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PLANT QUARANTINE IN THE EXPORT OF PULSES AND GROUNDNUT GERMPLASM FROM ICRISAT

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Abstract

The need for increased production of grain legumes in Asian and Pacific countries necessitates more extensive exchange of germplasm for crop improvement work in the region. Seeds carry pests and diseases from one country to another unless strict plant quarantine measures are enforced. The paper highlights the economically important seedborne pests and diseases of chickpea, pigeonpea and groundnut reported from India, and measures for the export of seeds of these crops without biotic risk.

Introduction

When the Consultative Group Meeting for Asian Regional Research on Grain Legumes was held at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, in 1983, regional constraints to production of chickpea (*Cicer arietinum* L.), pigeonpea (*Cajanus cajan* (L.) Mill sp.) and groundnut (*Arachis hypogaea* L.) were enumerated, and they included lack of suitable cultivars. Plant genotypes with desired traits are being identified, and these now need to be distributed amongst the Southeast Asian countries for use in crop improvement programmes, including the development of pest resistant cultivars. In this context, the role of ICRISAT as the main supplier of germplasm material to the countries of the region is a very important and responsible one.

To facilitate the inter-country movement of germplasm of the above three crops, it is essential to know which pests are likely to be carried through seeds, and their world distribution. The seedborne pest of ICRISAT mandate grain legumes in India and the quarantine implications in the export of their seeds are discussed in the present paper.

Insect pests

In India, pulses and groundnut seeds are commonly attacked by beetles belonging to the family Bruchidae; Coleoptera. They are serious pests of grain legumes in storage. The larvae, being internal feeders, go undetected until they or the adult emerges by biting a small hole through the seed coat. The common species recorded in the country on chickpea, pigeonpea, and groundnut are given in Table 1.

The most common and injurious species are *Callosobruchus chinensis* and *C. maculatus* that have been recorded from a large number of economic hosts (21, 22, 23, 24, 29). *C. phaseoli* generally infests field beans (*Lablab purpureus* (L.) Sweet) (32) but it has been found breeding on chickpea and pigeonpea in captivity (21) and there is every possibility of this species also infesting other pulse seeds. *C. analis* has been reported to attack seeds of many legume crops (2, 22, 23), but *C. theobromae* (24, 30) and *C. dolichosi* (29) have a limited range of host.

Caryedon serratus is a serious pest of undecorticated and decorticated groundnuts (22, 32). Other insect pests that are recorded on groundnut seeds in India generally attack old seeds that have not been properly dried and stored. They are universal in distribution, occurring on cereals, legumes, oilseeds and a variety of other stored products and may not be of quarantine interest.

Seedborne diseases

Plant diseases that can be internally or externally seedborne have important implications for plant quarantine. Seeds for export should, wherever possible, be free from all pathogens, including pathogens of other crop plants. It should be realized that a minor disease of a crop in one country may well become a major disease of the crop if introduced into a new environment

Table 1
Insect pests recorded in seeds of chickpea, pigeonpea, and groundnut in India

Crop	Species	Distribution
Chickpea and Pigeonpea	*Callosobruchus chinensis* (L.)	Asia, Africa, Mediterranean countries, North and South America, Australia.
	C. maculatus (F).	Asia, Africa, India, Iran, Israel, Mediterranean countries, North and South
	C. phaseoli (Gyll.)	India, Burma, Southeast Asia, Africa, Brazil, USSR, West Indies, Pacific Islands
	C. analis (F.)	Asia, Africa, Australia, India
Pigeonpea	*C. theobromae* (L.)	India, Sri Lanka
	C. dolichosi (Gyll.)	India, Burma, Nepal
Groundnut	*Caryedon serratus* (Ol.)	India, Africa, Asia, South America, West Indies
	Tribolium castaneum (HBst.)	Worldwide
	Oryzaephilus surinamensis (L.)	Worldwide
	Ephestia cautella (Wlkr.)	Worldwide
	Corcyra cephalonica (Staint)	Worldwide

Table 2
Important seedborne pathogens of chickpea, pigeonpea and groundnut in India

Crop/disease	Pathogen	Distribution
Chickpea		
Ascochyta blight	*Ascochyta rabiei* (Pass.) Labr.	Africa, Asia, Australia, Canada, Europe, Middle eastern countries
Wilt	*Fusarium oxysporum* Schlect. emend Snyd. & Hans. f. sp. *ciceri* (Padwick) Synd. & Hans.	Asia, Africa, Mexico, Middle eastern countries, South America
Leaf blight	*Alternaria alternata* (Fr.) Kiessler	Bangladesh, India
Stem blight	*Colletotrichum capsici* (Syd.) Butl. & Bisby	India
Stem rot	*Sclerotinia sclerotiorum* (Lib.) de Bary	Australia, Chile, India, Middle eastern countries, North Africa
Dry root rot	*Rhizoctonia bataticola* (Taub.) Butl.	Asia, Australia, Ethiopia, Middle eastern countries, US.

Table 2 *(concluded)*

Important seedborne pathogens of chickpea, pigeonpea and groundnut, in India

Crop/disease	Pathogen	Distribution
Pigeonpea		
Wilt	*Fusarium udum* Butler *(Fusarium oxysporum* f. sp *udum)*	Asia, Africa, Mauritius, Trinidad
Seed rot	*Aspergillus* spp.	Worldwide
Dry root rot	*Rhizoctonia bataticola* (Taub.) Butl.	India, Jamaica
Anthracnose	*Colletotrichum capsici* Rangel	Brazil, India Puerto Rico, Hawaii (USA)
Bacterial leaf blight	*Xanthomonas capsici* Kulkarni et al.	India, Panama, Sudan
Groundnut		
Crown rot	*Aspergillus niger* van Tiegh	Worldwide
Yellow mould	*A flavus* Link. ex Fr.	Worldwide
Dry root rot, seed rot	*Macrophomina phaseolina* (Tassi) Goid	Asia, Gambia, Israel, North and South America
Blight	*Rhizoctonia solani* Kuhn	Worldwide
	Peanut mottle virus (PMV)	Worldwide
	Peanut clump virus (PCV)	India and West Africa

and this is particularly a risk in the case of virus diseases. Some of the most important diseases of chickpea, pigeonpea and groundnut that occur in India and are likely to be seedborne are listed in Table 2.

Discussion

In terms of plant quarantine, the transfer of plant material as seeds is considered to be quite safe (3, 20), so much so, that some countries have excluded seeds, particularly for research purpose, from the purview of quarantine regulations.

As far as is known, none of the above-named pests with the exception of peanut mottle and peanut clump viruses have been included as prohibited, or requiring additional declaration in phytosanitary certificate in their plant quarantine schedules by the countries of Southeast Asia. Restriction has, however, been imposed against the entry of peanut mottle and other viruses by Brunei and Malaysia.

It is interesting to note that the bruchids and other storage pests that have innumerable hosts have worldwide distribution, while species with restricted hosts, such as *Callosobruchus theobromae, C. dolichosi,* and *Caryedon serratus,* have limited distribution. If the present pest status of these three species is considered, their spread could be restricted to some extent by appropriate plant quarantine precautions.

There is no risk of insect pests gaining entry into a country through seeds, if they are properly fumigated. Methyl bromide fumigation at the rate of $32gm_3$ for a 4-hour exposure under vacuum kills all the stages of insect pests including eggs. Groundnuts are fumigated with aluminium phosphide at $3g/m_3$ with a 5-day exposure period. X-ray examination of legume seeds to detect hidden infestation, coupled with fumigation will in all probability prevent insect pests from gaining entry into new areas or countries.

Seed for export should wherever possible be collected from disease free mother plants, and any shrivelled or mould-damaged seed removed before submission to plant quarantine. It may also be necessary to grow crops from which seed for export has to be taken under conditions where diseases are not likely to be serious, e.g., by growing the crop out of season and in isolation from other crops. In the ICRISAT Plant Quarantine Unit, all seeds of chickpea, pigeonpea and groundnut are examined for visual symptoms of disease and are tested by blotter and agar plate methods according to the recommendations of the International Seed

Testing Association. Seeds are routinely fumigated and treated with thiram or benomyl and thiram mixture.

Of the diseases recorded on chickpea seeds in India, the internallyborne ascochyta blight and fusarium wilt are recognized to be the most serious. It is rather gratifying that both these diseases have so far very limited distribution in Asia (18) and that plant quarantine can help to check their spread. Fortunately, ascochyta blight does not occur in southern part of India because the climatic conditions there do not favour the disease and seeds collected from this region are always free from this disease. However, seed treatment with thiram (16), Granosan® (4) Calixin-M® (10% tridemorph + 36% maneb) (13, 25), Bavistin 25% + thiram 50% (9) and thiabendazole (27) has been found effective in controlling *A. rabiei* giving increased seed germination and yield. Similarly, complete eradication of chickpea wilt has been achieved by seed treatment with Benlate® + thiram (1, 9). The other pathogens (Table 2) originate either from plant debris, or soil, and being superficial in nature can be easily controlled by common seed surface disinfection methods. Besides, seed treatment against the two major diseases of chickpea may also be beneficial in checking the infection of others.

The internallyborne pathogen *Fusarium udum* is the most important transmitted in pigeonpea seed. The infection can be fully controlled by seed treatment with captan (5) or Benlate T® (benomyl 30% + thiram 30%) (14). Dressing seed with Benlate T® at 3g kg ^{1} was also found to effectively control other pathogens, such as *Aspergillus* spp., *Rhizoctonia bataticola*, *Alternaria* sp. *Penicillium* sp. and *Sclerotium rolfsii* (Sacc.) without adversely affecting seed germination.

Anthracnose caused by *Colletotrichum cajani* is not a prevalent pigeonpea disease in India and the presence of its inoculum on seeds is most unlikely. However, *Xanthomonas cajani* bacterial infection can be avoided by seed treatment with streptocycline (100 ppm), Agrimycin® (150 ppm) or Agallol® (2000 ppm) (7).

With the exception of peanut mottle and peanut clump virus diseases, no very important disease of groundnut in India is known to be seedborne. The fungal diseases listed in Table 2 are also soilborne, and are distributed worldwide. However, it is still important that they are not moved from India to other countries. This is particularly the case of *A. flavus* as some strains of this fungi are highly efficient producers of aflatoxins. The standard seed treatment with captan (6) or thiram (12, 16, 17) should remove external contamination with these fungi. Seed samples found to have high levels of internal contamination with *A. flavus* and other mould fungi should not be exported.

Satisfactory control of *Macrophomina phaseolina* inoculum has also been achieved by dressing seed with captan/captafola (28) or thiram/carbendazin (8). Against *Rhizoctonia solani*, seed treatment with organic mercury fungicides (11) has been reported effective, but use of mercurial fungicides is not recommended if this pathogen is present along with *Aspergillus* spp. (17, 26). In such cases, TCMTB (2-(thio-cyanomethylthio) benzothiazole) has given a high degree of control *R. solani* (1). Reddy and McDonald (26) have reported a wide spectrum of fungi associated with groundnut seed and seedling diseases that can be controlled with thiram and captan.

Seed should not be collected from plants showing symptoms of peanut mottle or peanut clump virus diseases. Transmission of PMV in groundnut seeds occurs up to 8.5% (15) and PCV, though known to be seed transmitted (19), its rate of transmission has yet to be estimated. Antisera are available against both viruses and it is therefore possible to check mother plants or seed for the presence of the virus using ELISA (enzyme-linked immunosorbent assay) (31).

Conclusion

It is apparent that except for the systemic or internallyborne diseases, such as, *A. rabiei* and *F. oxysporum* f. sp. *ciceri* in chickpea, *F. udum* in pigeonpea and peanut mottle and clump viruses in groundnut and other diseases are surfaceborne on seeds. *S. sclerotiorum* and *R. bataticola* in chickpea, *Aspergillus* spp., *R. bataticola* and *F. udum* in pigeonpea and *M. phaseolina*, *R. solani* and *Aspergillus* spp. in groundnut are also soilborne and universally distributed. External contamination can be easily and effectively controlled by treatment with thiram or captan, and interna

seedborne pathogens of chickpea and pigeonpea can also be completely eradicated by using thiram in combination with Benlate®

Export of decorticated groundnut and preentry quarantine that aims at inspecting groundnut crops for PMV and PCV at source reinforced by the ELISA test can ultimately result in the selection and export of healthy virus free seeds

For plant quarantine purposes, seed treatment may not be considered an absolutely safe measure But the collection of seeds destined for export from crops grown in open quarantine being a common practice, only by selecting healthy-looking seeds, physical and biological examination, and resorting to seed treatment can possibly be the only practical way for the exchange of germplasm without risk Since 1974 to date, ICRISAT has exported 168,579 samples of chickpea, pigeonpea and groundnut seeds to as many as 125 countries without any risk to the recipient countries Plant quarantine calls for a positive approach and therefore, prudent handling of seed material through inspection, fumigation and chemical seed treatment at the place of origin and further examination at the point of entry in the importing country can be considered to be a practical and safe method in the international exchange of germplasm

Session discussion

K.G. Singh: Could you give some comments on The Seed Health Unit of ICRISAT and how it provides the service for the benefit of plant quarantine?

Answer: The seeds meant for export are collected by the different programmes of ICRISAT from another healthy plants and sent to the plant quarantine unit of ICRISAT They are fumigated and physically examined followed by microscopic examination after incubation Recording the mycoflora, the seeds are reexamined by the central government plant quarantine officials and the seed samples by them are chemically treated, certified and despatched

Surachmat: 1 Just a little comment on *Alternaria alternata* (Table 2) This fungus is commonly found in seeds tested by incubation method I think this fungus is widely distributed
2 You mentioned that peanut stripe mosaic virus occurs in peanut in China and Indonesia As I have not heard of any report that it occurs in Indonesia, I will be grateful if you could tell me any report or publication about it

Answers: 1 Yes, the disease has a wide distribution on so many other crops
2 This information may come out in a book "Compendium of Peanut Diseases" now in publication

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