seed, stored products	*Avena sativa, Hordeum vulgare,* ***Oryza sativa***, *Secale cereale, Sorghum* sp., *S. bicolor, Triticale, Triticum* sp., *T. aestivum, Vicia faba, Zea mays*	Afghanistan, Algeria, Argentina, Australia, Belgium, Canada, Chile, Denmark, France, Greece, Hungary, India, Iraq, Israel, Italy, Japan, Mexico, Morocco, Poland, Romania, Russian Federation, Saudi Arabia, Slovenia, South Africa, Spain, Sri Lanka, Swaziland, Sweden, Syria, Thailand, Turkey, UK, USA, Yemen	A serious pest in cool climates both in temperate and tropical latitudes. Causes serious damage under hot conditions. Can develop at temperature down to 11^0C. Severe infestation reduces the grains to a mass of hulls and frass. Has a low susceptibility to synthetic pyrethroids. **Quarantine pest for many countries including those with exclusive hot climates.**

#Sitophilus zeamais Motschulsky [I] Synonyms: *Calandra chilensis* (Philippi & Philippi), *Calandra platensis* (Zacher), *Calandra quadrimacula* (Walker), *Calandra zemais* (Motschulsky), *Calendra zeamais* Motschulsky, *Sitophilus oryzae zeamaiz* Motschulsky Order: Coleoptera Family: Dryophthoridae	Greater grain weevil, greater rice weevil, maize weevil billbug, northern corn weevil	Seed, stored products	*Colocasia esculenta, Glycine max, Manihot esculenta,* ***Oryza sativa,*** *Phaseolus vulgaris, Sorghum* sp., *S. bicolor, Triticum sp., T. aestivum, Vigna angularis, V. unguiculata, Zea mays*	Afghanistan, Algeria, Antigua and Barbuda, Argentina, Australia, Austria, Bahrain, Bangladesh, Belgium, Belize, Benin, Bolivia, Brazil, Bulgaria, Cameroon, Cape Verde, Central African Republic, Chile, China, Colombia, Congo, Côte d'Ivoire, Cuba, Cyprus, Egypt, El Salvador, Ethiopia, Fiji, French Guiana, Gambia, Germany, Ghana, Greece, Guatemala, Guyana, Honduras, Hungary, India, Indonesia, Iran, Iraq, Israel, Italy, Jamaica, Japan, Kenya, Korea (Republic), Kuwait, Laos, Lesotho, Liberia, Libya, Macedonia, Malawi, Malaysia, Mexico, Morocco, Mozambique, Myanmar, Nepal, New Caledonia, Nicaragua, Nigeria, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Rwanda, Saudi Arabia, Senegal, Singapore, Solomon Islands, Somalia, South Africa, Spain, Sri Lanka, Sudan, Swaziland, Switzerland, Syria, Tanzania, Thailand, Togo,	Most important pest of maize in South Carolina, USA, Kentucky, Taiwan, and in central Italy (Trematerra *et al*., 1999). Causes weight losses upto 30-40% in stored maize. Pupation occurs within the grain. Has great ability and tendency to fly (Giles, 1969).

				Tonga, Trinidad and Tobago, Tunisia, Turkey, Uganda, UK, Uruguay, USA, Uzbekistan, Venezuela, Vietnam, Yemen, Yugoslavia (erstwhile), Zambia, Zimbabwe	
Trogoderma variabile Ballion Synonyms: *Trogoderma parabile* Beal, *Trogoderma persica* Pic, *Trogoderma persicum* Chao & Lee Order: Coleoptera Family: Dermestidae	Grain dermestid, warehouse beetle	Seed, stored products	*Avena sativa, Hordeum vulgare,* ***Oryza sativa*** *Triticum* sp., *Zea mays*	Afghanistan, Australia, Canada, China, Finland, Kazakhstan, Mexico, Mongolia, Russian Federation, Saudi Arabia, South Africa, Tajikistan, Turkmenistan, UK, USA, Uzbekistan	The larvae are known to enter diapause (Wright and Cartledge, 1994), which is less readily broken than that of *T. granarium*. **It is under quarantine restriction in New South Wales (Australia) (**Rees *et al.*, 2003)**.**
Typhaea stercorea (Linnaeus) Synonyms: *Dermestes stercorea* Linnaeus, *Typhaea fumata* Linnaeus Order: Coleoptera Family:	Fungus beetle, hairy fungus beetle	Seed, stored products	*Hordeum vulgare, Nicotiana tabacum,* ***Oryza sativa,*** *Sorghum* sp., *Triticum* sp., *T. aestivum, Zea mays*	Africa, Australia, Central America, China, Germany, Indonesia, North America, Singapore, South America, USSR (erstwhile)	Fungivorous, also occurs in its absence and contaminates stored foods.

Mycetophagidae					
Nematodes					
Aphelenchoides arachidis Bos	Groundnut testa nematode, peanut testa nematode	Seed, soil	*Arachis hypogaea,* ***Oryza sativa****, Pennisetum glaucum, Saccharum officinarum, Sorghum bicolor, Zea mays*	Nigeria	In addition to the host crop plants, *A. arachidis* has also been found in large numbers in roots of wild grasses (Bos, 1977).
#Aphelenchoides besseyi Christie[1] Synonyms: *Aphelenchoides oryzae* Yokoo, *Asteroaphelenchoides besseyi* (Christie) Drozdovski	White tip nematode of paddy, rice leaf nematode, summer crimp nematode	Seed, inflorescence, soil	*Allium cepa, Chrysanthemum morifolium, Colocasia esculenta, Cyperus iria, Digitaria sanguinalis, Dioscorea* sp.*, D. trifida, Fragaria ananassa, Glycine max, Hibiscus* sp.*, Ipomoea batatas,* ***Oryza* sp., *O. breviligulata, O. glaberrima, O. sativa****, Polianthes tuberosa, Setaria viridis, Zea mays*	Widely distributed and now occurs in most rice growing areas	Infection and damage caused are generally more in lowland and deep water systems than in upland environments. Twenty races known globally. Though reported from India, has the risk of introduction of new strains
Fungi					
Monographella nivalis (Schaffnit) E.Müll.[I] Synonyms: *Calonectria nivalis* Schaffnit,	Foot rot of cereals, head blight of cereals, pink snow mould, seedling blight of cereals, snow blight of cereals, snow	Seed, inflorescence, soil	*Aegilops* sp.*, Agrostis canina,* *A. capillaris, A. stolonifera****,*** *Avena sativa*, *Bromus* sp.*, Festuca rubra, Hordeum vulgare, Lolium multiflorum,L.*	Austria, Australia, Bahrain, Belgium, Bolivia, Brazil, Canada, China, Colombia, Czech Republic, Denmark, Estonia, Ethiopia, Finland, France, Germany, Iceland, Ireland, Italy, Latvia, Lithuania, Netherlands,	Yield losses upto 40-45% reported in Ireland and UK, respectively. Variability of strains and differential host preference exists in the fungus (Simpson *et al.*,

Fusarium nivale Ces. ex Sacc., *Fusarium nivale* f.sp. *graminicola* W.C.Snyder & H.N.Hansen, *Fusarium nivale* var. *majus* Wollenw., *Gerlachia nivalis* (Ces. ex Sacc.) W.Gams & E.Müll., *Griphosphaeria nivalis* (Schaffnit) E.Müll. & Arx, *Microdochium nivale* (Fr.) Samuels & I.C. Hallet, *Micronectriella nivalis* (Schaffnit) C.Booth	mould of cereals		*perenne,* ***Oryza sativa****, Poa annua, P. pratensis, Secale cereale, Triticum aestivum*	New Zealand, Norway, Pakistan, Poland, Romania, Russian Federation, Senegal, Switzerland, Ukraine, UK, USA, Yugoslavia (erstwhile), Zambia	2000). Fungicide resistant strains reported in Sweden (Ovalong and Kroeker, 1987; Tvaruzek *et al*., 2000). Polymerase chain reaction (PCR) assay can be used for detection and identification of the fungus (Nicholson *et al*., 1996; Doohan *et al*., 1998). The fungus was intercepted in species of *Aegilops, Hordeum* and *Triticum* imported from Germany, Hungary, Italy, Mexico, Sweden, UK and USA (Dev *et al*., 1989; Agarwal *et al*., 2001b).
#Drechslera maydis (Nisik.) Subram. & Jain **(Race-T)[I]** Synonyms: *Bipolaris maydis* (Nisik & Miyake) Shoem., *Cochliobolus heterostrophus* (Drechsler) Drechsler,	Southern corn leaf blight, maydis leaf blight, southern leaf spot	Seed, inflorescence, plant debris	*Arachis hypogaea,* Cynodon dactylon, *Glycine max, Helianthus annuus,* ***Oryza sativa,*** *Pennisetum glaucum, Pisum* sp., *Populus deltoides, Setaria glauca, Sorghum* sp., *S. sudanense, Triticum* sp., *Vigna unguiculata, Zea mays, Z. mexicana*	Argentina, Australia, Bangladesh, Bolivia, Brazil, Brunei, Bulgaria, Cambodia, Canada, China, Colombia, Croatia, Cuba, Cyprus, Denmark, Ecuador, Egypt, El-Salvador, Fiji, France, Germany, Ghana, Guatemala, Guinea, Guyana, India, Indonesia, Iran, Israel, Italy, Jamaica,	Race-T of *D. maydis* caused epidemic of maize leaf blight in Texas male sterile cytoplasm (T-cms) in USA resulting in crop losses of more than one billion US $ in 1970. Upto 99% infection by race-T has been detected in maize

Helminthosporium maydis Nisik.				Japan, Kenya, Korea (DPR), Korea (Republic), Laos, Madagascar, Malawi, Malaysia, Mauritius, Mexico, Nepal, New Zealand, Nicaragua, Niger, Nigeria, Pakistan, Panama, Papua New Guinea, Paraguay, Philippines, Portugal, Romania, Russian Federation, Senegal, Sierra Leone, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Switzerland, Tanzania, Thailand, Togo, Trinidad and Tobago, Ukraine, USA, Vietnam, Yugoslavia (erstwhile), Zambia, Zimbabwe	seeds. Ram Nath *et al*. (1973) intercepted Race-T in sorghum seeds imported from USA.
Gaeumannomyces graminis var. ***graminis*** (Sacc.) v. Arx & Olivier Synonym: *Ophiobolus oryzinus* Saccardo	Crown sheath rot, crown sheath rot of rice, patch disease of turf, white-heads of grasses	Soil	*Cynodon dactylon, Eremochloa ophiuroides,* ***Oryza sativa****, Pennisetum clandestinum, Stenotaphrum secundatum, Triticale, Triticum aestivum, Zoysia japonica*	Egypt, Italy (Rossi *et al.,* 1995), Ethiopia (Kelbessa *et al.,* 2002), India (unconfirmed record), Peru (unconfirmed record), Philippines, Poland (Korabs, 1995), South Africa, USA	Considered as one of the major wheat diseases in Australia and Pacific Northwest. The disease has become increasingly important in rice with the intensive production system. A large number of cases of gangrene reported in Ethiopia due to consumption of contaminated barley (Kelbessa *et al.,* 2002).

Gibberella baccata (Wallr.) Sacc. Synonym: *Fusarium lateritium* Nees	Root rot of cereals, collar rot of coffee, dieback of pine, tuber rot of yam	Seed (Clark and Hoy, 1994)	*Abutilon theophrasti, Anoda cristata, Celosia argentea, Cucurbita* sp., *Fraxinus excelsior, Gossypium* sp., *Ipomoea batatas, Morus* sp., ***Oryza sativa***, *Piper betle, Pseudotsuga menziesii*	Australia (unconfirmed record), Brazil (unconfirmed record), Chile (unconfirmed record), China (unconfirmed record) , Hungary (Vajna, 2000), India (unconfirmed record), Iran (Niazmand *et al*., 2000), Kenya (unconfirmed record), Mexico (unconfirmed record), New Zealand (Johnston *et al.*, 1995), Peru (unconfirmed record), Poland (unconfirmed record), Puerto Rico (unconfirmed record), Slovenia (unconfirmed record), UK (unconfirmed record), USA	Variability of strains reported in the fungus (Clark *et al*., 1995; Nelson *et al*., 1995).
Gibberella baccata (Wallr.) Sacc. Synonym: *Fusarium lateritium* Nees	Root rot of cereals, collar rot of coffee, dieback of pine, tuber rot of yam	Seed (Clark and Hoy, 1994)	*Abutilon theophrasti, Anoda cristata, Celosia argentea, Cucurbita* sp., *Fraxinus excelsior, Gossypium* sp., *Ipomoea batatas, Morus* sp., ***Oryza sativa***, *Piper betle, Pseudotsuga menziesii*	Australia (unconfirmed record), Brazil (unconfirmed record), Chile (unconfirmed record), China (unconfirmed record) , Hungary (Vajna, 2000), India (unconfirmed record), Iran (Niazmand *et al*., 2000), Kenya (unconfirmed record), Mexico (unconfirmed record), New Zealand (Johnston *et al.*, 1995), Peru (unconfirmed record), Poland (unconfirmed record), Puerto Rico (unconfirmed	Variability of strains reported in the fungus (Clark *et al*., 1995; Nelson *et al*., 1995).

				record), Slovenia (unconfirmed record), UK (unconfirmed record), USA	
Monographella nivalis (Schaffnit) E.Müll.[I] Synonyms: *Calonectria nivalis* Schaffnit, *Fusarium nivale* Ces. ex Sacc., *Fusarium nivale* f.sp. *graminicola* W.C.Snyder & H.N.Hansen, *Fusarium nivale* var. *majus* Wollenw., *Gerlachia nivalis* (Ces. ex Sacc.) W.Gams & E.Müll., *Griphosphaeria nivalis* (Schaffnit) E.Müll. & Arx, *Microdochium nivale* (Fr.) Samuels & I.C. Hallet, *Micronectriella nivalis* (Schaffnit) C.Booth	Foot rot of cereals, head blight of cereals, pink snow mould, seedling blight of cereals, snow blight of cereals, snow mould of cereals	Seed, inflorescence, soil	*Aegilops* sp., *Agrostis canina, A. capillaris, A. stolonifera*, *Avena sativa*, *Bromus* sp., *Festuca rubra, Hordeum vulgare, Lolium multiflorum, L. perenne,* ***Oryza sativa***, *Poa annua, P. pratensis, Secale cereale, Triticum aestivum*	Austria, Australia, Bahrain, Belgium, Bolivia, Brazil, Canada, China, Colombia, Czech Republic, Denmark, Estonia, Ethiopia, Finland, France, Germany, Iceland, Ireland, Italy, Latvia, Lithuania, Netherlands, New Zealand, Norway, Pakistan, Poland, Romania, Russian Federation, Senegal, Switzerland, Ukraine, UK, USA, Yugoslavia (erstwhile), Zambia	Yield losses upto 40-45% reported in Ireland and UK, respectively. Variability of strains and differential host preference exists in the fungus (Simpson *et al*., 2000). Fungicide resistant strains reported in Sweden (Ovalong and Kroeker, 1987; Tvaruzek *et al*., 2000). Polymerase chain reaction (PCR) assay can be used for detection and identification of the fungus (Nicholson *et al*., 1996; Doohan *et al*., 1998). The fungus was intercepted in species of *Aegilops, Hordeum* and *Triticum* imported from Germany, Hungary, Italy, Mexico, Sweden, UK and USA (Dev *et al*., 1989; Agarwal *et al*., 2001).
Rhizoctonia oryzae-	Aggregate sheath	Soil, straw	*Hordeum vulgare,*	Australia (Lanoiselet *et al*.,	Aggregate sheath spot

sativae (Sawada) Mordue Synonyms: *Ceratobasidium oryzae sativae* (Lanoiselet *et al*.), *Sclerotium oryzae-sativae* (Sawada) Mordue	spot, lodging of rice, sheath browning of rice, stem rot of rice	(Miller and Webster, 2001)	***Oryza sativa,***	2001), China, Italy, Japan, Taiwan, UK (unconfirmed record), USA (unconfirmed record), Vietnam	caused yield losses as high as 20.3% (Lanoiselet *et al.,* 2005).
Bacteria					
#*Acidovorax avenae* subsp. ***avenae*** *(*Manns) Willems *et al.* Synonyms: *Bacillus avenae* (Manns*)* Burgvits, *Bacterium alboprecipitans* (Rosen) Elliott, *Bacterium rubrilineans* (Lee *et al*.) Elliott, *Bacterium setariae* Okabe, *Chlorobacter setariae* (Okabe) Patel & Kulkarni, *Phytobacterium alboprecipitans* (Rosen) Magrou & Prévot, *Phytomonas alboprecipitans* (Rosen)	Bacterial leaf blight, brown stripe, bacterial leaf stripe, bacterial brown stripe, maize bacterial leaf blight	Seed, seedling, inflorescence	*Agropyron* sp., ***Avena sativa****, Bromus atharticus, Bromus inermis, Bromus marnatus, Camellia sinensis, Caryota* sp., *Digitaria sanguinalis, Echinochloa crus-galli, Eleusine coracana, Hordeum vulgare,* ***Oryza sativa****, Panicum miliaceum, Paspalum* sp., *Pennisetum glaucum, Saccharum officinarum, Setaria italica, S. lutescens, S. viridis, Sorghum bicolor, Triticum aestivum, Zea mays, Z. mexicana*	Argentina, Australia, Bangladesh, Bhutan, Brazil, Cambodia, China, Comoros, Congo, Costa Rica, Cuba, Egypt, El Salvador, Ethiopia, Fiji, French Guiana, Guadeloupe, Guatemala, Guyana, India, Indonesia, Iran, Iraq, Italy, Jamaica, Japan, Kenya, Korea (DPR), Korea (Republic), Madagascar, Malawi, Malaysia, Mauritius, Mexico, Mozambique, Myanmar, Nepal, Nicaragua, Nigeria, Portugal, Pakistan, Panama, Papua New Guinea, Paraguay, Philippines, Puerto Rico, Saint Lucia, South Africa, Sri Lanka, Sudan, Suriname, Tanzania, Thailand, Trinidad and Tobago, Turkey, Uganda, USA, Venezuela, Vietnam,	Variability of strains reported (Kadota and Nishiyama, 1998). Individual strains can infect only one or few host spp. (Che *et al*., 2002). Pathogen could be isolated from discolored as well as healthy looking seeds of rice (Xie *et al*., 1998) and can remain viable for 8 years in seeds stored at 5 ^{o}C (Shakya *et al*., 1985). In India the disease is reported only from Bihar, Delhi, Punjab, Maharashtra, Tamil Nadu and Uttar Pradesh.

Bergey *et al.*, *Phytomonas avenae* (Manns) Bergey *et al.*, *Phytomonas rubrilineans* Lee, Purdy, Barnum & Martin, *Phytomonas setariae* (Okabe) Burkholder, *Pseudomonas alboprecipitans* Rosen, *Pseudomonas avenae* subsp. *avenae* Manns, *Pseudomonas avenae* Manns, *Pseudomonas rubrilineans* (Lee *et al.*) Stapp, *Pseudomonas setariae* (Okabe) Savulescu, *Xanthomonas rubrilineans* (Lee *et al.*) Starr & Burkholder, *Xanthomonas rubrilineans* var. *indicus* Summanwar & Bhide				West Africa (Somda *et al.*, 2001), Zimbabwe	
* ***#Burkholderia glumae*** (Kurita & Tabei) Urakami *et al.* <u>Synonym</u>: *Pseudomonas glumae*	Bacterial grain rot, bacterial seedling rot, rice seedling blight, sheath rot, grain sterility of rice, grain iscoloration of rice	Seed, inflorescence, plant debris	***Oryza sativa,*** *Lolium multiflorum*	China, Colombia, Japan, Korea, Philippines, Sri Lanka, Taiwan, Vietnam	Yield reduction upto 15% reported (Katana and Kawanami, 2004). Physiological variations known to occur.

Kurita & Tabei					
* # ***Pseudomonas fuscovaginae*** (ex Tanii *et al*) Miyajima *et al*. Synonym: *Pseudomonas fluorescens biovar* II	Sheath brown rot, bacterial sheath brown rot, bacterial sheath rot, bacterial rot of rice sheaths, rice sheath rot and grain discoloration, brown rot	Seed, inflorescence, plant debris	*Agrostis* sp., *Avena sativa, Bromus marginatus, Hordeum vulgare, Lolium perenne,* ***Oryza sativa****, Poa pratensis, Secale cereale, Sorghum* sp., *Triticale, Triticum* sp., *T. aestivum, Zea mays*	Argentina, Bolivia, Brazil, Burundi, Chile, China, Colombia, Congo, Costa Rica, Cuba, Dominican Republic, Ecuador, El-Salvador, Guatemala, Indonesia, Japan, Jamaica, Madagascar, Mexico, Nepal (Shakya and Manandhar, 1992), Nicaragua, Panama, Peru, Philippines, Russian Federation, Rwanda, Suriname, Tanzania, Trinidad and Tobago, Uruguay, Yugoslavia (erstwhile)	Most important bacterial disease of rice in Hokkaido (Japan) and it is the principal limiting factor in irrigated rice cultivation at altitudes higher than 1500 m, with losses reaching 100%. Substantial yield losses in South America reported (CAB, *International*, 2007) Presence of strains reported (Miyajima, 1983). PCR-RFLP demonstrated 25 composite 16S-rDNA haplotypes (Jaunet *et al*., 1995).
* #***Pseudomonas syringae*** pv. ***oryzae*** (ex Kuwata) Young *et al*.	Halo blight	Straw, leaves, soil	***Oryza sativa***	Japan	Limited to some areas of northern Japan. Barley, oats and beans may be source of inoculum.
Weeds					
Brachiaria plantaginea **Link**	Marmeladegrass, Alexandergrass	Seed as contamination	*Citrus* sp., *Daucus carota, Glycine max, Gossypium* spp., *Helianthus annuus, Lactuca sativa,* ***Oryza sativa****, Phaseolus* spp.,	Argentina, Brazil, Costa Rica, France, Guatemala, Mexico, Nicaragua, Puerto Rico, USA	Seeds deeper in the soil can remain dormant for years. Biotypes resistant to acetyl carboxylase

			Prunus domestica., Saccharum officinarum, Zea mays		group of herbicides reported from Brazil (Adoryan *et al*., 1997).
#*Echinochloa crus-galli* (L.) Beauv. <u>Synonyms</u>: *Echinochloa crus-pavonis* (auct. div) non (H.B.K.) Schultes, *Echinochloa glaberescens* Kossenko, *Echinochloa hispidula* (Retz.) Nees ex Royle, *Echinochloa muricata* (P. Beauv.) Fern., *Echinochloa spiralis* Vasinger, *Echinochloa subverticillata* Pilger, *Panicum crus-galli* L., *Panicum hispidulum* Retz.	Barnyard grass, chicken panic grass, barngrass, watergrass, German grass, wild millet, cockspur barnyard millet, cockspur grass, cocksfoot panicum	Seed as contamination	*Allium cepa, Arachis hypogaea, Beta vulgaris, Brassica juncea var. juncea, B. napus* var. *napus, B. oleracea var. botrytis, B. oleracea* var. *capitata, Cajanus cajan, Camellia sinensis, Capsicum annuum, Citrus* spp., *Coffea arabica, Colocasia esculenta, Corchorus* spp., *Crotalaria juncea, Cucumis sativus, Fragaria* spp., *Glycine max, Gossypium hirsutum, Helianthus annuus, Hordeum* spp., *Ipomoea batatas, Lycopersicon esculentum, Manihot esculenta, Medicago sativa, Musa* spp., *Nasturtium officinale, Nicotiana tabacum,* ***Oryza sativa****, Pennisetum glaucum, Phleum pretense, Pinus* spp., *Pisum* spp., *Ricinus communis, Saccharum officinarum, Solanum tuberosum, Sorghum bicolor, Triticum aestivum, Vitis*	Afghanistan, Argentina, Australia, Austria, Bangladesh, Belgium, Bhutan, Brazil, Brunei, Bulgaria, Cambodia, Canada, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Czech Republic, Dominican Republic, Egypt, Fiji, France, Germany, Greece, Guinea, Hungary, India, Indonesia, Iran, Iraq, Israel, Italy, Jamaica, Japan, Korea (DPR), Korea (Republic), Laos, Lebanon, Madagascar, Malaysia, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Nepal, Netherlands, New Zealand, Norway, Pakistan, Papua New Guinea, Peru, Philippines, Poland, Portugal, Romania, Russian Federation, Senegal, Slovakia, South Africa, Spain, Sri Lanka, Sudan, Swaziland, Sweden, Switzerland, Tanzania, Thailand, Tunisia, Turkey, Uganda, Ukraine, UK, Uruguay, USA, Uzbekistan, Vietnam, Yugoslavia	Most serious weed of rice in many countries in Asia, and is a major weed in a wide range of crops throughout the tropical and subtropical world. In direct-sown rice damage may be more consistently serious. In India, unchecked weed growth of *E. crus-galli* in direct-seeded lowland rice can cause a 53% reduction in grain yield leading to 30% yield loss (Ali and Sankaran, 1984).

			sp., *Zea mays*	(erstwhile)	
* # ***Emex spinosa***	Devil's thorn, spiny emex, prickly dock	Seed as contaminant	*Avena sativa, Beta vulgaris, Brassica rapa* ssp. *oleifera, Brassica rapa subsp. chinensis, Citrus , Hordeum vulgare, Lactuca sativa, Lycopersicon esculentum, Malus domestica, Olea europaea,* **Polyphagous,** *Secale cereale, Sesamum indicum, Triticale, Triticum aestivum,*	Algeria, Brazil, Cyprus, Equador, Egypt, Gibraltar, Greece, Iran, Iraq, Israel, Italy, Jordan, Kenya, Lebanan, Libya, Mauritius, Morocco, Malta, Pakistan, Portugal, Saudi Arabia, Spain, Syria, Turkey. Tunisia, UK, USA,	
***Galium aparine* L.**	Cleavers, catchweed bedstraw, harrif, goose grass, robin run over the hedge		*Avena sativa, Beta vulgaris, Brassica napus* var. *napus, Coffea* sp., *Glycine max, Gossypium* spp., *Hordeum vulgare, Linum usitatissimum, Medicago sativa,* ***Oryza sativa****, Secale cereale, Solanum tuberosum, Triticum aestivum, Vitis vinifera*	Afghanistan, Argentina, Australia, Belgium, Brazil, Canada, Chile, China, Ethiopia, Finland, France, Germany, Greece, Hong Kong, Hungary, Iceland, Italy, Israel, Japan, Korea (DPR), New Zealand, Norway, Pakistan, Poland, Portugal, Russian Federation, Spain, Sweden, Tunisia, Turkey, UK, Uruguay, USA, Yugoslavia (erstwhile)	30-60% yield reduction in cereals reported. The plant also acts as an alternative host to a range of crop pathogens (CAB *International*, 2007).
* # ***Ischaemum timorense* Kunth**	Centipede grass, lucuntu grass	Seed as contamination, rhizome	*Allium cepa, Arachis hypogaea, Elaeis guineensis, Glycine max,* ***Oryza sativa,*** *Saccharum officinarum, Xanthorrhoea* spp.	Cameroon, French Polynesia, Indonesia, Malaysia, Papua New Guinea	Major weed of rice in Indonesia (CAB *International*, 2007) and in the Punjab, India (Shetty *et al.* 1975).

#*Mimosa pigra* L., nom. cons. Synonyms: *Mimosa asperata* L., *Mimosa hispida* Willd., *Mimosa pallida* Humb. & Bonpl. ex Willd., *Mimosa pigra* var. *pigra* (A.Gray ex Torr.); L.Turner *Mimosa polyacantha* Willd.	Giant sensitive plant, catclaw mimosa	Seed as contamination	***Oryza sativa***, Polyphagous	Argentina, Australia, Brazil, Cambodia, China, Colombia, Congo, Costa Rica, Djibouti, Egypt, Ecuador, El-Salvador, Ethiopia, Fiji, Ghana, Guatemala, Guinea, Honduras, India, Indonesia, Jamaica, Kenya, Laos, Madagascar, Malaysia, Mauritania, Mauritius, Mexico, Myanmar, Nigeria, Papua New Guinea, Paraguay, Philippines, Senegal, Sierra Leone, Singapore, South Africa, Sri Lanka, Taiwan, Tanzania, Thailand, Uganda, USA, Vietnam	Spreads readily into fallow rice fields increasing reclamation efforts and costs. The occurrence of *M. pigra* along irrigation systems increases sediment accumulation and restricts water flow. **Declared a noxious weed in Florida, USA, northern Australia and Thailand. In Western Australia and Queensland, legislation exists to prohibit the introduction of the weed** (CAB *International*, 2007).
***Oryza longistaminata* A. Chev. & Roehr.** Synonyms: *Oryza barthii sensu* Hutch. & Dalz., non A. Chev., *Oryza dewildemanii* Vanderyst, *Oryza perennis* Wild *Oryza sylvestris* A. Chev.	Perennial wildrice, rhizomatous wild rice	Seed as contamination	***Oryza sativa***	West Africa- Angola, Botswana, Burkina Faso, Cameroon, Congo Democratic Republic, Côte d'Ivoire, Gabon, Gambia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Senegal, Sierra Leone, South Africa- Sudan, Tanzania, Uganda, Zambia, Zimbabwe	Yield losses have been estimated to be in the order of 85% in fields with severe infestations. Both *O. barthii* and *O. punctata* are listed as potential problem to USA agriculture. Also acts as an alternate host of some important rice pests like *Rice yellow mottle virus*, *Sobemovirus* and

					Xanthomonas oryzae pv. *oryzae.*
***Polygonum lapathifolium* L.** Synonyms: *Persicaria lapathifolia* (L.), *Persicaria nodosum* Pers., Gray, *Polygonum andrzejowskianum* Klokov, *Polygonum brittingeri* Opiz, *Polygonum incanum* F. W. Schmidt, *Polygonum linicola* Sutulov, *Polygonum nodosum* Pers., *Polygonum paniculatum* Andrz., *Polygonum tomentosum* Schrank, *Polygonum zaporoviense* Klokov	Pale persicaria, pale smartweed, white smartweed	Seed as contamination	*Allium cepa, Apium graveolens, Avena sativa, Beta vulgaris, Brassica* spp., *B. napus* var. *napus, Daucus carota, Glycine max, Helianthus annuus, Hordeum* spp., *Linum, Medicago sativa, Ornithopus sativus,* ***Oryza sativa****, Pisum, Solanum* spp., *S. tuberosum, Triticum aestivum, Vitis vinifera, Zea mays*	Afghanistan, Albania, Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bulgaria, Canada, Chile, China, Croatia, Cyprus, Czechoslovakia (erstwhile), Denmark, Egypt, Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Japan, Jordan, Korea (DPR), Korea (Republic), Lebanon, Lithuania, Morocco, Netherlands, New Zealand, Norway, Pakistan, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, Switzerland, Taiwan, Thailand, Tunisia, UK, USA, Yugoslavia	Potentially damaging weed in spring-sown crop. Seeds remain viable for 6-10 years. The weed also acts as an alternate host to a number of pests like *Cucumber mosaic virus, Rhizoctonia solani* and eriophiid mites (CAB *International*, 2007).
***Richardia brasiliensis* Gomes**	Tropical Richardia, Mexican clover		*Allium cepa, Arachis hypogaea, Cajanus cajan, Citrus* spp., *Coffea arabica, Glycine soja,*	Argentina, Australia, Brazil, Cuba, Ghana, Indonesia, Kenya, Malawi, Mozambique, Myanmar,	Major crop seed contaminant in South Africa and a nuisance in lawns and gardens,

Synonyms: *Richardsonia brasiliensis* *Richardsonia emetica* Mart., (Gomez) Hayne, *Richardia pilosa* Ruia & Pav., *Richardia rosea* (St Hil.) Schult., *Rcihardsonia rosea* St Hil., *Richardsonia scabra* St Hil., *Spermacoce hexandra* A. Rich.			*Gossypium* spp., *Helianthus annuus, Hevea brasiliensis, Medicago sativa,* ***Oryza sativa****, Phaseolus vulgaris, Saccharum officinarum, Solanum tuberosum,* *Zea mays*	Nigeria, South Africa, Swaziland, Thailand, USA, Zambia, Zimbabwe	and has also invaded and replaced native vegetation. It acts as an alternate carrier for *Fusarium roseum* and *Meloidogyne javanica.*
#*Rumex crispus* L.	Curled dock, curly dock		*Allium cepa, Avena sativa, Beta vulgaris, Brassica napus* var. *napus, B. rapa* subsp. *oleifera, Camellia sinensis, Carthamus tinctorius, Daucus carota, Hordeum distichon, H. vulgare, Linum usitatissimum, Medicago sativa,* ***Oryza sativa****, Pisum sativum, Saccharum officinarum, Secale cereale, Solanum tuberosum, Triticum aestivum, Vitis vinifera, Zea mays*	Afghanistan, Albania, Argentina, Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, China, Colombia, Costa Rica, Czechoslovakia (erstwhile), Denmark, Ecuador, Egypt, Finland, France, Germany, Greece, Guatemala, Hungary, Iceland, India, Iran, Iraq, Ireland, Italy, Japan, Kenya, Korea (DPR), Korea (Republic), Lesotho, Mauritius, Mexico, Namibia, Netherlands, New Zealand, Norway, Peru, Poland, Portugal, Romania, South Africa, Spain, Sweden, Switzerland,	Characterized as one of the most serious weeds of arable land. In the absence of effective soil tillage, it may become a weed of economic importance in competitive annual crops, such as cereals. Due to similarities in specific gravity and size it is difficult to completely remove seeds of *R. crispus* in seed lots of clover and lucerne.

				Tunisia, Turkey, UK, Uruguay, USA, USSR (erstwhile), Venezuela, Yugoslavia (erstwhile)	
***#*Striga hermonthica (Del.) Benth.** Synonyms: *Buchnera hermontheca* Del., *Striga hermontheca* (Del.) Benth., *Striga senegalensis* Benth.	Witchweed, purple witchweed	Seed as contamination	*Eleusine coracana, Eragrostis tef, Hordeum vulgare,* ***Oryza sativa****, Panicum* spp.*, Rottboellia cochinchinensis, Saccharum officinarum, Sorghum bicolor,* *S. halepense, Zea mays*	Angola, Benin, Burkina Faso, Burundi, Cambodia, Cameroon, Central African Republic, Chad, Congo Democratic Republic, Congo, Côte d'Ivoire, Egypt, Ethiopia, Gambia, Ghana, Guinea, Kenya, Madagascar, Malawi, Mali, Mauritania, Morocco, Mozambique, Namibia, Niger, Nigeria, Rwanda, Saudi Arabia, Senegal, South Africa, Sudan, Swaziland, Tanzania, Togo, Uganda, Yemen, Zambia, Zimbabwe	Responsible for more crop loss in Africa than any other individual weed species. All species are prohibited imports to USA and Israel (CAB I*nternational*, 2007).

***Thlaspi arvense* L.**	Pennycress, field pennycress, bastardcress, fanweed, stinkweed		*Allium cepa, A. porrum, Avena sativa, Asparagus officinalis, Beta vulgaris, Brassica napus* var. *napus, Carthamus tinctorius, Cicer arietinum, Daucus carota, Glycine max, Gossypium* spp., *Helianthus annuus, Hordeum vulgare, Lens culinaris Linum usitatissimum, Medicago sativa,* ***Oryza sativa****, , Phaseolus* spp., *Pisum sativum, Solanum tuberosum, Triticum aestivum, Vicia faba, Zea mays*	Afghanistan, Albania, Argentina, Armenia, Australia, Austria, Azerbaijan, Belarus, Belgium, Bhutan, Bulgaria, Canada, China, Colombia, Czechoslovakia (erstwhile), Denmark, Estonia, Finland, France, Georgia, Germany, Greece, Greenland, Hungary, Iceland, Iran, Ireland, Israel, Italy, Japan, Jordan, Korea (DPR), Korea (Republic), Latvia, Lebanon, Lithuania, Luxembourg, Mongolia, Netherlands, New Zealand, Norway, Pakistan, Poland., Portugal, Romania, Russian Federation, South Africa, Spain, Sweden, Switzerland, Tajikistan, Tunisia, Turkey, Turkmenistan, UK, USA, Yugoslavia (erstwhile)	Prolific seed producer and capable of building up large reserves of seeds in the soil. Seed exhibits long-term dormancy. Reported as a contaminant of commercial oilseed (rapeseed) stocks in the USA and may be toxic to cattle.

*** pest (insect/ nematodes/ fungi/ bacterium/ weed) not reported from India,**

 # pest included in PQ Order 2003,

I pest intercepted during quarantine processing

References:

1. Adoryan M, C Pedro, C Marluce, G Gelmini, M Nova, R Victoria and R Vidal (1997) Group A/1 resistant Alexander grass (*Brachiaria plantaginea*). http://www.weedscience.org/Case/Case.asp?Resist1D=498. Accessed on 28.11.2016.
2. Agarwal PC, Usha Dev and Indra Rani (2001) *Fusarium* species intercepted in exotic crop germplasm during 1976-99. *Indian Journal of Agricultural Sciences* 71: 736-739.
3. Ali MA and S Sankaran (1984) Crop-weed competition in direct seeded lowland and upland bunded rice. *Indian Journal of Weed Science* 16: 90-96.
4. Bos WS (1977) A preliminary report on the distribution and host-range of the nematode *Aphelenchoides arachidis* Bos. in the north of Nigeria. *Samaru Agricultural Newsletter* 19: 21-23.
5. CAB *International* (2007) Crop Protection Compendium. CAB International, Wallingford: UK.
6. Che F, Y Nakajima, N Tanaka, M Iwano, T Yoshida, S Takayama, I Kadota, A Isogai and FS Che (2002) Flagellin from an incompatible strain of *Pseudomonas avenae* induces a resistance response in cultivated rice cells. Journal of Biological Chemistry 275: 32347-32356.
7. Clark CA and MW Hoy (1994) Isolation of *Fusarium lateritium* form sweet potato seed. Plant Disease 78: 585-587.
8. Clark CA and MW Hoy (1994) Isolation of *Fusarium lateritium* form sweet potato seed. Plant Disease 78: 585-587.
9. Dev Usha, A Majumdar, PC Agarwal and Ram Nath (1989) Interception of *Fusarium nivale* in exotic wheat (*Triticum* specices) germplasm. *Indian Journal of Agricultural Sciences* 59: 602-603.
10. Doohan FM, DW Parry, P Jenkison and P Nicholson (1998) The use of species specific PCR-based assays to analyse *Fusarium ear* blight of wheat. Plant Pathology 47: 197-205.
11. Giles PH (1969) Observations in Kenya on the flight activity of stored products insects particularly *Sitophilus zeamais* Motsch. *Journal of Stored Products Research* 4: 317-329.
12. Gudzinskas Z (1993) Genus *Ambrosia* L. (Asteraceae) in Lithuania. *Thaiszia* 3: 89-96.
13. http://irri.org/rice-today/where-rice-pests-and-diseases-do-the-most-damage- Accessed on 28.11.16
14. http://www.fao.org/docrep/003/x6905e/x6905e04.htm- Accessed on 30.11.16
15. https://www.worldriceproduction.com/- Accessed on 22.11.16.
16. Jaunet T, G Laguerre, P Lamanceau, R Frutos and JL Notteghem (1995) Diversity of *Pseudomonas fuscovaginae* and other fluorescent pseudomonads isolated from diseased rice. *Phytopathology* 85: 1534-1541.
17. Johnston PR, SL Parkes and P Broadhurst (1995). Fungi associated with gorse and broom in New Zealand. *Australasian Plant Pathology* 24: 157-167.
18. Katana M and M Kawanami (2004) Yield and root morphology of rice infected by bacterial grain rot (*Pseudomonas glumae* Kurita and Tabei). *Japanese Journal of Crop Science* 73: 48-57.
19. Kelbessa U, D Asfaw, WM Yeshi, WM Yeshi, N Agata, B Abebbe and Z Wubalem (2002) Laboratory studies on the outbreak of gangrenous ergotism associated with consumption of contaminated barley in Arsi, Ethiopia. *Ethiopian Journal of Health Development* 16: 317-323.
20. Korbas M (1995) Pathogenic fungi isolated from diseased stem base of triticale. Prace Naukowe Instyuta Ochrony Roslin 36: 146-151.

21. Lanoiselet VL, Cother EJ, Ash GJ and Harper JDI (2005) Yield loss in rice caused by *Rhizoctonia oryzae* and *R. oryzae-sativae* in Australia. *Australasian Plant Pathology* 34: 175. doi:10.1071/AP05013

22. Lanoiselet VM, GJ Ash, EJ Cother, MJ Priest and A Watson (2001) First Report of *Waitea circinata* causing sheath spot and *Rhizoctonia oryzae-sativae* causing aggregate sheath spot on rice in south-eastern Australia. *Australasian Plant Pathology* 30: 369-370.

23. Lee RE Jr, JM Strong-Gunderson, MR Lee and EC Davidson (1992) Ice-nucleating active bacteria decrease the cold-hardiness of stored grain insects. *Journal of Economic Entomology* 85: 371-374.

24. Miller TC and RK Webster (2001) Soil sampling techniques for determining the effect of cultural practices on *Rhizoctonia oryzae-sativae* inoculums in rice field soils. Plant Disease 85: 967-972.

25. Miyajima K (1983) Studies on bacterial sheath brown rot of rice plant caused by *Pseudomonas fuscovaginae,* Tanii, Miyajima and Akita. *Reporter of Hollaido Experimental Station* 43: 1-74.

26. Nelson PE, JH Juba and CA Clark (1995) An unusual strain of *Fusarium lateritium* affecting *sweetpotato. Mycologia* 87: 507-509.

27. Niazmand AR, M Torabi, J Ershad and HR Zamanizadeh (2000) Etiology of *Fusarium* blight of barley in Mazandaran province. *Seed and Plant* 16: 19-29.

28. Nicholson P, AK Lees, N Maurin and DW Parry (1996) Development of a PCR assay to identify and quantify in *Microdochium nivale* var. *majus* in wheat. *Physiological and Molecular Plant Pathology* 48: 257-271.

29. Olvang H and G Kroeker (1987) Fungicide resistance, present situation and strategies in Sweden. *Vaxtskyddsrapporter* 48: 29-35.

30. Plant Quarantine (Regulation of Import into India) Order (2003) In *The Gazette of India* Part-II-Section 3-Sub-section (ii) published by Ministry of Agriculture (Department of Agriculture & Cooperation) Notification, New Delhi, dated 18th November, 2003, 104p.

31. Prado R, C Dominguer and M Tena (1993) Triazine resistance in biotypes of *Solanum nigrum* and four *Amaranthus* species found in Spain. *Weed Research* 33: 17-24.

32. Ram Nath, AK Lambat, MM Payak, L Ramani and I Rani (1973) Interception of race T of *Helminthosporium maydis* on sorghum seed. *Current Science* 42: 872-874.

33. Rees DP, N Starick and EJ Wright (2003) Current status of the warehouse beetle Trogoderma variabile (Coleoptera: Dermestidae) as a pest of grain storage in Australia. In Stored grain in Australia 2003 (eds. Wright EJ, MC Webb and E Highley. Proceedings of the Australian Postharvest Technical Conference, Canberra, 25–27 June 2003. CSIRO Stored Grain Research Laboratory, Canberra.

34. Shakya DD and S Manandhar (1992) Bacterial sheath brown rot of rice caused by *Pseudomonas fuscovaginae* in Nepal. *Plant Pathogenic Bacteria, 8th International Congress, Versailles, France, INRA* pp. 73-78.

35. Shakya DD, F Vinther and SB Mathur (1985) Worldwide distribution of a bacterial stripe pathogen of rice identified as *Psecudomonas avenae*. *Phytopathologische Zeitschrift* 114: 256-259.

36. Shashi Bhalla, VC Chalam, Baleshwar Singh, Rajan, Kavita Gupta, P. Firke, N. Kumar, Anju Jain, R. Som, Gurinder Jit Randhawa, Manju Lata Kapur and RK Khetarpal (2008) Quarantine Processing of Imported Transgenic Rice and Evaluation of Risk in Import. *Journal of Plant Genetic Resources* 21(2): 141-145

37. Shetty VR, HS Gill and LS Brar (1975) Weed flora of rice (*Oryza sativa* L.) in the Punjab. *Journal of Punjab Agricultural Research* 12: 43-51.

38. Simpson DR, HN Rezanoor, DW Parry and P Nicholson (2000) Evidence for differential host preference in *Mcordochium nivale* var. *majus* and *Microdochium nivale* var. *nivale*. *Plant Pathology* 49: 261-268.

39. Singh Baleshwar, Rajan, Shashi Bhalla, VC Chalam, BM Pandey, SK Singh, N Kumar and RK Khetarpal (2003) Quarantine processing of imported transgenic planting material. *Indian Journal of Agricultural Sciences* 73: 97-100.

40. Singh Baleshwar, D Chand, AK Maurya, R Sharma and PC Agarwal (2014) Pathogenic fungi intercepted in introduced transgenics during 2006-2013. *Plant Pathology & Quarantine* 4(2): 99–107, Doi 10.5943/ppq/4/2/4 (Online publication)

41. Somda I, MS Veena and CN Mortensen (2001) First report on the occurrence of bacterial stripe organism *Acidovorax avenae* subsp. *avenae* subsp. *avenae i*n rice from Burkina Faso. *Plant Disease* 85: 804.

42. Trematerra P, F Fontana, M Mancini and A Sciarretta (1999) Influence of intact and damaged cereal kernels on the behaviour of rice weevil, *Sitophilus oryzae* (L.) (Coleoptera: Curculionidae). *Journal of Stored Products Research* 35: 265-276.

43. Tvaruzek L, H Hrabalova and P Kraus (2000) Sensitivity of *Microdochium nivale* isolates to some DMI fungicides commonly used in Czech Republic. *Plant Protection Science-UZPI* 36: 7-10.

44. Vats A K, Bhusal Nand Behl RK (2016) Climate Resilient Wheat: Temperature Perspectives. 7th IFSDAA-International Seminar 2016 on Sustainable Resource Management Towards Food, Energy, Environment and Livelihood from 2-29 Nov. 2016 held at Germany (ABSTRACTS) pp.51.

45. Wright EJ and AP Cartledge (1994) Effect of food volume and photoperiod on the initiation of diapause in the warehouse beetle *Trogoderma variabile* Ballion (Coleoptera: Dermestidae). In: Highley E, EJ Wright, HJ Banks and BR Champ (eds.) *Proceedings of the Sixth International Working Conference on Stored Products Protection*. Canberra, Australia, 17-23 April 1994. Vol. 1: 613-616.

46. Xie GL, Sun XL and Mew TW (1998) Characterization of *Acidovorex avenae* subsp. *avenae* from rice seeds. *Chinese Journal of Rice Science* 12: 165-171.

Glossary

Contaminant	Soil, fungal spores, fruiting bodies, plant debris, live/ dead/ dormant insects/ stages thereof
Endangered area	An area where ecological factors favour the establishment of a pest whose presence in the area will result in economically important loss (http://wInNv.ippc.org
Grain	A commodity class for seeds intended for processing or consumption and not for planting (http://www.ippc.org)
Interception (of a pest)	The detection of a pest during inspection or testing of an imported consignment((http://www.ippc.org)
Pathway	Any means that allows the entry or spread of a pest (http://www.ippc.org)
Pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plant or plant products (http://www.ippc.org)
Pest risk analysis	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 (http://www.ippc.org)
Plant debris	Dried plant parts or pieces thereof other than seed
Plant products	Unmanufactured material of plant origin (including grain) and those manufactured products that, by their nature or that of their processing, may create a risk for the introduction and spread of pests
Plant quarantine	All activities designed to prevent the introduction and/or spread of quarantine pests or to ensure their official control (http://www.ippc.org)
Plants for planting	Plants intended to remain planted, to be planted or replanted
Post-entry quarantine	Quarantine applied to a consignment after entry
Quarantine	Official confinement of regulated articles for observation and research or for further inspection, testing and/or treatment (http://www.ippc.org)
Quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled (http://www.ippc.org)
Seed	A commodity class for seeds for planting or intended for planting and not for consumption or processing (http://www.ippc.org)
Seed-borne	The pest present on, in or along with the seed
Seed-transmitted	The pest present in or with the seed and transmitted to the next generation of growing seedlings
Stored products	Stored grain, flour or processed plant products

Acronyms

AFLP	Amplified fragment length polymorphism
APHIS	Animal and Plant Health Inspection Service
APPPC	Asia and Pacific Plant Protection Commission
ATMT	*Agrobacterium tumefaciens*–mediated transformation
CGIAR	Consultative Group on International Agricultural Research
CIAT	Centro Internacional Agricultura Tropical (=International Center for Tropical Agriculture)
CPPC	Caribbean Plant Protection Commission
DIBA	Dot lmmuno-binding Assay
ELISA	Enzyme-linked lmmunosorbent Assay
EM	Electron Microscopy
EMBL	European Molecular Biology Laboratory
EPPO	European and Mediterranean Plant Protection Organization
FAO	Food and Agriculture Organization
ICARDA	International Center for Agricultural Research in the Dry Areas
ICTV	International Committee on Taxonomy of Viruses
IGS	Intergenic spacer
IITA	International Institute of Tropical Agriculture
IPPC	International Plant Protection Convention
ISPM	International Standards for Phytosanitary Measures
ITS	Internal transcribed spacer
mtDNA	mitochondrial DNA
NBPGR	National Bureau of Plant Genetic Resources
NPPO	National Plant Protection Organization
OEPP	Organisation Europeenne et Mediterraneenne pour la Protection des
OIRSA	Organismo Internacional Regional de Sanidad Agropecuaria
PAGE	Polyacrylamide gel electrophoresis
PCR	Polymerase Chain Reaction
PQ Order	Plant Quarantine (Regulation of Import into India) Order
PPPO	Pacific Plant Protection Organization
PQP	Potential Quarantine Pest
PRA	Pest Risk Analysis
RAPD	Random Amplified Polymorphic DNA
rDNA	ribosomal DNA
RFLP	Restriction Fragment Length Polymorphism

RPPO	Regional Plant Protection Organization
RT-PCR	Reverse Transcription Polymerase Chain Reaction
SCAR	Sequence Characterized Amplified Regions
SPS	Sanitary and Phytosanitary
USDA	United States Department of Agriculture
VCGs	Vegetative compatible groups
WTO	World Trade Organization

Useful Websites

1. www.padil.gov.au PaDIL – High quality images and information tools designed for biosecurity and biodiversity
2. http://www.cabi.org/ISC/ Invasive Species Compendium