Pathogenic Fungi and Bacterium Intercepted in Oilseed Crops Introduced During 1999-2008

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A large number of germplasm and trial material of oilseed crops are being introduced each year to develop better crop varieties. There is always an inherent risk of introduction of a new pathogen(s) or race(s) or virulent strain(s) into the country along with such imports. During 1999-2008, a total of 10,450 germplasm samples of different species of oilseed crops viz., brassicas, crambe, linseed, safflower, sesame, soybean and sunflower were imported from several countries. Seed health testing of these samples for quarantine clearance resulted in the detection of pathogenic fungi in 1,300 samples which included – *Alternaria brassicae*, *A. brassicicola*, *Botrytis cinerea*, *Phoma lingam* in *Brassica* spp.; *A. brassicicola* in *Crambe* spp.; *B. cinerea*, *Fusarium solani*, *Puccinia carthami* in *Carthamus* spp.; *Cercospora kikuchii*, *Colletotrichum dematium*, *F. oxysporum*, *F. solani*, *Macrophomina phaseolina*, *Peronospora manshurica* in *Glycine* spp.; *A. helianthi*, *P. helianthi* in *Helianthus* spp.; *A. lini* in *Linum* spp.; *A. sesami*, *C. sesami*, *M. phaseolina*, *Rhizoctonia bataticola* in *Sesamum* spp. and a bacterium *Xanthomonas campestris* pv. *campestris* in *Brassica* spp. Significance of interception of pathogenic fungi and the bacterium is discussed.

Key Words: Germplasm, Interceptions, Oilseed crops, Pathogenic fungi, Pathogenic bacterium, Quarantine, Salvaging

Introduction

India spends enormous foreign exchange on imports of edible oil and during 2007-08 the imports were 6.3 million tones of vegetable oils worth ₹ 25,000 crores. The country has been importing exotic germplasm of oilseed crops to develop high yielding varieties by their utilization under various breeding programmes aimed to increase oil production. Such imports carry risk of inadvertent introduction of exotic pests like pathogenic fungi and bacteria. A large number of economically important pathogenic fungi were intercepted in introduced germplasm at the National Bureau of Plant Genetic Resources, New Delhi, from time to time including *Peronospora manshurica* (Naum.) Syd. Ex Gaum. on soybean which is not yet reported from India; *Puccinia carthami* Corda which are known to possess a number of virulent races; *Botrytis cinerea* Pers.: Fr., *Fusarium solani* (Mart.) Sacc. and *Macrophomina phaseolina* (Tassi) Goid which have a wide host range (Agarwal *et al.*, 2006; Khetarpal *et al*., 2001; Singh *et al*., 2007). In this paper pathogenic fungi and a bacterium intercepted on germplasm of various oilseed crops imported from several countries during 1999-2008 is presented and economic importance of important ones is discussed.

Materials and Methods

During 1999-2008, a total of 10,450 germplasm samples of brassicas, crambe, linseed, safflower, sesame, soybean and sunflower were received from several countries for quarantine processing. All the seeds were first examined visually and then under stereo-binocular microscope for the presence of fungal fructifications, rust pustules and spores adhered on the seed surface, crusts of soybean downy mildew etc., for symptoms such as discolouration/spots. Seed samples of soybean found treated with microbial cultures or suspected to carry traces of crusts of oospores of downy mildew were subjected to washing test (Agarwal *et al.*, 2006a). The unhealthy-looking seeds of all the crops were subjected to blotter test. The seeds were placed on 3 layers of moist blotters in plastic Petri plates (seeds/plate varied from 10 to 25, depending on the size of the seed and the sample) and incubated for 7 days at 20±1^{0}C under alternating cycles of 12 h light and darkness. Observations for the associated pathogenic fungi and/or bacteria were recorded on the 8th day under stereo-binocular microscope. Slides were also prepared and observed under compound microscope, wherever needed. The fungi intercepted were identified as per the characteristics described in IMI descriptions of fungi and bacteria. For detection of *Xanthomonas*

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campestris pv. *campestris* in brassicas, seedlings showing 'V' shaped lesions in the blotter test were cut with a sharp blade, to see the bacterial ooze from vascular bundles indicated the bacterial association with infected portion (Shekhawat *et al*., 1982).

Infected seed samples were salvaged by hot water treatment, alcohol + sand wash and fungicidal treatment techniques (Agarwal *et al.*, 1990; Dev *et al*., 1999) before their release to the indenters.

Results and Discussion

Eighteen seed-borne fungi and one bacterium of quarantine significance were intercepted during 1999-2008 on introduced germplasm of different crops from several countries (Table 1). During visual and stereoscopic observations *P. manshurica*, the causal agent of downy mildew was intercepted as crust of oospores on soybean (*Glycine max* (L.) Merr.) seeds from Brazil, Japan, Taiwan, Thailand and USA. The interception of this downy mildew is of high quarantine significance to India as it is not yet reported from the country and it had a number of physiological races as well as its oospores could remain viable for 8 years. Crop losses of 10 to 11.8% due to downy mildew have been reported (Agarwal *et al.*, 2006a). *Puccinia carthami* Corda, rust of safflower (*Carthamus tinctorius* L.) was intercepted in *Carthamus* spp. from USA. The teleutospores of *P. carthami* carried on the seed surface were found responsible for the serious epiphytotics of safflower rust reported in USA (CAB International, 2007). Yield losses can approach 100% on susceptible varieties (http://wiki.bugwood.org/HPIPM:Safflower_Rust). *P. helianthi* Schwein., rust of sunflower (*Helianthus annuus* L.) was intercepted in *H. annuus* from Australia, Bulgaria, China, Egypt, France and USA. Yield losses in sunflower as high as 50% due to a reduction in the capitulum and seed size and in oil content have been reported in Canada and Argentina (Siddiqui and Brown, 1977). Among the insect pests and diseases, diseases of sunflower alone cause 10% yield loss in the field itself (http://orissagov.nic.in/e-magazine/Orissareview/2008/feb-march-2008/engpdf/83-84.pdf).

Observations on seeds incubated on moist blotters revealed presence of a large number of economically important fungi. *Alternaria brassicae* (Berk.) Sacc., Alternaria blight, leaf blight fungus of crucifers was intercepted in *Brassica juncea* from Australia, Canada, and Korea; in *B. napus* from Australia; in *B. nigra* from Canada; in *B. oleracea* from the Netherlands and Taiwan; in *B. oleracea* var. *capitata* from the Netherlands; in *B. rapa* from Sweden; in *Brassica* spp. from Canada and in *Crambe abyssinica* var. *galacticia* from UK. In a field experiment conducted in Himachal Pradesh (India), *B. rapa* variety yellow sarson suffered maximum yield loss (27.53%), followed by *B. rapa* variety brown sarson (25.01%) and *B. juncea* (20.28%) due to Alternaria blight (Kumar, 1997). Seed yield losses due to *A. brassicae* may be greater than 50% and even the occurrence of a moderate disease may cause losses of 20% (Szopinska *et al*., 2007). Yield losses ranging from 10-75% have been reported from different parts of India. The losses were higher in yellow sarson (38-45%) followed by brown saron (26%) and mustard (17-18%) (Saharan and Mehta, 2002).

A. brassicicola (Schwein.) Wiltshire, the causal agent of Alternaria blight, black spot of crucifers and brown rot of cabbage was intercepted in a number of brassicas from several countries (Table 1); in *C. abyssinica* from USA and in *C. abyssinica* var. *galacticia* from UK. Reductions in seed yield and oil content of 38 and 14%, respectively, have been reported due to this pathogen on *B. juncea* (CAB International, 2007). It is of worldwide economic importance resulting in yield reductions upto 50% in affected crops (http://www.seedquest.com/News/releases/2007/september/20346.htm).

A. helianthi (Hansf.) Tubaki and Nishihara, causal agent of leaf blight of sunflower was intercepted in sunflower seeds from France and USA. The disease is reported to reduce seed and oil yields by 27 to 80% and 17 to 33%, respectively, leading to germination losses varying from 23 to 32% (Balasubrahmanyam and Kolte, 1980).

A. lini (Dey), the causal agent of leaf and bud blight in linseed, was intercepted in linseed seeds from France and USA. The loss due to the disease is estimated to vary from 28 to 60% in Uttar Pradesh (Singh *et al.*, 2005)

A. raphani (Groves & Skolko) [syn. *A. japonica* (Yoshii)], the Alternaria black spot fungus of crucifers was intercepted in *B. rapa* from Australia. *A. japonica* in association with *A. brassicae* can cause yield losses between 40 and 70% in certain rapeseed cultivars; alone it caused yield losses of 34-42% (CAB International, 2007).

Table 1. Pathogenic fungi and bacterium intercepted in oilseed crops during 1999-2008

Fungi/bacterium	Crop	Source/ country	No. of samples	
			Received	Found infected
Alternaria brassicae	*Brassica juncea*	Australia	263	7
		Canada	488	28
		Korea	146	4
	B. napus	Australia	287	5
	B. oleracea	Netherlands	472	11
		Taiwan	1	1
	B. oleracea var. *capitata*	Netherlands	167	6
	B. rapa	Sweden	14	2
	Crambe abyssinica var. *galacticia*	UK	2	2
A. brassicicola	*Brassica* spp.	Australia	57	11
		Belgium	1	1
		Canada	12	3
		China	4	1
		Germany	35	16
		Hungary	25	1
		Netherlands	179	13
		USA	53	24
	B. juncea	Australia	440	126
		Canada	569	367
		Korea	146	6
	B. napus	Australia	287	12
		Russia	2	1
	B. nigra	Australia	57	4
		Canada	26	1
	B. oleracea	Netherlands	484	77
		Taiwan	2	1
		UK	80	6
	B. oleracea var. *capitata*	Netherlands	167	10
	B. rapa	Australia	4	3
		Sweden	9	1
	C. abyssinica	USA	72	1
	C. abyssinica var. *galacticia*	UK	2	2
A. helianthi	*Helianthus annuus*	France	477	2
		USA	52	3
A. lini	*Linum* spp.	Russia	4	2
A. raphani	*B. rapa*	Australia	4	2
A. sesami	*Sesamum* spp.	Japan	12	1
		Sudan	1	1
		Uganda	4	1
	S. indicum	Brazil	3	2
		USA	329	1
Botrytis cinerea	*B. juncea*	Canada	80	1
		Germany	8	1
	B. oleracea var. *capitata*	Netherlands	167	1
	Carthamus spp.	Germany	9	2
Cercospora kikuchii	*Glycine max*	USA	47	1
C. sesami	*Sesamum* spp.	Uganda	4	1

Contd.

Table 1. Contd.

Fungi/bacterium	Crop	Source/ country	No. of samples	
			Received	Found infected
Colletotrichum dematium	*C. abyssinica* var. *galacticia*	UK	2	2
	G. max	Australia	2	1
		Taiwan	205	5
	H. annuus	USA	12	5
Fusarium oxysporum	*G. max*	Brazil	48	1
F. solani	*B. juncea*	Canada	50	2
	Carthamus spp.	Germany	9	1
	G. max	Taiwan	68	4
Macrophomina phaseolina	*G. max*	Taiwan	205	2
	Sesamum spp.	Sudan	1	1
Peronospora manshurica	*G. max*	Brazil	48	33
		Japan	15	1
		Taiwan	1566	21
		Thailand	9	3
		USA	2245	131
Phoma lingam	*B. juncea*	Australia	170	24
		Canada	468	7
Puccinia carthami	*Carthamus* spp.	USA	275	33
P. helianthi	*H. annuus*	Australia	80	10
		Bulgaria	2	1
		China	6	6
		Egypt	5	5
		France	1166	171
		USA	641	33
Rhizoctonia bataticola	*G. max*	Taiwan	1000	1
	Sesamum spp.	Sudan	1	1
Xanthomonas campestris pv *campestris*	*B. juncea*	Australia	313	29
		Canada	568	30
		Germany	8	7
		USA	4	1
	B. napus	Australia	287	3
		Germany	21	5

A. sesami (Kaw) Mohanty and Behera, the Alternaria blight, leaf blight fungus of sesame was intercepted on *Sesamum indicum* from Brazil and USA; in *Sesamum* spp. from Japan, Sudan and Uganda. The disease has been reported in epiphytotic form in Orissa in 1957 and Maharashtra in 1975 (Deshpande and Shinde, 1976). In Karnataka, the disease caused yield losses ranged from 0.1 to 5.7 g seeds/capsule (Siddaramaiah *et al*., 1981; Agarwal *et al.*, 2006b).

Botrytis cinerea Pers. Fr. [=*Botryotinia fuckeliana* (de Bary) Whetzel], Botrytis rot, grey mould-rot fungus was intercepted in *B. juncea* from Canada, Germany; in *B.oleracea* var. *capitata* from the Netherlamds and in *Carthamus* spp. from Germany. It is difficult to assess the damage caused by *B. cinerea*. However, economic losses of >50% may occur in many crops, depending on the prevailing environmental conditions (CAB International, 2007). Grey mould can lead to 40% loss in stored cabbage (http://www.brassicastoday.com/news.aspx?id=3bed9072-5046-46b4-a805-be8081c77189).

Cercospora kikuchii (Matsu & Tomoyasu) Gardner, a purple blotch fungus was intercepted on soybean from USA. Most of the economic losses cased by *C. kikuchii* are due to the purple seed stain phase of the disease. The incidence of purple seed stain can be as high as 50% of a seed lot (Bowers and Russin, 1999).

C. sesami (Zimm.) causes leaf spot in sesame was intercepted in *Sesamum* spp. from Uganda. Singh *et al.* (2005) reported the estimated yield losses about 5 to 20% due to Cercospora leaf spot in sesame.

Colletotrichum dematium (Pers.) Grove, the causal agent of leaf spot, leaf blight, stem spot, dieback and anthracnose was intercepted in *C. abyssinica* var. *galacticia* from UK. The anthracnose disease causes damage in warm humid areas, resulting in reduced stand, seed quality and loss of yields in soybean ranged from 26% to 100% in certain areas of Brazil and India (Sinclair and Backman, 1989). In field studies, yield loss in soybean estimated due to anthracnose was 17% for Kansas, 23% for cv. Cosoy 79 and 30% for cv. Williams 82 (Khan and Sinclair, 1992).

Fusarium oxysporum Schlecht. ex Fr. causes wilt disease was intercepted in *G. max* from Brazil. Lange *et al*. (2007) while compared the yield of wilt susceptible (cv. Canterra 1604) and resistant (cv. Cougar CL) rapeseed in Canada reported that the susceptible variety was severely affected and yielded 44% of resistant variety. Hanif *et al*. (1999) reported that chickpea wilt caused by *F. oxysporum* f. sp. *ciceris* is the most devastating disease resulting 10-50% crop loss every year in Pakistan.

F. solani (Martius) Sacc. [=*Nectria haematococca* (Wollenw.) Gerlach], the causal agent of tuber rot, sudden death syndrome of soybean, foot rot of peas and beans was intercepted in *B. juncea* from Canada; *Carthamus* spp. from Germany and *G. max* from Taiwan. *F. solani* causes substantial economic losses in all crops world over. Root rot, caused by *F. solani* f. sp. *phaseoli*, considered among the most serious and wide spread soil-borne diseases of bean with yield losses of up to 84% is attributed to this pathogen (Park and Tu, 1994).

Macrophomina phaseolina (Tassi) Goid (Syn.- *Rhizoctonia bataticola* (Taubenh.) E.J. Butler; *Sclerotium bataticola* Taubenh.), the causal agent of charcoal rot, ashy stem blight and root rot in a variety of crops was intercepted in *G. max* from Taiwan and in *Sesamum* spp. from Sudan. Yield losses of 36.8 to 79.2% have been reported in sunflower from Venezuela. Yield losses due to *M. phaseolina* in sesame have been estimated up to 57% (Singh *et al.,* 2005). A decrease of grain yield by 31 to 38% has been reported in sorghum from India due to this fungus (CAB International, 2007).

Phoma lingam (Tode ex Fr) Desm. [=*Leptosphaeria maculans* (Desm.) Ces. & De Not.], the causal agent of black leg in crucifers was intercepted in *B. juncea* from Australia and Canada. The yield losses due to *P. lingam* were usually 0-10% but could often reach 30-50% in individual fields (Zhou *et al*., 1999). The major economic losses caused by Phoma are from the stem canker disease phase. It is these cankers which can give yield loss of up to 50% in extreme cases, and frequently 0.5-1 t/ha, largely as a result of limiting seed fill due to restricted water movement from the roots and weakening the collar, causing premature ripening and also lodging (http://www.bayercropscience.co.uk/docushare/SRC/Proline_OSR_SRC_M15097.pdf).

Xanthomonas campestris pv. *campestris* (Pammel) Dowson, the causal agent of black rot in crucifers, was intercepted in *B. juncea* from Australia, Canada, Germany and USA; *B. napus* from Australia, Germany; *B. oleracea* from the Netherlands, UK; and *B. rapa* from Australia. Black rot caused 23 to 57% losses in susceptible cabbage cultivars in some regions of Russia. It is also reported that the disease appeared annually in Manipur (India) near the end of February and its effects were more severe (up to 50% losses) in susceptible cultivars of cabbage. The pathogen could survive in seeds upto 3 years (CAB International, 2007).

Infected seed samples of brassicas were salvaged through Hot Water Treatment at 50^0C for 20 min.; safflower and sunflower seeds against rust through ethyl alcohol wash for 1 min. and air dried (Agarwal *et al.*, 1990). Rest of the samples of crambe, linseed, safflower, sesame, soybean and sunflower found infected with various pathogens were salvaged by treating the seeds with Thiram + Bavistin (1:1) mixture (Dev *et al.,* 1999).

All the samples of soybean found infected with downy mildew fungus were rejected and incinerated. During examination of plates after incubation, in some cases, more than one pathogen was detected on single seed in the sample and 8.97% samples were found infected with pathogens. Data analysis on Pathogen-wise interception indicated that *A. lini* and *A. raphani* were intercepted in 50% samples followed by *A. brassicicola* (25.35%), *C. sesami* (25%), *P. carthami* (12%) and *P. helianthi* (11.89%). *R. bataticola* caused the least infection (0.19%) (Table 2 and 3).

Country-wise analysis of data on interceptions (Table 2) indicated that samples received from Belgium, Egypt and Sudan were found 100% infected; from Bulgaria and Russia with 50% infection, though the number of samples received from these countries were very less. Brazil showed 36.36% infection while over

Table 2. Country-wise distribution of pathogenic fungi intercepted in oilseed crops introduced during 1999-2008

Source/ Pathogen	A.b	A.bc	A.hel	A.lin	A.rap	A.ses	B.c	C.d	C.k	C.s	F.o	F.s	M.p	P.m	P.l	P.c	P.h	R.b	X.c.c	Total infected samples (Total samples processed)	Total infected samples (%)
Australia	12 (550)	156 (845)			2 (4)			1 (2)							24 (170)		10 (80)		34 (604)	239 (2255)	10.59
Belgium		1(1)																		1 (1)	100.00
Brazil						2(3)					1(48)			33(48)						36 (99)	36.36
Bulgaria																	1(2)			1 (2)	50.00
Canada	28 (488)	371 (607)					1(80)					2 (50)			7(468)				31 (580)	440 (2273)	19.35
China		1(4)															6(6)			7 (10)	7.00
Egypt																	5(5)			5 (5)	100.00
France			2(277)														171 (1166)			173 (1443)	11.98
Germany		16(35)					3 (17)					1(9)							18 (54)	38 (115)	33.04
Hungary		1(25)																		1 (25)	4.00
Japan						1 (12)								1(15)						2 (27)	7.40
Korea	4(146)	6(146)																		10 (292)	3.42
Netherlands	17 (639)	100 (830)					1(167)												12 (200)	130 (1836)	7.08
Russia		1(2)		2(4)																3 (6)	50.00
Sudan						1 (1)							1(1)					1(1)		3 (3)	100.00
Sweden	2 (14)	1 (9)																		3 (23)	13.04
Taiwan	1 (1)	1 (2)						5 (205)				4 (68)	2 (205)	21 (1566)				1 (1000)		35 (3047)	1.14
Thailand														3(9)						3 (9)	33.33
Uganda						1 (4)				1 (4)										2 (8)	25.00
UK	2 (2)	8(82)						2 (2)											1(80)	13 (166)	7.83
USA		25 (125)	3 (52)			1 (329)		5 (12)	1 (47)					131 (2245)		33 (275)	33 (641)		25(57)	257 (3783)	6.79
Total infected samples/ Total samples processed	66 (1840)	688 (2713)	5 (529)	2 (4)	2 (4)	6 (349)	5 (264)	13 (221)	1 (47)	1 (4)	1 (48)	7 (122)	3 (206)	189 (3883)	31 (638)	33 (275)	226 (1900)	2 (1001)	121 (1575)	1402 (15628)	8.97
Total % infected samples	3.58	25.35	0.94	50.00	50.00	1.71	1.89	5.88	2.12	25.00	2.08	5.73	1.45	4.86	4.85	12.00	11.89	0.19	7.68	8.97	

Figures outside parenthesis are No. of samples found infected and in parenthesis are total number of samples processed

A.b=*Alternaria brassicae*; A.bc= *A. brassicicola*; A.hel= *A. helianthi*; A.lin= *A. lini*; A.rap= *A. raphani*; A.ses= *A. sesami*; B.c= *Botrytis cinerea*; C.d= *Colletotrichum dematium*; C.k= *Cercospora kikuchii*; *C.s*= *C. sesami*; F.o= *Fusarium oxysporum*; F.s= *Fusarium solani*; M.p= *Macrophomina phaseolina*; P.m= *Peronospora manshurica*; P.l= *Phoma lingam*; P.c= *Puccinia carthami*; P.h= *P. helianthi*; R.b= *Rhizoctonia bataticola*; X.c c= *Xanthomonas campestris* pv. *campestris*

Table 3. Crop-wise distribution of pathogenic fungi intercepted in oil-seed crops introduced during 1999-2008

Crop/ ↓ Pathogen →	A.b	A.bc	A.hel	A.lin	A.rap	A.ses	B.c	C.d	C.k	C.s	F.o	F.s	M.p	P.m	P.l	P.c	P.h	R.b	Xcc	Total infected samples (Total samples processed)	Total infected samples (%)
Brasica spp.	64 (1838)	685 (2639)			2(4)		3 (255)					2 (50)			31 (638)				121 (1575)	908 (6999)	12.97
Crambe spp.	2 (2)	3 (74)						2 (2)												7 (78)	8.97
Carthamus spp.							2 (9)					1(9)				33 (275)				36 (293)	12.28
Glycine spp.								6 (207)	1 (47)		1 (48)	4 (68)	2 (205)	189 (3883)				1 (1000)		204 (5458)	3.73
Helianthus spp.			5(529)					5 (12)									226 (1900)			236 (2441)	9.66
Linum spp.				2(4)																2 (4)	50.00
Sesamum spp.						6 (349)				1 (4)			1 (1)					1(1)		9 (355)	2.53
Total infected samples/ Total samples processed	66 (1840)	688 (2713)	5 (529)	2 (4)	2 (4)	6(349)	5 (264)	13 (221)	1 (47)	1 (4)	1 (48)	7 (127)	3 (206)	189 (3883)	31 (638)	33 (275)	226 (1900)	2 (1001)	121 (1575)	1402 (15628)	8.97
Total % infected samples	3.58	25.35	0.94	50.00	50.00	1.71	1.89	5.88	2.12	25.00	2.08	5.73	1.45	4.86	4.85	12.00	11.89	0.19	7.68	8.97	

Figures outside parenthesis are No. of samples found infected and in parenthesis total number of samples processed
A.b=*Alternaria brassicae*; A.bc= *A. brassicicola*; A.hel= *A. helianthi*; A.lin= *A. lini*; A.rap= *A. raphani*; A.ses= *A. sesami*; B.c= *Botrytis cinerea*; C.d= *Colletotrichum dematium*; C.k= *Cercospora kikuchii*; *C.s= C. sesami*; F.o= *Fusarium oxysporum*; F.s= *Fusarium solani*; M.p= *Macrophomina phaseolina*; P.m= *Peronospora manshurica*; P.l= *Phoma lingam*; P.c= *Puccinia carthami*; P.h= *P. helianthi*; R.b= *Rhizoctonia bataticola*; X.c.c= *Xanthomonas campestris* pv. *campestris*

33% infection was detected in samples from Germany and Thailand. Samples from Taiwan showed the least infection *i.e.* 1.14%.

Crop-wise analysis of data (Table 3) indicated that highest infection of 50% samples of *Linum* spp., though the number of samples received was very less. *Brassica* spp. samples showed 12.97% infection followed by *Carthamus* spp. with 12.28%. *Sesamum* spp. samples showed least infection of 2.53% samples.

Interception of a number of pathogenic fungi and a bacterium indicated that international movement of planting material has played an important role in the spread of many seed-borne pathogens *viz*., *X. campestris* pv. *campestris* from Europe to USA in seeds of kale and cauliflower, *X. axonopodis* pv. *phaseoli* from the Netherlands to Canada in bean seeds and *Septoria linicola* from Canada to Australia etc. (Neegaard, 1977). A number of pathogenic fungi including *P. manshurica*, the downy mildew fungus of soybean which is not yet reported from India; *B. cinerea*, *C. dematium*, and *F. solani*, which have a wide host range and *P. carthami* that possesses a number of virulent races and a bacterium, *X. campestris* pv. *campestris* that also possesses a number of virulent races, were intercepted on a large number of crops during 1999-2008 while processing germplasm for quarantine clearance. If such pathogens get introduced and establish in the country, they may cause a great loss to the crop production. A thorough and critical examination of seeds and other planting material has prevented their entry into the country and is being done with utmost care.

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