INTERNATIONAL COCOA QUARANTINE CENTRE (ICQ,C) - AN OVERVIEW

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Introduction

Germplasm is the basic genetic resource required for any breeding program. Germplasm collections comprised of wild species, native types of centre of origin and geographical distribution, domesticated/ cultivated types, genetic stocks and breeding lines. In cocoa around 4000 germplasm collections are available worldwide and conserved in important international gene banks *viz.*, Cocoa Research Centre (CEPEC), Brazil, International Cocoa Genebank in Trinidad (ICG,T), Tropical Agronomic Research and Teaching Centre (CATIE), Costa Rica etc. Cocoa research institutes of Nigeria, Ghana, Ivory Coast, Cameroon, Ecuador, Malaysia, Indonesia etc. are also maintaining national gene banks for their breeding programs. In India cocoa research initiated in 1969 with narrow genetic base with few germplasm from Malaysia and Nigeria by CPCRI and collection efforts continued with regular imports and conserved at National Active Germplasm Site for cocoa at Regional Station, Vittal, Karnataka. Both CPCRI and KAU are involving in enriching the germplasm from the International Cocoa Quarantine Centre (ICQ,C) situated in University of Reading, United Kingdom (UK). It is important to know about the activities of the centre and the procedures involved in germplasm exchange.

Establishment of ICQ, C

Cocoa in its native zones of South and Central America and other major producing countries of Africa is suffering with many debilitating diseases comprised of both viral and fungal pathogens and serious pests. To safe guard the germplasm exchange programs and to ensure continuous breeding activities of cocoa research centres of different regions, it was proposed to have an Intermediate quarantine centre in Europe far away from the production zones. The University of Reading took over the responsibility for cocoa quarantine from the Royal Botanic Gardens at Kew in 1985 and created the facility with twin-clad polyethylene covered tunnels (greenhouse) in 1987 at Shinfield Unit, 4.8 km from the main campus of Reading (Hadley and Lee, 1992). The centre is collecting important clones from ICG, T, CEPEC, CATIE and also from other wild and national collections, carrying out the quarantine for major diseases and supply to cocoa researchers. For this facility, the funding for construction and management is provided by Biscuit Cake Chocolate and Confectionery Alliance (BCCCA), Master Foods/ Mars Incorporated, United States Department of Agriculture (USDA), Common Fund for Commodities (CFC), Dutch Government (LNV), alongside Cocoa Research Association Ltd. (CRA) etc. during different time periods. Many clones have passed through this facility and many shipments are made to 20 countries.

Facilities at ICQ, C

Currently facilities are available to accommodate around 370 clones for exchange and quarantine. The clones undergoing quarantine in the recent years are from Costa Rica, Ecuador, Venezuela and Trinidad. Collections from international gene banks are made either according to the request of the indenters or clones with desirable traits collected by the centre itself.

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Over 1000m^2 of greenhouse space is available for the purpose. The tunnels are covered with two layers of polyethylene to enable maintenance of high humidities and a nominal day temperature of 28°C and a night temperature of 19°C with a 12 hour thermo- period under UK winter conditions. Relative humidity is generally maintained at 75 to 85%. Fans, vents and doors are all netted to provide insect proofing.

Plants in pots are placed either at ground level in case of collection or on benches positioned at 30 cm above the floor of the house in the case of material passing through quarantine. Plants are grown hydroponically in pots containing a completely inorganic medium of vermiculite, sand and gravel irrigated with a nutrient solution, the concentration and pH of which are controlled automatically with a micro- processor controller. This reduces the incidence of nutrient disorders. Watering is done frequently (9 times per day).

Quarantine procedures

- Material for quarantine is obtained from international gene banks as bud sticks with phytosanitory certificates. On arrival the material is inspected by plant health inspectors from Ministry of Agriculture, Fisheries and Food, UK for presence of pests and diseases and any material found to be contaminated is destroyed. The material is first budded on to approximately 3 month old seedlings of the variety West African Amelonado, which is susceptible to cocoa swollen shoot virus (CSSV) and other viruses of cocoa in West Africa. Appearance of typical leaf and stem systems are used for indexing.
- Successfully grafted plants are divided into two groups. The first group is regularly inspected for virus transmission from the bud patch to the mother plant by observation over a period of approximately 24 months. Both root stock and scion are examined for evidence of virus transmission.
- The other group is used for propagation and for these plants, the shoot of the mother plant is removed, along with virus transmission all the materials are checked regularly for other pest and disease problems also. Since the majority of the material in quarantine is from South American origin the main disease threat is Witches Broom disease (*Crinipellis perniciosa*). Any material suspected of being infected (either with virus or fungus) is immediately destroyed by burning the affected plant and any plantlets derived from them. Clones in the propagation, quarantine and maintenance phases of the operation are kept in different areas.
- In addition to regular inspection by Reading staff, all material within the facilities is inspected approximately once every 6 months by a virologist and a pathologist.
- Quarantine procedures adopted at Reading follow guidelines laid down in the FAO/ Bioversity International (earlier IPGRI) technical guidelines for the safe movement of cocoa germplasm (Frison and Feliu, 1989; Michelle End *et al.*, 2014). Strict quarantine procedure including virus indexing over a two year period, weekly observation by staff, and six-monthly inspections by independent experts in pathology, entomology and virology, plus an annual inspection by the UK Department for Environment, Food and Rural Affairs (Defra) is also being followed.
- The clones which cleared the quarantine will be published in the ICQ, C newsletter for ready reference for researchers. As per the indents bud sticks will be supplied along with phytosanitary certificate to countries having import permits. So far bud wood material supplied to over 20 institutions around the world. Leaves, pods and flowers supplied for research within UK and Europe. The collection is not permanent and individual clones can be deleted when transfer has been completed.

Dispatch of material

- Budwood is normally supplied as 2-3 budsticks, 7-10 mm in diameter, each with 3-5 buds.
- An import permit from the destination country is required before material can be dispatched.
- Treatment of budsticks prior to dispatch varies and depends on the phytosanitary requirement stated in the import permit but includes dipping in insecticide and fungicide solutions.
- Each consignment of budwood is examined by inspectors or the Plant Health Division of Ministry of Agriculture, Fisheries and Food, UK who will supply a phytosanitary certificate which will accompany the budwood together with a quarantine certificate from the University of Reading.
- The cut ends of the budsticks are then coated in paraffin wax, wrapped in damp paper towels and placed in a polythene bag for retention of moisture during transit.

International Cocoa Germplasm Database (ICGD)

This database was set up in 1988 in the School of Plant Sciences at the University of Reading, UK and now under School of Agriculture, Policy and Development which aimed to collate all the records of cocoa germplasm collected in the wild into a single computerised database. From 1990 onwards it became widely available published information on all cocoa clones, their origins, their characteristics and where they are currently being grown. Information in the database has been obtained from publications, research meeting proceedings and reports sent directly to the ICGD from individual researchers from research institutions and genebanks. The ICGD is now funded by the UK cocoa trade via levies raised through NYSE Liffe. Database is under open access for information on synonyms, origins and locations, wide range of morphological and agronomic characters of cocoa clones with photographs and genetic fingerprints (SSR/ SNP profiles) as well.

Table 1. Pest and disease risks of cocoa and level of precaution needed when exporting/ exchanging plant parts

S.No.	Disease/ Pest	Geographical spread	Precautions
1	Cacao necrosis virus (CNV)	Not present in India	Pod: potential risk Seed: low risk Budwood: high risk
2	Cacao swollen shoot virus (CSSV)	"	
3	Cacao yellow mosaic virus (CYMV)	" (Reported in Sri Lanka)	
4	Witches broom disease *(Moniliophthora perniciosa)*	"	Whole pods: high risk Seed: moderate risk Budwood: moderate risk
5	*Moniliophthora* pod rot (Frosty pod rot or Moniliasis disease)	"	Pod: high risk Seed: moderate risk Budwood: moderate risk
6	*Phytophthora palmivora*	Worldwide	Whole pods: high risk (not recommended) Seed: low risk Budwood: high risk (intermediate quarantine recommended)
	P. capsici	Present in India	
	P. arecae	"	
	P. citrophthora	"	
	P. hevea	"	
	P. nicotinae var. parasitica	"	
	P. megasperma	Not present in India	
	P. megakarya	Not present in India	

S.No.	Disease/ Pest	Geographical spread	Precautions
7	Vascular streak die back *(Ceratobasidium/ Oncobasidium theobromae)*	Kerala state (India) All South and South East Asia (Papua New Guinea, China, Malaysia, Indonesia, Thailand, Myanmar, Vietnam, Philippines)	Whole pods: high risk, (not recommended) Seed: low risk Budwood: high risk- (intermediate quarantine recommended)
8	*Verticillium* wilt of cocoa	Worldwide	Whole pods: low risk, Seeds: low risk Budwood: moderate risk
9	*Ceratocystis* wilt	syn. Mysore wilt	Pod: high risk Seed: low risk Budwood: moderate risk
10	*Rosellinia* root rot*R. bunodes, R. Pepo, R paraguayensis*	India and Asian countries	Pod: low risk Seed: low risk Budwood: high risk
11	Cocoa pod borer (*Conopomorpha cramerella*)	SE Asia- Malaysia, Indonesia, Philippines, Papua New Guinea	Pod: high risk (not recommended) Seed: high riskBudwood: moderate risk
12	Mealy bugs (*Planococcus lilacinus*)	All cocoa growing regions	Pod: moderate risk Seed: low risk Budwood: moderate risk
13	Mirids (Tea mosquito bugs) *Helopeltis antonii* Signoret, *H. bradyi* Waterhouse, *H. theobromae* Miller, *H. theivora* Waterhouse	All cocoa growing regions	Pod: moderate risk Seed: low risk Budwood: moderate risk (Michelle End *et al.*, 2014)

- In order to minimise potential risks associated with the movement of cocoa germplasm, it is vital that appropriate quarantine procedures are applied.
- The Safe Movement of Cocoa Germplasm document serves as a reference point to for all those involved in moving cocoa germplasm (researchers, breeders, extension workers and curators).
- As an on-line resource, the document can be frequently updated as new information becomes available on cocoa pests and diseases and on quarantine measures.
- Since the quarantine procedure involves a two year visual observation period to check for latent viral infections, research is underway to improve and accelerate the quarantine process using new technologies such as tissue culture and molecular biology tools.
- Though no viral diseases of cocoa are reported in India post entry quarantine is also required in the importing countries. We have to be also alert with the major pests and diseases of Asian countries, as India is accessible.
- National Bureau of Plant Genetic Resources (NBPGR), New Delhi act as nodal agency for post entry quarantine in India. Division of germplasm exchange provides the import permit and quarantine division enhances the safety of imported material by testing with team of scientists of virology, pathology, entomology and nematology. Conservation division carry out the accessioning and allotting EC Nos. (Exotic Collection) and distribute to the indentors.

References

1. Hadley, P. And Lee, T. 1992. Current cocoa quarantine facilities of the University of Reading. International workshop on conservation, characterisation and utilization of cocoa genetic resources in the 21st century, Trinidad 13- 17, Sep. 1992. p. 65-68.
2. Michelle End, J., Daymond, A.J and Hadley, P. 2014. Technical guidelines for the safe movement of cacao germplasm. Revised from FAO/ IPGRI technical guidelines no. 20. Global Cacao Genetic Resources Network (CacaoNet) Bioversity International, Montpellier, France, p.69.
3. Frison, E.A. and Feliu, E. 1989. FAO/ IBPGR technical guidelines for the safe movement of cacao germplasm. Food and Agricultural Organisation of the United Nations, International Board for Plant Genetic Resources, Rome.
4. www.icgd.rdg.ac.uk

INTERNATIONAL COCOA QUARANTINE CENTRE

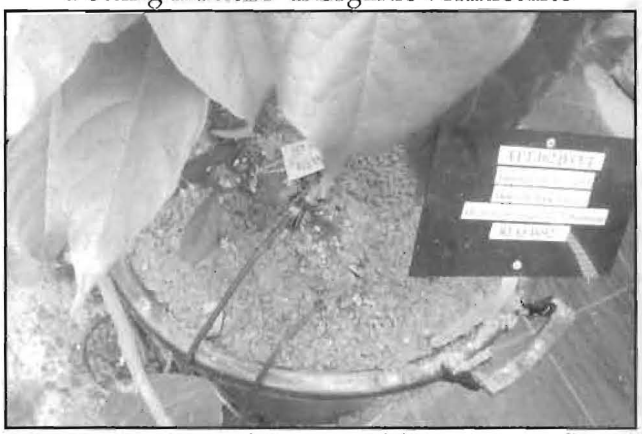
Outside poly tunnels-Asia Pacific cocoa breeders

Inside poly green house

Cocoa plants kept on benches

Plants budded for virus indexing

Potting mixture- Inorganic vermiculite



Automated water and nutrient supply

Automated weather control/ insect proofing

Plants ready for bud wood collection

Selecting bud woods

Bud sticks collected

Bud sticks packed for dispatch

Collected germplasm grafted at imported country (India-Vittal)