Department of Plant Pathology
College of Agriculture, Rewa (M.P.)

Class : M. Sc.(Ag) Previous
Subject : **Seed Health Technology (PL.PATH 510)**
Teacher : Dr. A. K. Jain, Professor

Lect. 8 & 9. Seed certification ,tolerance limit and objectionable seed borne diseases

A true seed is defined as a fertilized mature ovule consisting of embryo, stored food material and protective coats. Seed is considered as the basic, crucial and vital input for sustainable agricultural production and enhancing productivity. It is a highly complex, biologically dormant entity composed of a living organ, food reserve, and a protective layer.

Increased globalization of agricultural markets, removal of trade barriers and trend of seed companies to amalgamate, forming large multinational companies, the production and movement of commercial quantities of seeds across and within the countries increased. It results the risk of introducing exotic diseases through imports and increased manifold. Thus seeds become both vehicle and victims of disease.

It is well known fact that infected / contaminated seeds are primary source of inoculum for a large number of destructive diseases of important food, fodder and fiber crops. Besides, affecting the yield, seed borne pathogens also affect the nutritive quality, value of seed for trading.

Now, seed trading is under International agreements of the WTO (World Trade Organization) as well as with the removal of quantitative restrictions in the imports from 1st April 2001. Thus , seed borne diseases, seed health testing and seed certification procedures has assumed greater importance.

Seed Certification

It is a legal approved system to maintain quality of seeds during seed production, post harvest operations and distribution of the seeds.

Good Quality Seed

- High genetic purity
- High germination per cent
- Minimum Inert matter, weed seed and seed of other crops
- Free from diseases
- Meets the certification standards

Seed certification for a crop comprises of legal norms for ensuring:

- ✓ Genetic purity

- ✓ Physical purity
- ✓ Germinability
- ✓ Freedom from seed transmitted pathogen and weeds.

- **Objectives** of seed certification is to ensure the supply of quality seed to the farmers and to protect the interest of seed traders
- To ensure genuineness and quality seed of notified varieties to the purchaser
    - To maintain varietal purity and identity
    - To maintain reasonable standards of other seed quality parameters
        - Weeds,
        - Diseases
        - Viability
        - Mechanical purity

Over all procedure of seed certification involves **4 steps:**

I. Verification of seed source for raising seed crop

II. Crop inspection to verify conformity of seed standard

III. Seed testing

IV. Post harvest supervision

Principles of Seed Certification Agency

- It should not be involved in seed production
- It should have autonomy
- The standard and procedure should be uniform throughout the country
- Its long term objective should be operated on a no-profit no-loss basis
- It should be closely associated with the technical institute
- It should have provision for creating adequate facilities for ensuring timely and thorough inspection

Steps in Certification (as per Section 8 of Seed Act 1966 and Seed Rules 1968)

- Application for seed certification
- Seed certification fee deposition
- Inspection of seed fields
- Rejecting/accepting the fields
- Inspection of the seed processing
- Seed sampling
- Tagging and sealing
- Control of plot testing
- Conditions for inter-cropping
- Extension of validity period
- Appeal against certification agency

Minimum seed certification standards

A. General

Eligibility requirement for certification:

- It must be notified variety
- Source of seed : NS → BS → FS → CS
- Field area for certification: Not fixed
- Unit area for certification: 10 ha
- Field inspection: Without notice
- Re-inspection
- Seed processing and packing schedule
- Seed standard of genetic purity
- Foundation seed 99%
- Certified seed
- i. Varieties, composite, synthetics and multiline 98%
- ii. Hybrids 95%
- Reclining, re-sampling and retesting
- Seed standards for insect damage
- Seed moisture contents
- Specification of the tags

Certified	15 cm × 7.5 cm	Blue (ISI No 104 Azure blue)
Foundation	15 cm × 7.5 cm	White
Breeder	12 cm × 6 cm	Golden Yellow (No. 356)

- Packing tagging sealing and issuance of certificate
- Refusal for certificate
- Validity period of the certificate
- Revocation of the certificate

Retention of certificate records

B. Specific

a) Field standards

- Preceding crop
- Isolation
- Number of field inspections
  - Self pollinated crops 2
    - Flowering
    - Maturity
  - CP and OCP crops 3
    - Before flowering
    - Flowering
    - Maturity
    - Seed bin inspection
  - Cole vegetable/Lettuce 3
    - Before marketable stage
    - After head formation
    - At flowering stage
- Off types
  - Objectionable weeds (OW)

- Inseparable other crop plants (OCP)
- Disease infected plants

b) Seed Standards

- The minimum percentage of pure seed
- The maximum permissible limits of
- Inert matter
- Other crop seeds
- Weed seeds
- Objectionable weed seeds
- Seed infected by seed born diseases
- Seeds of other distinguishable varieties
- Moisture content

ISTA (International Seed Testing Association) and **AOSCA** (Association of Official Seed Certifying Agencies) introduced Minimum Seed Certification Standards (MSCS) for each crops. It involves:

- Genetic purity and quality of seed production in the field during harvest, processing, storage and finally inspection in the market.
- Quality control for seed transmitted diseases at seed stage and seed standards (tolerance limit) were fixed.

The MSCS prescribed the maximum permissible levels for certain designated seed borne diseases i.e

- The percentage of affected plants in the seed crop (field standards)
- Infected seeds in the seed lots (seed standards)

Seed Health Standards for seed borne diseases are available only in 43 crops for 59 fungal, 17 bacterial, 14 viral and 1 phytoplasma diseases.

Threshold value : It is the level of infection on or in the seed that will significantly affect disease development and results in economic loss.

Tolerance value : It is the permissible level of seed contamination or infection, beyond which the economic loss will occur.

Field standards : Percent plant infected in a seed production plot by seed borne pathogens is referred as **Field standards.** If disease incidence is within the permissible limit (tolerance value), then the seed production plot is accepted for seed purpose. The results are expressed as *"% plant infected".*

Seed Standards : Percent seed infection by number in a seed lot by seed borne pathogens in prescribed limit is referred as Seed standards. The results are

expressed as *"% seed infection by number*". The analysis of seed standards is done by a qualified seed analyst in lab.

Example Karnal bunt of wheat (0.05 and 0.25%) Kernel smut (bunt) of rice (0.10 and 0.50%), Ear cockle (zero% tolerance).

Table 1.1: Designated objectionable seed borne diseases at seed crop (in field stage) and in seed lots (in samples) (Tunwar and Singh, 1988; Kumar and Vari, 2006)

Group	Objectionable disease		
	Crop	Seed crop (Field)	Seed lot (sample)
Field crops			
Cereals	Wheat	Loose smut	Ear cockle, Tundu
		-	Karnal bunt
	Rice and hybrids	-	Bunt (Kernel smut)
	Sorghum	Kernel smut, Head smut	Ergot
	Barley	Loose smut	-
	Oat	Loose smut	-
	Pearl millet	Ergot	Ergot
		Grain smut	-
		Downy mildew / green ear	-
	Triticale	Ergot	Karnal bunt
Oilseed crops	Sesame	Cercospora leaf spot	-
	Sunflower and hybrids	Downy mildew	-
Pulses	Green gram	Halo blight	-
Fiber	Jute	Jute chlorosis	-
Forage	Sudan grass	Kernel smut	
	sorghum	Head smut	
Spice	Ginger	Rhizome rot	-
		Phyllosticta leaf spot	Phyllosticta
		Bacterial wilt	Dry rot
	Turmeric	Rhizome rot	-

Table 1.2: Designated objectionable seed borne diseases at seed crop (in field stage) and in seed lots (in samples) Tunwar and Singh, 1988; Kumar and Vari, 2006)

Group	Objectionable disease		
	Crop	Seed crop (Field)	Seed lot (sample)
Vegetables			
Beans	Cowpea	Ashy stem (Macrophomina)	-
		Anthracnose	
		Ascochyta blight (for Hills)	-
		Cowpea mosaic	-
	French & Indian bean	Bacterial blight	-
		Anthracnose	-
		Ascochyta blight (for Hills)	-
		Bean mosaic	-
	Cluster bean	Bacterial blight	-
		Ascochyta blight (for Hills)	-
Cucurbits	Musk melon & hybrids	Cucumber mosaic virus	-
	Summer squash	Cucumber mosaic virus	-
		Watermelon mosaic virus	-
Solanaceae	Eggplant and Hybrids	Phomopsis blight & fruit rot	-
	Chilli	Alternaria leaf blight	-
		Anthracnose	-
	Tomato	Early blight	-
		Stemphylium leaf spot	-
		Tobacco mosaic virus	-
Leafy	Celery	Septoria leaf blight Phoma root rot	-
	Celeriac (turnip rooted celery)	Septoria leaf spot	-
	Lettuce	Lettuce mosaic virus	-
	Parsley	Septoria leaf spot	-
Cole crops	Cabbage, cauliflower, broccoli, knoll-kohl, Chinese cabbage, turnip, radish	Black leg Xanthomonas black rot Erwinia soft rot	- - -
Ornament flower crop			
Flower	Annual carnation	Streak mosaic	-
	Snap dragon & hybrid	Anthracnose	-
		Phyllosticta blight	-
	Chrysanthemum	Botrytis grey mould	-
		Septoria blight	-
	Petunia	Alternaria leaf blight	-
		Phytophthora crown rot	-
	Petunia hybrid	Cercospora leaf blotch	-
		Ascochyta leaf spot	-
		Phyllosticta leaf spot	-
		Alternaria leaf blight	-
		Phytophthora crown rot	
		Tobacco mosaic virus	-
		Cucumber mosaic virus	-

Group	Objectionable disease		
	Crop	Seed crop (Field)	Seed lot (sample)
Vegetables			
	Sunflower and hybrids	Downy mildew	-
		Orobanchy infestation	Orobanchy
	Marigold and hybrids	Alternaria leaf spot	-
		Alternaria flower bud rot	-
		Rhizoctonia collar rot	-

Table 1.3: Designated objectionable seedborne diseases at seed crop (in field stage) and in seed lots (in samples) Tunwar and Singh, 1988; Kumar and Vari, 2006)

Group	Objectionable disease		
	Crop	Seed crop (Field)	Seed lot (sample)
Vegetables			
Others	Multiplier onion (potato onion)	-	Pseudomonas brown rot
			Erwinia soft rot
			Fusarium basal rot
Potato	Potato	-	Phytophthora
			Late blight, Fusarium dry rot or charcoal rot Macrophomina
		Mild mosaic	-
		Severe mosaic, leaf roll, yellows	-
		Bacterial wilt	-
		-	Sclerotial wet rot
		-	Common scab
		-	Black scurf
	True potato seed	Mild mosaic	
		Severe mosaic, leaf roll, yellows	-
		Brown wilt	-
	Potato tissue culture	Mild mosaic	-
	Raised mini tuber	Severe mosaic, leaf roll, yellow and apical leaf curl	-
		Brown rot syn. bacterial wilt	-
Sugarcane	Sugarcane	Red rot	-
		Smut	-
		Wilt	-
		Grassy shoot	-
		Leaf scold	-
Sweet potato	Sweet potato		
	Plant bed	Black rot	Storage and Black rot
		Wilt	Wilt
			Internal cork virus
		Scurf	Scurf
	Seed bed	-	Nematode
		Fusarium wilt	-

Group	Objectionable disease		
	Crop	Seed crop (Field)	Seed lot (sample)
Vegetables			
		Mosaic	-
	Taro (arvi)	Phytophthora rot	-
		Dasheen mosaic	-
	Tapioca (cassava)	Mosaic	-

Table 2: Designated seed borne diseases and permissible limits for seed crop of field crops at field stage (Tunwar and Singh, 1988)

Crop group	Disease/causal organism	Field standard (%)	
		Foundation	Certified
Cereal			
Wheat	Loose smut (*Ustilago tritici*)(=*Ustilago segatum* var. *tritici*)	0.10	0.50
Sorghum	Kernel smut (*Sphacelotheca* sp. =*Sporisorium sorghi*) Head smut (*Sphacelotheca reiliana* = (*Sporisorium reiliana*)	0.050	0.10
Barley	Loose smut (*Ustilago nuda* = *Ustilago segatum* var. *nuda*)	0.10	0.50
Oat	Loose smut (*Ustilago nuda* = *Ustilago segatum* var. *avenae*)	0.10	0.50
Pearl millet	Grain smut (*Tolyposporium penicillariae*)	0.050	0.10
	Downy mildew/Green ear (*Sclerospora graminicola*)	0.050	0.10
	Ergot (*Claviceps microcephala* = *C. Fusiformis*)	0.020	0.040
Triticale	Ergot (*Claviceps purpurea*)	0.020	0.040
Oil Seed			
Sesame	Leaf spot (*Cercospora sesami*)	0.50	1.0
Sunflower and hybrids	Downy mildew (*Plasmopara halstedii*)	0.050	0.50
Pulses			
Green gram	Halo blight (*Pseudomonas phaseoli* = *P. syringe* pv. p*haseolicola*)	0.10	0.20

Table 3: Designated seedborne diseases and permissible limits for seed crop of vegetables at field stage (Tunwar and Singh, 1988)

Crop group	Disease / causal organism	Field standard (%)	
		Foundation	Certified
Bean legume vegetable			
Cowpea	Ashy stem (*Macrophomina phaseolina*) Anthracnose (*Colletotrichum lindemuthianum*) Blight (*Ascochyta phaseolorum*) (for hill region only) Cowpea mosaic	0.10	0.50
French and Indian bean	Bacterial blight (*Xanthomonas* spp.) Anthracnose *Colletotrichum lindemuthianum*) Blight (*Ascochyta* sp.) (for hill region only) Bean mosaic	0.10	0.20
Cluster bean	Bacterial blight (*Xanthomonas* spp.) Blight (*Ascochyta rabiei*) (for hill region only)	0.10	0.20
Cucurbits			
Musk melon and hybrids	Cucumber mosaic virus	0.10	0.20
Summer squash	Cucumber mosaic virus (CMV) Watermelon mosaic virus (WMV)	0.10	0.50
Solanaceous vegetables			
Eggplant and hybrids	Blight and fruit rot (*Phomopsis vexans*)	0.10	0.50
Chilli	Leaf blight (*Alternaria solani*) Anthracnose (*Colletotrichum capsici*)	0.10	0.50
Tomato	Early blight (*Alternaria solani*) Leaf spot(*Stemphylium solani*) Tobacco mosaic virus	0.10	0.50
Potato	See Table -4		
Leafy Vegetables			
Celery	Leaf blight (*Septoria apicola*) Root rot (*Phoma apicola*)	0.10	0.50
Turnip rooted celery	Leaf spot (*Septoria petroselini*)	0.10	0.50
Lettuce	Lettuce mosaic virus	0.10	0.50
Parsley	Leaf spot (*Septoria petroselini*)	0.10	0.50
Cole crops			
Cabbage, cauliflower, Broccoli, Knol-khol, Chinese cabbage, Turnip, Radish	Black leg (*Lephosphaeria maculans*) Black rot (*Xanthomonas campestris* pv. *campestris*) Soft rot (*Erwinia caratovora* subsp. *carotovora*)	0.10	0.50
Other			
Sweet potato Plant bed	Black rot (*Ceratostomella fimbricata*)	0.0	0.0
	Wilt (*Fusarium oxysporum* fsp. *batatas*)	0.0	0.0
	Scurf (*Monilichates infuscans*)	0.0	0.0
Seed bed	Wilt (*Fusarium oxysporum*)	0.050	0.10

Crop group	Disease / causal organism	Field standard (%)	
		Foundation	Certified
	Mosaic		
Taro (Arvi)	Phytophthora rot (*Phytophthora colocasiae*)	0.0	0.00
	Dasheen mosaic	0.50	0.10
Tapioca (Cassava)	Mosaic	0.10	0.50

Table 4: Designated seedborne diseases of potato and TPS and the permissible limits for seed crop at field stage (Tunwar and Singh, 1988; Kumar and Vari, 2006)

Disease/causal organism	Stage	Maximum permissible limits %		
		Foundation		Certified
		Stage I	Stage II	
Potato				
Mild mosaic	I and II inspection	1.0	2.0	3.0
Severe mosaic, leaf roll and yellows	I and II Inspection	0.50	0.750	1.0
*Total virus	-	1.0	2.0	3.0
**Bacterial wilt (*Pseudomonas solanacearum*)	I and II Inspection	0.0	0.0	3 plants/ ha
True Potato Seed				
Mild mosaic	-	-	-	3.0
Severe mosaic, leaf roll and yellows	-	-	-	1.0
Brown wilt (*Pseudomonas solanacearum*)	-	-	-	3 plants/ ha
Potato tissue culture raised mini tuber (PTCMT)				
Plants showing symptoms				0.05%
*Mild mosaic *Severe mosaic, leaf roll, yellows and apical leaf curl				0.05%
**Plant infected with brown rot (*Ralstonia solanacearum*) Syn. Bacterial wilt				0.0

* Maximum permitted before dehalming

**To maintain the crop hygiene, the disease must be watched

All diseased plants should be rouged out along with tubers.

(A.) A crop pf seed potato or true potato seed hybrids shall not be eligible for certification if grown on land infested with wart (*Synchytrium endobioticum*), brown rot (*Ralstonia solanacearum*), common scab (*Streptomyces scabies*)or non-cyst forming nematode within previous three years .

(B.) Of the two inspection , the higher virus percentage will be considered for the purpose of the specified limits of tolerance

(C.) The presence of brown rot infected plants within the specified limits of tolerance shall be permitted in the areas known to be infected with the disease. In case of

plants suspected to be infected with brown rot, the neighboring plants, one or either side should also be roughed along with tubers.

(D.) All diseased plants should be roughed out along with the tubers and be destroyed.

Stage .I. First inspection 35 days after planting in the hills and 45 days after planting in the plains.

Stage. II. Second inspection 60-65 days after planting for early varieties and 70-75 days after planting for late varieties.

Table 5: Designated seed borne diseases and permissible limits for fiber forage and spice crops at field stage (Tunwar and Singh, 1988; Kumar and Vari, 2006)

Crop group	Disease/causal organism		Field standard (%)	
			Foundation	Certified
Fiber				
Jute	Chlorosis virus		1.0	2.0
Forage				
Sudan grass Forage sorghum	Kernel smut (*Sphacelotheca* sp. = *Sporisorium sorghi*) Head smut (*Sphacelotheca reiliana* = *Sporisorium reilianum*)		0.050	0.10
Spice		Inspection stage		
Ginger*	Rhizome rot	I	0.0	0.0
	Phyllosticta leaf spot (*Phyllosticta* sp.)	II	1.0	5.0
	Bacterial wilt (P*seudomonas solanacearum* = *Ralstonia solanacearum*	III	1.0	1.0
Turmeric*	Rhizome rot	I	0.0	0.0

Note:

Ginger : Planting should be avoided, if soil is infested with *Pythium* sp., *Pseudomonas solanacearum* (=*Ralstonia solanacearum*) and root knot (*Meloidogyne incognita*). First inspection at the time of planting, second after 45-125 days after planting and third inspection shall be made about 180-190 days after planting, fourth inspection shall be mad before harvest or between 240-250 days after planting. Inspections are made to verify the presence of disease and other parameters.

Turmeric: The crop of seed turmeric shall not be eligible for certification if grown on the land infested with *Pythium* sp., *Pseudomonas solanacearum* and *Meloidogyne incognita*. A minimum four inspection shall be made first inspection at the time of planting, second inspection at 45-50 days after planting, third at 120-180 days after planting and fourth inspection before harvest or between 240-250 days.

Table 6: Designated seed borne diseases and permissible limits for seed crop of ornamental flower plants at field stage (Kumar and Vari, 2006)

Crop group	Disease/causal organism	Field standard (%)	
		Foundation	Certified
Annual carnation (Magurite or Chaubad type) (*Dianthus caryophyllus*)	Streak mosaic virus (at third and final inspection before (harvesting) capsule start opening (shattering)	0.10	0.20
Snap dragon (*Antirrhinum* spp.) and hybrids	Anthracnose (*Colletotrichum antirrhini* and *C. fusaum*) Blight (*Phyllosticta antirrhimi*) (at final stage of inspection (III) prior to harvesting)	0.10	0.20
Annual chrysanthemum (*Chrysanthemum* spp.)	Grey moulds (*Botrytis cinerea*) Blotch (*Septoria chrysanthmella*) (at final stage of inspection (III) prior to harvesting)	0.10	0.20
Petunia (*Petunia* spp.)	Leaf blight (*Cercospora petuniae*) Leaf spot (*Ascochyta petuniae*) Leaf spot (*Phyllosticta petuniae*) Leaf blight (*Alternaria alternata*) Crown rot (*Phytophthora parasitica*) Tobacco mosaic virus (TMV) Cucumber mosaic virus (CMV) (at third and final inspection before harvesting)	0.10	0.20
Ornamental sunflower (*Helianthus* spp.)	Downy mildew (*Plasmopara halstedii*) at each three inspection Plants infested with *Orobanchy cumana* (at final third inspection) (First inspection at the stage of 6-7 pair of leaves, second inspection during flowering and third at maturity and prior to harvesting)	0.050 None	0.050 None
Ornamental sunflower (*Helianthus* spp.) hybrids	Downy mildew (*Plasmopara halstedii*) at each four inspection Plants infested with *Orobanchy cumana* (at final fourth inspection)	0.050 None	0.050 None
Marigold (*Tagetes* spp.) and hybrids	Leaf spot (*Alternaria tagetics*) Flower bud rot (*Alternaria alternate* and *Alternaria dianthi*) Collar rot (*Rhizoctonia solani*) (At final (III) inspection I marigold and at final (IV) inspection in hybrids crop maturity stage)	0.10	0.20

Table 7: Designated seed borne diseases and permissible limits for seed crop of sugarcane at field stage (Kumar and Vari, 2006)

Crop	Disease / causal organism	Inspection stage	Field standard (%)	
			Foundation	Certified
Sugarcane	Red rot (*Glomerella tucumensis*)	I, II, III	0.0	0.0
	Smut (*Ustilago scitaminea*)	I II III	0.02* 0.01* 0.0	0.01* 0.10* 0.0
	Wilt (*Cephalosporium sacchari*)	III	0.01*	0.01*
	Grassy shoot (Mycoplasma-like-organism)	II III	0.05* 0.0	0.50* 0.0
	Leaf scald (*Xanthomonas albilineans*)	II III	0.01* 0.0	0.05* 0.0

*Subject to immediate roughing of the whole clump

Note: All off types and diseased plants shall be ranged at along with roots and destroyed.
Inspection stage: Stage I at 45-60 days after planting, II at 120-130 days after planting, III 15 days prior to harvest of seed cane.

Table 8: Designated diseases and their maximum permissible limits for standards in seed lots (Tunwar and Singh, 1988; Kumar and Vari, 2006)
(Seed standard = Maximum percent of infected seed by number)

Crop group	Disease/causal organism	Field standard (%)	
		Foundation	Certified
Cereal Crops			
Rice and hybrids	Bunt (Kernel smut) (*Neovossia horrida*)	0.10	0.50
Wheat	Ear cockle (*Anguina tritici*) Tundu (*Corynebacterium michigansis = Clavibacter tritici*)	0.00	0.00
Triticale	Karnal bunt (*Neovossia indica*)	0.050	0.250
Sorghum	Ergot (*Claviceps purpurea = Claviceps sorghi*)	0.02	0.040
Pearl millet	Ergot (*Claviceps fusiformis = Claviceps microcephala*)		
Vegetables crops			
Sweet potato	Storage rots	0.0	0.0
	Scurf (*Monilichates infuscans*)	0.0	0.0
	Wilt (*Fusarium oxysporum* fsp. *batatas*)	0.0	0.0
	Block rot (*Ceratostomella fimbricata*)	0.0	0.0
	Internal cork virus (ICV)	5.0	5.0
	Nematode	0.0	0.0
Multiplier onion	Bacterial brown rot (*Pseudomonas*	0.0	0.0

Crop group	Disease/causal organism	Field standard (%)	
		Foundation	Certified
(potato-onion)	*acruginesa*)		
	Bacterial soft rot (*Erwinia caratovora* subsp. *caratovona*)	0.0	0.0
	Basal rot (*Fusarium oxysporum* f. *cepae*)	0.0	0.0
Potato	See Table -10		
Flower plant			
Ornamental sunflower and hybrids	Seed infested with *Orobanchy cumana*	0.0	0.0
Spice crop			
Ginger	Dry rot	1.0	5.0
	Phyllosticta	5.0	10.0
Turmeric	Dry rot	1.0	5.0

Table 9: Designated seed borne diseases for seed crop of banana and grape at field stage (Kumar and Vari, 2006)

Crop	Disease / causal organism	Inspection stage	Field standard (%)	
			Foundation	Certified
Banana	Bunching top, Nematode, Panama disease *Note : Mother plant should be healthy (free from diseases) certificate be given to nurseries*	Minimum one inspection at the time of fruit maturity for health of mother plant	Not specified	Not specified
Grape	Nematode and anthracnose *Note : Mother plant/scion be healthy (free from diseases)*	Minimum one inspection at the time of fruit maturity for health of mother plant	Not specified	Not specified

Table 10: Designated seedborne diseases of potato and their maximum permissible limits for standard in seed lots (Tunwar and Singh, 1988; Kumar and Vari, 2006)

Disease / causal organism	Maximum permissible limits % (by number)		
	Foundation		Certified
	Stage I	Stage II	
Late blight (*Phytophthora infestans*), Dry rot (*Fusarium caeruleum*) or Charcoal rot (*Macrophomina phaseolina*)	1.0	1.0	1.0
Wet rot (*Sclerotium rolfsii*)	0.0	0.0	0.0
*Common scab (*Streptomyces scabies*)	3.0	3.0	5.0
**Black scurf (*Rhizoctonia solani*)	5.0	5.0	5.0
***Total disease	5.0	5.0	5.0

* Even if a single tuber infected with common scab is detected in a seed lot, the entire seed lot shall be treated with approved fungicide before seed lot is declared fit for certification. Seed lots having infected tubers more than the prescribed limits will not be certified even after treatment.

** (a) A tuber carrying 10% or above scurfed surface will be considered as one infected unit.
(b) Seed lot having black scurf infection more than the prescribed limits could be certified after treatment with approved chemical fungicide.

*** For all diseases, the higher disease percentage will be considered for the purpose of the specified limits of tolerance.

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Difference Between Seed and Grains

Seed	Grain
Result of planned programme	Part of the commercial produce
Scientific effort is needed	No need of scientific effort
Pedigree is ensured	Varietal purity is unknown
Roguing is to be done	No such effort is made
Field inspection is essential	No need of field inspection
Processed, treated, packed, labeled with proper lot identity	Manually cleaned and some time treated at the time of sowing
Seed testing is required	No seed testing is to be done
Seed quality is essential part	No such standard is applied

Department of Plant Pathology
College of Agriculture, Rewa (M.P.)

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Teacher : Dr. A. K. Jain, Professor

Lecture 10 -Symptoms of diseases caused by designated objectionable seed borne pathogens

1. Loose smut of wheat

Common name of the disease: Loose smut of wheat

Causal organism *:* *Ustilago segetum* var. *tritici*

Major symptoms: Diseased seeds cannot be differentiated from normal healthy seeds. The earheads are converted into dark brown powdery mass (teliospores-smut spores). Spores are dispersed by wind leaving behind naked rachis.

Nature of the disease : Exclusively internally seed borne

Location of the pathogen : Pathogen survives in the seed as dormant mycelium, may be present in pericarp, aleurone layer, and endoderm

Mode of infection / spread: Through seeds, new infection takes place through infection by germinating teliospores, lodged on the flowers. Infected seeds give rise diseased earheads, quite early, as compared to healthy ones. This serves as source of inoculum/foci.

Detection techniques : Embryo count method under stereoscopic binocular microscope.

Certification standard : Foundation - 0.10 %, Certified 0.50% plant infection

Isolation distance of 150 m is recommended from the field of wheat infected by loose smut disease.

Management : Seed treatment with hot water, solar heat treatment, ST with *Trichoderma viride, T. harzianum* @ 4-6 g kg^{-1} seed.

- ST with Carboxin, Carbendazim, mixture of Carboxin + Thirum, Carbendazim + Mancozeb @ 2 g kg^{-1} seed.

Roughing -careful removal of infected ear head avoids spread of teliosopres of the fungus.

Loose smut of wheat

2. Head smut of sorghum

Common name of the disease: Head smut of sorghum

Causal organism: *Sporisorium sorghi* (*Sphacelothica reliana*)

Major symptoms: Infected earhead is modified / converted in to a gall. It is first covered with a grey membrane of fungal tissue. Black brown spores of smut spores are exposed and liberated / blown out. Spores are embedded in a long thin dark brown filament, which are the vascular bundles of earhead. No individual floret is converted into smut sori, but the whole earhead is modified into smut spores.

Nature of the disease: Seed and soil borne.

Location of the pathogen: Smut spores are adhered on the seed surface**.**

Mode of infection / spread: Infected seeds give rises the diseased seedling and infects growing points. No infection takes place once the shoot comes out from the soil.

Detection techniques: seed wash test**,** observation of seed under microscope for adhered smut spores

Certification standard: Foundation - 0.050 %, Certified 0.10% plant infection

Management: Use disease free seed, deep sowing be avoided,

Removal of infected heads from the field.

- ST with *Trichoderma viride, T. harzianum* @ 4-6 g kg^{-1} seed.
- ST with Carboxin, Carbendazim, mixture of Carboxin + Thirum, Carbendazim + Mancozeb @ 2 g kg^{-1} seed.

- ST & FS of Triozol (Triadiminol) @ 0.2% at 5-7 days interval.
- Resistant varieties: CSH 9, SPV 102, 104, 115, 245, Jawahar Jowar 8, 1022,1041

Head smut of sorghum

3. Downy mildew of Pearl millet

Common name of the disease: Downy mildew of Pearl millet

Causal organism : *Sclerospora graminicola*

Major symptoms: Floral parts are transformed into green leafy structure, earheads remain green, white downy growth of the fungus observed underside of the leaf under humid condition.

Nature of the disease : Seed and soil borne

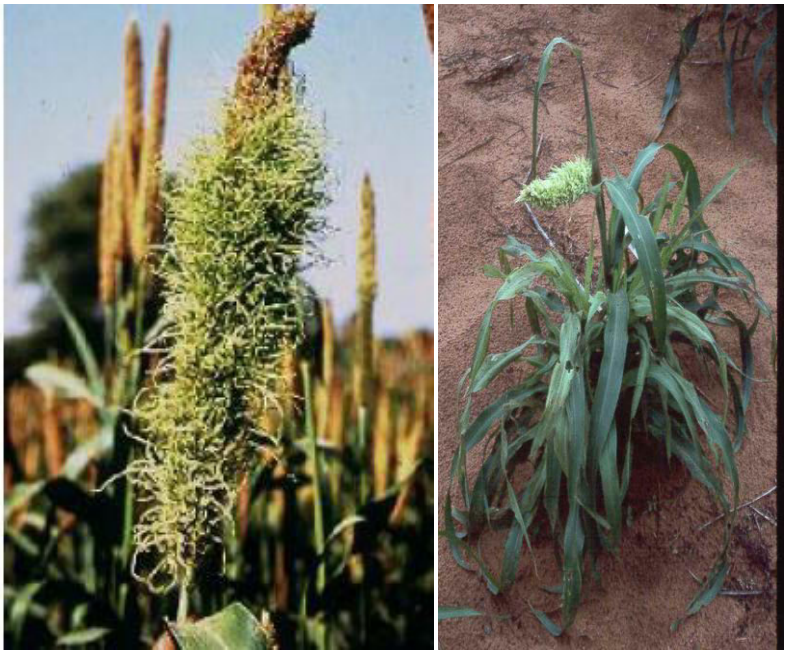
Location of the pathogen : Externally seed borne. Oospores are adhered on the surface of the seed.

Mode of infection / spread: Through seeds, new infection takes place through infection by germinating oospores present in the soil. Systemic infection results in variation of the symptoms. Oospores can survive upto 10 years in the soil.

Detection techniques : Seed carried oospores are detected by seed wash test

Certification standard: Foundation - 0.050 %, Certified 0.10% plant infection

Management: Use disease free seed, Hot water treatment : 55^0C for 10 min. seed treatment with Ridomil MZ or Apron 35 DS 6 g per kg seed, foliar application of Metalxil or Mancozeb (0.2%), use of open pollinated var. e.g. WC- C75, ICM 7703, ICTP 8023, ISMV 155 form ICRISAT, Hyderabad.



Downy mildew of pearl millet

4. **Downy mildew of sunflower**

Common name of the disease: Downy mildew of sunflower

Causal organism: *Plasmopara halstedii*

Major symptoms: Under cool and moist conditions, the infected seed produce infected seedlings, which are killed by whitish downy growth of the fungus. In systemic infection, extreme stunting is observed, venial chlorosis, downy growth, thickening of leaves, erect and sterile head.

Nature of the disease: Seed and soil borne.

Location of the pathogen: Oospores present on the seed surface, within the pericarp

Mode of infection / spread: Through infected seed**.** Oospores present in the soil from the preceding crop or through seed cause primary infection**.**

Detection techniques: Seed wash test.

Certification standard: Foundation - 0.050 %, Certified 0.50% plant infection

Management: Use disease free seed, optimum plant spacing 60x45 or 45x 30, shallow sowing not desirable, seed treatment with Ridomil 0.3% or Apron 0.6% with foliar application offers best promise.

Downy mildew of sunflower

5. Grain smut of pearl millet

Common name of the disease: Grain smut of pearl millet

Causal organism: *Tolyposporioum penicillariae*

Major symptoms: Florets in an earhead are transformed into smut sori (spore sac) containing powder of smutted spores. The infected seed become grey or creamy colored and then brown. The infected seeds are easily broken, spilling out thousand of black spore balls of smut fungus.

Nature of the disease: Seed and soil borne.

Location of the pathogen: Smut balls /spores are adhered on the seed surface. Whole seed is converted into spore sac.

Mode of infection / spread: Through infected seeds carrying the spores. New infection is caused by the germinating smut spores fallen on the ground**.**

Detection techniques: Under microscope observation for the associated adhered spores; seed wash test; immersing seed in water, lighter seed with sori float on the surface and then counted.

Certification standard: Foundation - 0.050 %, Certified 0.10% plant infection

Management: Use disease free seed and seeds from healthy fields, removal of infected plants to reduce the inoculum. ST with *Trichoderma viride, T. harzianum* @ 4-6 g kg^{-1} seed.

- ST with Carboxin, Carbendazim, mixture of Carboxin + Thirum, Carbendazim + Mancozeb @ 2 g kg^{-1} seed.
- For grain smut, Fs of Carbendazim or Tebuconazol @ (1%) is recommended.
- Resistant varieties : Jawahar Bajra 2, MH 179, MBH 188, WCC 75, JBV 3, 4

Grain smut of pearl millet

6. Ergot of pearl millet

Common name of the disease: Ergot of pearl millet, sugary disease

Causal organism: *Claviceps fusiformis* (= *C. microcephala*)

Major symptoms: Diseased florets exude the droplets of pink or honey coloured sticky liquid, which turn darker. Under advanced conditions these infected florets are transformed into straight or cured brown hard structure called sclerotia. These transformed florets attain large size as compared to normal seeds.

Nature of the disease: Sclerotial bodies (ergot) are mixed with seeds. Disease observed as concomitant contamination.

Location of the pathogen: The whole embryo is transformed into sclerotia (ergot).

Mode of infection / spread: Through admixed of seed. Sclerotia take about 40 days to germinate and it is coincided with the flowering of host crop. The soil rested sclerotia forcibly produce spores, which attack the flower of the plant, and infection takes place.

Detection techniques: Visual observation of ergot. Detection is done along with purity test of 2500 seeds.

Certification standard: Foundation - 0.02 %, Certified 0.04% plant infected cobs. The hybrids and open pollinated crop should not have *Claviceps fusiformis* at the time of final inspection.

Management: Use disease free seed and seeds from healthy fields, removal of infected plants to reduce the inoculum.

- Crop rotation with leguminous crops.
- Intercropping with pulses (Red gram).
- Early sown crops escapes as compared to late sown crops.
- Use of 10% brine solution to separate sclerotia.
- FS with Ziram or a mixture of Copper oxychloride + Zineb (1:2), applied 2-3 times at 5-7 days interval started prior to earhead emergence.
- FS of Captan (0.2& is also effective.
- Soil application of *T. viride* @ 500g/acre
- Resistant varieties: HB 5, BD 763, MBH 110, PSB 8,JBB 4

Ergot of pearl millet

Ergot of sorghum

7. Ergot of sorghum

Common name of the disease: Ergot of sorghum

Causal organism: *Claviceps sorghi*

Major symptoms: The field symptoms are alike ergot of Pearl millet .At flowering, the disease spikelets (florets) exude the droplets of pink coloured sticky liquid (like honeydew). The sticky liquid contains thousands of fungal spores. Later the

liquid turn darker, cover large area of the inflorescence. After some times the infected florets turn into straight or curved, cremate light brown horny structure. These horny hard structures are sclerotia (ergot). The floral ovary is transformed into the sclerotial body.

Nature of the disease: The sclerotia bodies (ergot) are mixed with seeds as admixture. The sclerotia are compact hard structure of mycelial mat.

Location of the pathogen: The whole floral ovary is transformed into ergot.

Mode of infection / spread: The ergot reaches the soil with seeds during sowing. It takes about 30-40 days to germinate, which coincide with flowering stage of the host plant. The soil -rested sclerotia germinate and produce ascospores and forcedly ejected towards the developing florets. Upon landing, these spores infect the floret, germinate and lead to honey dew stage. Insect feed on the honey liquid and helps in the spread of the pathogen.

Detection techniques: Visual observation or use of magnifying glasses for the presence of sclerotia in seeds.

Certification standard: The seed standards for Foundation and Certified seeds are 0.020 and 0.040 % with partial or entirely modified broken or ergotted seeds by number.

Management: Use clean ergot free seeds, Repeated deep ploughing reduces the viability of sclerotia. At honeydew stage, infected heads must be removed from the field.

- Crop rotation with leguminous crops.
- Intercropping with pulses (Red gram).
- Early sown crops escapes as compared to late sown crops.
- Use of 10% brine solution to separate sclerotia.
- FS with Ziram or a mixture of Copper oxychloride + Zineb (1:2), applied 2-3 times at 5-7 days interval started prior to earhead emergence.
- FS of Captan (0.2& is also effective.
- Soil application of *T. viride* @ 500g/acre
- Resistant varieties: CSH 3,6,9, GSH 1, CSV 4,10, CO 25, Swati

8. Halo Blight of Mung bean

Common name of the disease: Halo Blight of Mung bean

Causal organism: *Pseudomonas syringe* pv. *phaseolicola*

Major symptoms: On the under side of the leaves, translucent water soaked appear at the initial stage .The central dry dead portions of leaf spot are surrounded by yellow green halo portion .the halo effect tends to disappear when air temperature rises. The leaves or entire plant dry quickly with upper leaves crinkled and mottled.

Nature of the disease:

Location of the pathogen:

Mode of infection / spread: the disease is transmitted through seed, wind blown rains irrigation water, insect and men. Favored by cool conditions. Infected seed give rise the diseased seedling and it spread to the adjoining plants. Above 28 C no symptoms develop.

Detection techniques: Grow out test, serodigonostic methods, ELISA

Certification standard: Foundation - 0.10 %, Certified 0.20%. Infected plants

Management: Use disease free seed and seeds from healthy fields, removal of infected plants to reduce the inoculum. Ensure seed production in areas with high temperature and low moisture. Formulation of copper fungicide incorporated with streoptocycline provides protection to limited extent.

Halo blight of mung bean

9. Cercospora leaf spot of sesame

Common name of the disease: Cercospora leaf spot of sesame

Causal organism: *Cercospora sesami*

Major symptoms: Under conditions of high humidity (60%) moderate temperature (25C) the disease appear as minute small, ci9rcular leaf spots. Later increases in size upto 10 mm. linear dark coloured deep-seated lesions are formed on petioles stem and pods. Capsules show as more or less circular, brown to black lesions with deformed and shriveled seeds.

Nature of the disease: Seed borne

Location of the pathogen: External and internal nature has been reported.

Mode of infection / spread: Through infected seeds

Detection techniques: Incubation of seeds on nutrient rich medium helps in sporulation, which can be observed under microscope.

Certification standard: Foundation - 0.50 %, Certified 0.10% plant infection

Management: Use disease free seed and seeds from healthy fields, removal of infected plants to reduce the inoculum. Seed treatment with Vitavex @ 0.15 % or bavistin @ 0.15%. Storage of seeds for a year auto-eliminate the external infection.

10. Rice Bunt

Common name of the disease: Paddy bunt Kernel Bunt or kernel smut

Causal organism: *Neovossia horrida* (= *Tilletia horrida*)

Major symptoms: In a panicle, few grains are converted into black powdery mass. The black powder mass, teliospore (smut spores) scatter on the other seeds and leaves. The disease is conspicuous at the time of crop maturity. Inner matter of the seed is converted into the smut powder.

Nature of the disease: Primarily disease is carried by seed, thereafter it establishes into the soil.

Location of the pathogen: Pathogen is present in the form of mycelium, which lies between the aleurone layer and seed coat, digesting endosperm. The smut spores are produced in the ovaries**.**

Mode of infection / spread: Through diseased seeds, later establishes in the soil. During the anthesis, flowers are infected by sporidia, (the infective spores) produced by germinating mycelium, already present in the soil.

Detection techniques: (I) visual observation of infected seeds having black powder (ii) NaOH (0.2%) seed soak method. Infected seeds exhibit the jet-black appearance.

Certification standard: Maximum of 0.10% and 0.50%-infected seed by number in the foundation and certified seed lot respectively. No standards for seed crop at field stage.

Management: Use disease free seeds and seeds from disease free location for sowing purpose. Avoid higher dosages of nitrogen fertilizer, which makes the flower to open for longer period and providing greater chances of infection. Two application of propiocanozole (e.g. 0.1%) first after 30-35 days after -transplanting and second after 15 days of first application offer effective control.

Bunt of rice

11. Karnal Bunt of Wheat

Common name of the disease: Partial bunt new bunt

Causal organism: *Neovossia indica* (= *Tilletia indica*)

Major symptoms: In an ear head, few seed are infected, hence difficult to locate the disease in the field. Seeds turn black and bunted .The diagnostic symptom of the disease is blackening of seed sat the germinal -end. It become slightly swollen and gives shiny silvery appearance. Seed becomes hollow, de-shaped and swollen. The infected seeds contain black powder mass of smut spores (teliospores). Infected seeds emit a bad odor similar to rotten fish due to the presence of a chemical -trimethylamine.

Nature of the disease: Primarily disease is carried by seed, thereafter it establishes into the soil.

Location of the pathogen: Fungal mycelium grows through the base of the glume into the sub-ovarian tissues and enters the pericarp through funiculus. Further growth is entirely within the pericarp. Whole endosperm, get converted into black mass.

Mode of infection / spread: Through infected seeds. The pathogen present in the seeds reaches the soil during harvesting; threshing winnowing or carried infected or contaminated seeds used for sowing. The teliospores present in the soil germinate and cause infection to the developing ovaries. Thereafter fungus grows well in the base of glumes.

Detection techniques: (I) Visual inspection de-shaped swollen seeds with black (bunt spore) powder (ii) seed wash test for the spores adhered with surface of the seeds (iii) NaOH seed soak method. Infected seeds exhibit the jet-black appearance.

Certification standard: Maximum of 0.050% and 0.250 %-infected seed by number in the foundation and certified seed lot respectively. No standards for seed crop at field stage

Management: Use disease free seeds and seeds from disease free location for sowing purpose. Avoid higher dosages of nitrogen fertilizer, which makes the flower to open for longer period and providing greater chances of infection. Avoid late planting, use split dosage of fertilizer; seed dressing fungicide have little effect; foliar application either with mancozeb (e.g. dithane M 45 @ 0.2%), carbendazim (e. g.

Bavistin or derosal @ 0.2%) or propiocanozole (e.g. tilt @ 0.1%) applied at early heading stage provide good control.

12. Ear cockle of Wheat

Common name of the disease: Ear Cockle of Wheat

Causal organism: Ear cockle is caused by a nematode, *Anguina tritici*. While association of a bacterium, *Clavibacter tritici* is called tundu.

Major symptoms: Earhead emerges 30-40 days earlier when disease seeds are sown and on this basis, infected plants can easily be located in the normal wheat field. The earhead from infected seed remains green and short. Seeds are replaced with loosely attached seed gall. Galls are normally smaller hard and brown in colour.

Nature of the disease: Basically seed borne and later on establishes in the soil.

Location of the pathogen: Seed galls (ear cockle) are smaller, hard and contain second stage juvenile larvae in dormant (cryptobiotic) stage. Nematode may range from 800- 35000 per gall. Dormant larvae can survive upto 32 years in the seed gall.

Mode of infection / spread: In an earhead loosely attached seed gall is separated with a slightest jerk and reach the soil, threshing floor or the to the seed lot. Soil moisture helps in softening the gall thereby realizing the juvenile nematodes attacking the near by growing seedlings .The nematode feed ectoparasitically on the plants and remain inactive for almost 60 days. Thereafter at the time it penetrate the floral primordial, lay eggs, which later develops to second stage larvae, as the gall mature.

Detection techniques: (I) visual examination of seed and gall during purity test observing on the work board.

Certification standard: Zero percent limit for seed gall for seed lot of any category. Presence of a single gall will reject the seed lot.

Management: Use disease free seeds and seeds from disease free location for sowing purpose. Remove the galls from the seed sample by winnowing or separator by dipping in the brine solution; cleaning the seeds by gravity separator.