

Plant quarantine inspection, procedures and facilities for the import and export of seeds and vegetative propagules at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT)

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Abstract The inevitable large-scale plant germplasm exchanges between countries for crop improvement have led to strict plant quarantine inspections, safeguards and sometimes restrictions. The paper describes the procedures and techniques adopted for the safe exchange by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) plant germplasm in India. Safeguards for the imported germplasm include intermediate quarantine for groundnut (*Arachis* sp.) cuttings, fumigation, dry seed inspection and microscopic examination followed by seed treatment and growing of healthy crops in a quarantine isolation area before releasing seeds of disease free progeny to the scientists. Similarly, inspection of crops before collection of seeds, followed by fumigation, microscopic examination, enzyme-linked immunosorbent assay (ELISA) test for groundnut viruses, seed treatment and finally good packing have been found effective for export of healthy seeds.

1. Introduction

The global movement of plant propagules for collection and research purposes by international, national, private organizations and individuals is necessary for development of crops for improving their yields and other qualities, hence the need for plant quarantine inspection. Apprehension regarding the global spread of potential pests, diseases, and weeds, with restricted distribution, through exchange of germplasm, is natural, but it leads to stringent plant quarantine measures which act as a hindrance to research. Countries have laid down rules, regulations and procedures for the import and export of seeds depending upon necessity and the available infrastructure for the protection of agriculture. The present paper highlights the arrangements for examination of seeds and plant material from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in line with the plant quarantine requirements of India, and briefly discusses some of the technical aspects that throw light on the reliability of the present system as experienced over the years.

2. Inspection of imported seed and plant material

The Government of India allowed the import of ICRISAT seed consignments of mandate crops, viz. sorghum (*Sorghum bicolor*), pearl millet (*Pennisetum americanum*), chickpea (*Cicer arietinum*), pigeonpea (*Cajanus cajan*) and groundnut (*Arachis hypogaea*) through the Director, Central Plant Protection Training Institute (CPPTI), Hyderabad, and

of non-mandate crops (minor millets) through the Director National Bureau of Plant Genetic Resources (NBPGR), New Delhi. These organizations carried out quarantine inspection of the seed before release to ICRISAT until July 1986. According to the latest arrangement all ICRISAT seed consignments are now being sent to the latter functionary since single-window clearance for research material has been decided by the Government of India. The groundnut cuttings imported through third country quarantine are inspected by the Indian quarantine officials at the airport before release to ICRISAT. All such imports are invariably accompanied by a Phytosanitary Certificate (PSC) as required under the Indian Plant Quarantine rules.

The seed packages, soon after their arrival, are fumigated with methyl bromide under vacuum for 4 h at a dose of 32 gm³. After fumigation the seeds from individual packets are thoroughly examined visually. Damaged, broken and discoloured seeds are removed along with the foreign material, if any, and incinerated. Radiographic examination of chickpea and pigeonpea seeds is done to detect hidden infestation of bruchids. For detection of fungal and bacterial pathogens, viruses, etc., seed samples are subjected to

1. dry seed inspection under a magnifying lens for separating seeds with ergot sclerotia, smut sori, moulds, etc.,
2. washing and sedimentation test of sorghum seeds for fungal spores and hyphae adhering to the seed coat
3. blotter test for detection of seedborne/transmitted diseases,
4. agar plate method for detection of specific pathogens such as *Ascochyta*, *Fusarium*, etc.,
5. Growing-on test of groundnut, pigeonpea and chickpea for viruses and for bacterial infections—groundnut is grown for 6 weeks in an insect-proof screen house, indexed for viruses, and healthy groundnut plants are released to ICRISAT for planting in the quarantine isolation area (QIA).

Seed samples of sorghum, pearl millet, chickpea, pigeonpea and minor millets are microscopically examined and then treated with fungicides/pesticides before release.

3. Seed treatment

All seeds are treated with approved fungicides before sowing in the quarantine isolation area.

3.1. Sorghum

Seeds are treated with thiram (tetramethylthiuram disulfide) or captan [N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide] at the dose of 2.5 g kg⁻¹ of seed as a prophylactic measure against head moulds and seed rot (Sharma *et al.*, 1976, Munghate and Raut, 1982). For specific treatment against smut or downy mildew, carboxin at 1.5 g kg⁻¹ (Selvaraj, 1978) and metalaxyl at 4 g kg⁻¹ (Frederiksen and Odvody, 1979, Anahosur, 1980) are respectively used.

3.2 Pearl millet

The seeds are given blanket treatment against downy mildew (*Sclerospora graminicola* (Sacc) Schroet) which is internally seed-borne (Shetty *et al.*, 1980). They are soaked in 0.1% mercuric chloride for 10 min and washed in running water for 5 min followed by hot water treatment at 55 °C for 12 min then cooled to room temperature in running water and finally soaked in a 1:1 suspension of metalaxyl and aqueous methyl cellulose (Williams and Singh, 1981). This treatment is effective for about 4 months (Pathak and Joshi, 1984).

3.3 Chickpea

The seeds are treated with mixture of benomyl and thiram (3:2) at 4.5 g kg⁻¹ of seed. This treatment is particularly effective for the control of chickpea wilt (*Fusarium oxysporum* Schlecht emend Snyd & Hans f. sp. *ciceri* (Padwick) Snyd & Hans) (Haware *et al.*, 1978). Chickpea seeds are treated with thiabendazole at 3 g kg⁻¹ against ascochyta blight (Reddy and Kababeh 1984) if received from areas affected by this disease.

3.4 Pigeonpea

The seeds are treated with a mixture of benomyl and thiram (3:2) at 4.5 g kg⁻¹ of seed for the control of *Fusarium* spp., *Aspergillus* spp., *Alternaria* spp., and *Rhizoctonia bataticola* (Kannaiyan *et al.*, 1980).

3.5 Groundnut

For the control of surface borne fungal diseases, seeds are dressed with thiram at 3 g kg⁻¹ of kernels (Reddy and McDonald, 1983).

4. Intermediate quarantine

For cytogenetic studies of groundnut, wild *Arachis* spp. from the Americas, are grown in the UK, a non-groundnut-growing country, and cuttings from healthy plants free from viruses are imported. After quarantine inspection at the port of entry, these are grown in the insect-proof screen house at ICRISAT for 6 weeks, and healthy plants free from viruses are transplanted in the field for seed collection.

5. Quarantine isolation area

All the imported seed material and groundnut plants released by the CPPTI/NBPGR after examination are

grown in the QIA at ICRISAT for one season. The QIA is a 6 ha plot sequestered in one corner of the ICRISAT farm, far from the precision fields and surrounded by forest trees. The crops are raised under close supervision of the staff of the national plant quarantine services and ICRISAT plant quarantine unit who inspect the crops bi-weekly from sowing to harvest. Diseased plants are promptly rogued out and burned. Seeds harvested from healthy plants are released to the scientists.

Every effort is made to keep the crops in QIA free from local pests, diseases, and weeds through various plant protection measures.

6. Import of seeds and groundnut cuttings

Between 1973 and 1986 total of 143,878 seeds samples and 5000 groundnut cuttings were imported by ICRISAT from 80 countries. Of the imported seed samples almost 88% were released to ICRISAT by the National Plant Quarantine Services after being subjected to thorough physical and biological examination and growing-on for one season in the quarantine isolation area. The cropwise import figure of seed samples and groundnut cuttings is given in Table 1.

Table 1 Import and export of plant material by ICRISAT

Crop	Import (1973–86)		Export (1974–86)
	Seed samples	Cuttings	seed samples
Sorghum	70,693		327,584
Pearl millet	15,642		121,420
Chickpea	25,805		157,185
Pigeonpea	13,599		33,640
Groundnut	10,687	5,000	31,141
Minor millets	7,452		8,731
Total	143,878	5,000	679,701

7. Processing of ICRISAT seeds for export

The crop areas from which seeds are collected for export are inspected regularly by plant pathologists and entomologists working on the respective crops. Seeds collected from healthy plants are submitted to the Plant Quarantine Unit for inspection and dispatch.

ICRISAT has a Plant Quarantine Laboratory for the examination of seeds offered by different programmes for export. The staff of this laboratory assist the CPPTI/NBPGR plant quarantine officials in the examination of outgoing seed material. The laboratory is fully equipped and manned by experienced staff. The work of the laboratory is supervised by the Chief Plant Quarantine Officer. The plant quarantine unit has a capability to handle export of over 50,000 seed samples annually.

All seed samples received for export are fumigated with methyl bromide under vacuum at the dose of 32 g m⁻³ for 4 h with the exception of groundnut, for which aluminium phosphide is used at the rate of 3 g m⁻³ for an exposure of 5 days (Varma and Ravi, 1984). After fumigation, seeds are examined/tested and treated as per the following procedure.

7.1 Visual examination

Seeds from each packet are poured into a tray and, using a magnifying lens, insect-damaged, discoloured, small seeds, smut sori, seeds infected with ergot sclerotia pycnidia and foreign material are removed and destroyed

7.2 Radiography

Chickpea, pigeonpea and groundnut seeds are X-rayed for detection of latent infestation of insect pests, particularly bruchids. Hidden infestation in sorghum and pearl millet is detected by an Ashman Simon detector

7.3 Plating

A sample of seeds is drawn at random from each packet and plated for the identification of seedborne/transmitted pathogens. Blotter or agar plate methods are used, according to the procedure laid by the International Seed Testing Association (ISTA). Seeds are examined microscopically and samples found infected with pathogens of quarantine importance are detained and the healthy samples dispatched after suitable treatment with insecticide and/or fungicides

7.4 ELISA test

The groundnut seed samples are tested at random for the presence of seedborne peanut mottle and clump viruses present in India using an enzyme-linked immunosorbent assay (ELISA) technique. Samples showing positive results are detained

7.5 Washing and sedimentation

Seed samples of sorghum and pearl millet are picked up at random and washed with water then centrifuged. The suspension is examined microscopically for oospores of downy mildew and smut spores, nematodes and *Striga* seeds

7.6 Embryo count

Samples of pearl millet seeds are tested at random by this technique for infection of downy mildew. Seed lots in which samples show downy mildew infection are not exported

7.7 Chemical treatment

Clean seeds are selected and treated prior to export

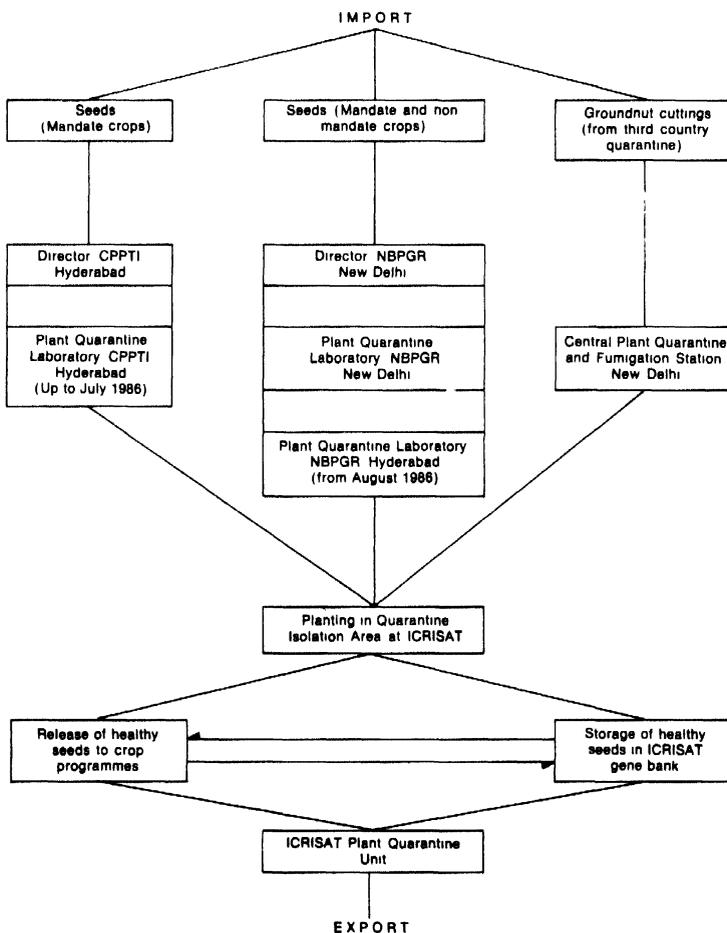


Figure 1 Flow of ICRISAT seeds and plant materials from import to export

unless the importers want untreated seeds Aldrin 5% dust is used at the dose of 3 g kg⁻¹ seed to prevent storage pest attack Sorghum and pearl millet seeds are treated with mixture of metalaxyl and mancozeb at the dose of 4 g kg⁻¹ and 2 g kg⁻¹ of seed respectively, whereas chickpea and pigeonpea are treated with benomyl + thiram (3:2) at the dose of 4.5 g kg⁻¹ of seed Groundnut seeds are treated with thiram at the dose of 3 g kg⁻¹ of seed Seeds intended for studies on disease resistance or for response to different strains of *Rhizobium* or chemical analysis are exported without treatment

8. Phytosanitary certificate (PSC)

The PSC is signed and issued by the officers authorized by the Government of India in the form prescribed by the International Plant Protection Convention, 1951, FAO The additional declaration is also given in the certificate after verification Every seed consignment is accompanied by a phytosanitary certificate

9. Export of seeds

ICRISAT has exported 679,701 seed samples to 125 countries during 1974–86 The details of cropwise seed exports are given in Table 1

Conclusions

For large-scale inspection and quarantine examination of imported germplasm or those meant for export, the procedure adopted at ICRISAT appears to be scientifically sound and working satisfactory (Figure 1) The imported seed samples, besides the accompanying standard phytosanitary certificate, have the following four effective safeguards before they are released to ICRISAT scientists

- 1 fumigation followed by visual and microscopic examinations,
- 2 chemical seed treatment,
- 3 growing released seeds and groundnut plants/cuttings in the quarantine isolation area for one season with thorough surveillance for pests/diseases by plant pathologists and entomologists twice a week, a full chemical protection of crops until harvest,
- 4 harvesting of seeds from healthy mother plants for research and/or storage in a gene bank

Similarly, the seed samples meant for export also pass through four strict safeguards before dispatch, such as

- 1 collection of healthy seeds after inspection of crops by plant pathologists and entomologists,
- 2 fumigation, visual and microscopic examinations of seeds and ELISA test for groundnut kernels,
- 3 chemical seed treatment,
- 4 good packing

Neither pest nor disease has escaped through seed material imported by ICRISAT, nor has there been any report about the introduction of pest or disease into any country receiving ICRISAT seeds The post- and pre-entry quarantine system evolved for seed inspection at ICRISAT seems to be practical and adequate for large-scale handling of imports and exports of germplasm

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