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COMPARATIVE FEASIBILITY OF GAMMA, ELECTRON BEAM AND X-RAYS FACILITIES AT THE KUALA LUMPUR INTERNATIONAL AIRPORT (KLIA), SEPANG, MALAYSIA

Muhamad LebaiJuri[1], Sidek Othman [1], Wan Manshol Wan Zain [1] and Ridzuan Ismail [2]

Present Address: [1] Malaysian Institute for Nuclear Technology Research (MINT), Bangi, 43000 Kajang, Malaysia

[2] Quarantine Department,
Ministry of Agriculture,
Kuala Lumpur, Malaysia

Synopsis

Malaysia is one of the world's leading producers of rubber, palm oil and cocoa beans. There is a great concern within the commodity industries of the possible outbreak of plant diseases yet to be detected in the country but endemic in the South American tropics and Africa. The risk of transferring the diseases to Malaysia are high because of increasing contacts between Malaysia and the South American countries and Africa through trades, tourism and the South-South cooperation. Diseases of particular importance are the South American leaf blight (SALB) of rubber, vascular wilts of oil palm and witches' broom of cocoa caused by Microcyclus ulei, Fusarium oxysporum f sp. elaeidies and Crinipellis perniciosa (Stahel) Singer respectively. Recent estimates by the Agriculture Department of Malaysia indicated in the event of large scale attack by SALB on rubber would result in revenue loss of a staggering RM 3-3.5 billion per annum, an equivalent of 70% loss in rubber acreage. This excludes massive unemployment in the rubber industry and cost of cleaning up activities to eradicate and free plantations of SALB. Recurring attacks of the diseases cannot be discounted given the fact that spores of fungi can remain dormant for years but still viable. Stringent control and quarantine steps are presently being exercised by the authorities to intercept at airports and hence prevent entry of infectious plant diseases in Malaysia. Many of the measures using chemicals, ultra violet light (UV), steam sterilization, air blowers etc. are not sufficiently effective in killing fungi especially when spores are carried in the personal belongings of air-passengers. There was suggestion that ionizing radiation offers alternative to the present methods for intercepting pathogens at the port of entry. This paper will firstly, discuss results on the investigations carried out to compare the effectiveness of various ionizing radiation sources, i.e., gamma, electron beam and x-rays; chemicals and UV to kill plant pathogens; and secondly, on the comparison of installing the different types of ionizing radiation facilities at the KLIA for treatment of baggage to intercept exotic plant pathogens.

INTRODUCTION

Geopathological, i.e., cross-border and intercontinental spread of phytopathological epidemic is no longer impossible under present circumstances. This is because of the advancement in communication systems and economic interdependence for instances air-transport, sea-bulk carriers, trades and tourism increases the mobility for people and goods from one country/region to another. From phytopathological point of view such speed travelling and economic activities posed enormous problems to authorities in an attempt to prevent spread of plant diseases which may be endemic in one region and the possibility of transferring the diseases to areas still free but of similar ecological and climatic condition.

The examples of the destruction and hardship caused by phytopathogens are firstly, potato blight epidemic in Ireland in 1840 in which millions of Irish perish due to famines (Klinwoski 1970). *Phytophatora infestan*, a species of fungi which attack potato plant causing its demise. Secondly, in 1960's *Ceratocytis ulmi*, a potent elm fungi, for some reasons was transferred from the U.S.A to U.K. and within 10 years killed approximately 60% of the 17.1 million in the British Isles.

The main concern in the Malaysian plantation industries is the possible migration due to trade and tourism of various catastrophic plant pathogens from the endemic regions of South America and Africa to Malaysia. The exotic plant pathogens of primary interest are as shown in Table 1. A scenario of attack by the South American Leaf blight (SALB) caused by the *Microcyclus ulei* which originated from Brazil on rubber plantation in Malaysia would result in 70% loss in yield and the rubber trees would eventually die and will cause untold damage to the industry. From epidemiological point of view, almost every organ of rubber are susceptible to the infection of SALB as shown in plates 1, 2, and 3. Plate 4 shows a plantation in Brazil under the attack of SALB which resulted in 70% reduction in latex yeild. The main reason for Brazil was not able to become world's natural rubber producer because of the persistent attack of *M. ulei* (Davis 1997). The effect on Malaysia's natural rubber industry would be more devastating due to absence of natural resistant of the cloned rubber trees and no natural competition from other fungi.

There is a great apprehension in Malaysia that rubber, palm oil and cocoa cultivation could be seriously damaged by exotic pathogenic fungi accidentally introduced from South America and Africa. There is an urgent need to find effective techniques to intercept these pathogens before they could land in Malaysian shores. This may include the use of ionising radiation as quarantine treatment for agriculture products, food and luggages of air-passengers at the point of entry to kill spores of the pathogenic fungi.

PRESENT METHODS OF QUARANTINE CONTROL AT THE AIRPORT

The current practices to intercept and minimise risks of transferring the deadly plant diseases to Malaysia are as shown in Plate 5, 6, 7, 8, and 9. The reasons for each measures are described in Table 2. These measures are undertaken/enforced for passangers flying in from the South American and African regions endemic with plant diseases.

In addition to these measures, Malaysians who have been visiting South America and Africa are advised to break their journey in temperate region of Europe or North America for a few days, clean their belongings and themselves before proceeding to Malaysia. This would minimise the chances of carrying viable conidia into Malaysia.

CRITERIA OF TECHNIQUE SELECTED FOR INTERCEPTION PATHOGENIC FUNGI AT THE KLIA

The treatment method selected for interception at the airport should satisfy the following criteria:

- able to effectively killed pathogenic fungi outside and inside of luggages,
- able to treat luggages for 5 flights/week,
- treatment should be carried out thoroughly, fast with minimal inconveniences to passengers,
- treatment process has to be reliable and incorporated into international airport without major implication for the airport design and safety

Various methods have been considered and scientifically studied to examine their effectiveness in decontaminating *Microcyclus ulei*. Table 3 showed the effect of the Ultraviolet light (UV), sterilants and low temperature treatment on the survival of conidia of *Microcyclus ulei*.

Most of the present techniques practised could not ensure pathogens are prevented from entering Malaysia. This may be due for instance UV is not penetrative, therefore, could not kill conidia present inside luggages. Use of detergents have their own limitations as they coulnnot guarantee 100% killing of the pathogenic fungi. Alternative method needs to be found to supplement present interception/quarantine techniques.

USE OF IONISING RADIATION FOR THE INTERCEPTION OF EXOTIC PLANT PATHOGENIC FUNGI

Ionising radiation has been proposed as techniques for interception of plant pathogenic fungi. The technique satisfies most of the criteria listed above. This includes effectiveness in killing microorganism; high penetration ability, therefore, conidia present on the outside and inside of the luggage can be effectively eliminated. The treatment is fast and should introduced minimum inconvenience to passengers. However, ionising radiation has some drawbacks as the treatment affects the characteristics of some belongings carried by air-passengers. Ionising radiation has long been employed to detect contraband items at airports.

Table 4 shows the D_{10} of *M. ulei* is 0.80 kGy, which is the lowest among the fungi studied. The dose of x-rays required to inactivate conidia of the fungi with Sterility Assurance Level (SAL) of 6 is about 4.8 kGy.

Table 5 indicates items normally carried by air-travellers. Ionising radiation between dose of 13-18 kGy affect the functional properties of some items.

SELECTION OF TYPE OF IONISING RADIATION FACILITY FOR INTERCEPTION OF PLANT PATHOGENIC FUNGI AT THE KLIA

The three types of facilities considered for installation at KLIA were gamma-, electron beam and x-rays. Table 4 indicates they are equally effective in decontamination of fungi conidia. Table 6 shows comparative performance characteristics of the different type of facilities. Selection would therefore depend on whether the facility selected satisfies the requirements as listed in the criteria of techniques, for instance fast treatment, minimal inconvenience to passengers. etc.

Use of gamma as treatment technique can be discounted because firstly, it involves handling and transfer of radioactives material from one loaction to another; secondly, radioactive source introduce special problems in the case of accidents and emergencies; and thirdly, treatment of luggage using gamma takes hours to complete due to slow dose/energy delivery.

The two techniques of potential to be use for interception are x-rays and electron beam. Fortunately, electron beam can be converted to x-rays using electron converter albeit some loss of effeciency. The conversion efficiency of electron beam to x-rays has been quoted at 30% (LebaiJuri 1996). The treatment times ranges from 3-32s which is acceptable at the airport which requires rapid check-out time.

PROSPECTS OF USING IONISING RADIATION FOR QUARANTINE AND INTERCEPTION OF PLANT PATHOGENS AT KLIA

Use of ionising radiation for interception and killing fungi is technically feasible. However, there are a few consideration which need to be taken into account when operating such facility at the airport.

These are as follows:

- For electron beam and x-rays, there is a need to ensure the radiofrequency (Rf) employed doesnot interfere with FM broadcast, Rf 108-111.975 Mhz use at the control tower of the airport (some EB emits very close to this band),
- Legal implications on the treatment of passengers luggages need to be look into especially when these items are required to be transported away from the air terminal and some items are affacted by radiation,
- Ionising radiation can be used to treat luggages. What about conidia carried on the body/clothing of passengers...?

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Table 1 Exotic plant pathogenic fungi of concern in Malaysian plantation industry

Species	Plant Affacted	Country of Origin
Microcyclus ulei	Hevea Rubber	South America/Brazil
Fusarium oxysporum f. sp. elaeidies	Oil palm trees (Vascular wilts)	Africa/South America
Crinipellis perniciosa (stahel) Singer	Cocoa trees (Witches broom)	South America

Table 2 Reasons for measures undertaken at airport to intercept plant pathogenic fungi

Plate Number	Actions/Measures Undertaken	Reasons
Plate 6	**Q- tagging**	Attached to luggages at the country of origin. To identify the luggages originated from endemic areas and to facilitate treatment at the disembarking airport.
Plate 7	**Detergent on mats**	Disembarking passangers need to step on the mat wetted with disinfectants which inactivate the conidia present on the soles of the shoes
Plate 8	**Air-blowers**	Disembarking passangers need to pass through the air-tunnel equipped with blowers. Conidia attach to clothing of passengers will be blown and sucked by special equipments.
Plate 9	**UV-treatment of luggage**	Tagged passengers luggages are collected and exposured for a duration of 15 minutes to inactivate conidia attached on the outside of these luggages.
Plate 10	**Detergent treatment of containers**	Containers carrying luggages from endemic region are tagged and decontaminated with detergents on arrival at the local airport.

Table 3 The effect of UV, temperature and sterilants on the germination of conidia of *M.ulei*

Types of Treatment		Pre-treatment germination rate of conidia (%)	Time/Temperature/% concentration of sterilant in solution to inhibit germination
Ultra-violet rays (254nm)		65	60 minutes
Dettol		80	5%
Bacillol plus		79	5%
Sterilium		78	2.5%
Ethyl-alcohol		81	70%
			Germination rate of conidia after storage at the various temperature for 24 hours
Temperature (^{o}C)	74	81	79%
	28	81	10%
	0-4	81	6%
	23	81	10%
	30	81	15%

Table 4 Comparative radiosensitivity of conidia of selected pathogenic fungi in dry condition to the different type of ionising radiation

Species	D_{10} (kGy)		
	Gamma	Electron beam	X-rays
Cy. quinqueseptatum	1.48	1.33	1.43
Co. gloeosprioides	1.81	1.51	0.90
F. monoliforme	1.39	1.57	1.32
P. botryosa	1.39	1.54	1.58
F. semitectum	nd	1.27	0.72
F.oxysporum	nd	1.31	1.33
M.ulei	nd	nd	0.80

*nd denotes not determined

Table 5 Personal items usually accompanying passengers affected by ionising radiation (Gamma-rays)

Personal Items	Dose received (kGy)	Effects
Automatic watch	17.2	√, not functioning
Camera	13-18	×
Camera film	15.8	√, not functioning
Cosmetic items	13-18	×
Clothings (synthetics and cottons)	13-18	×
Drinking glass	15.8	√, discoloration
Diskettes	13-18	×
Film transparency	13-18	×
Needles and thread	13-18	×
Slides	13-18	×
Shavers	13-18	×
Sports bags	13-18	×
Transistor radio	15.8	√, Not functioning
Umbrella	13-18	×
Video tapes	16.5	√, Quality of picture
Wellington boots	13-18	×
Wallets (synthetic and leather)	13-18	×

Table 6 Comparative performance characteristics of C0-60, X-rays and Electron Beam Accelerator (EB)

Characteristics	Co-60	X-rays	EB
Energy level (Mev)	1.25	up to 5	up to 10
Penetration in water	~30cm	~30cm	0.33cm/MeV
Dose rate (kGy/s)	0.02 (slow)	1.0 (Medium)	up to 1 bil. (fast)
Annual replenishment	Yes, 12.5%	none	none
Treatment time	Long (h)	Medium, 32s	Short, 3s
Size of treated luggage	Large	large	Small
Process control	Conveyor speed (time)	Conveyor speed (time)	Conveyor speed (time), Beam current, Energy level
Safety control	Water pool, Maze, Sheilding; Interlocking, Ozone removal	On/Off, Maze, Sheilding; Interlocking, Ozone removal	On/Off, Maze, Sheilding; Interlocking, Ozone removal

Plate 1 Young rubber seedling infected with South American Leaf Blight (SALB)

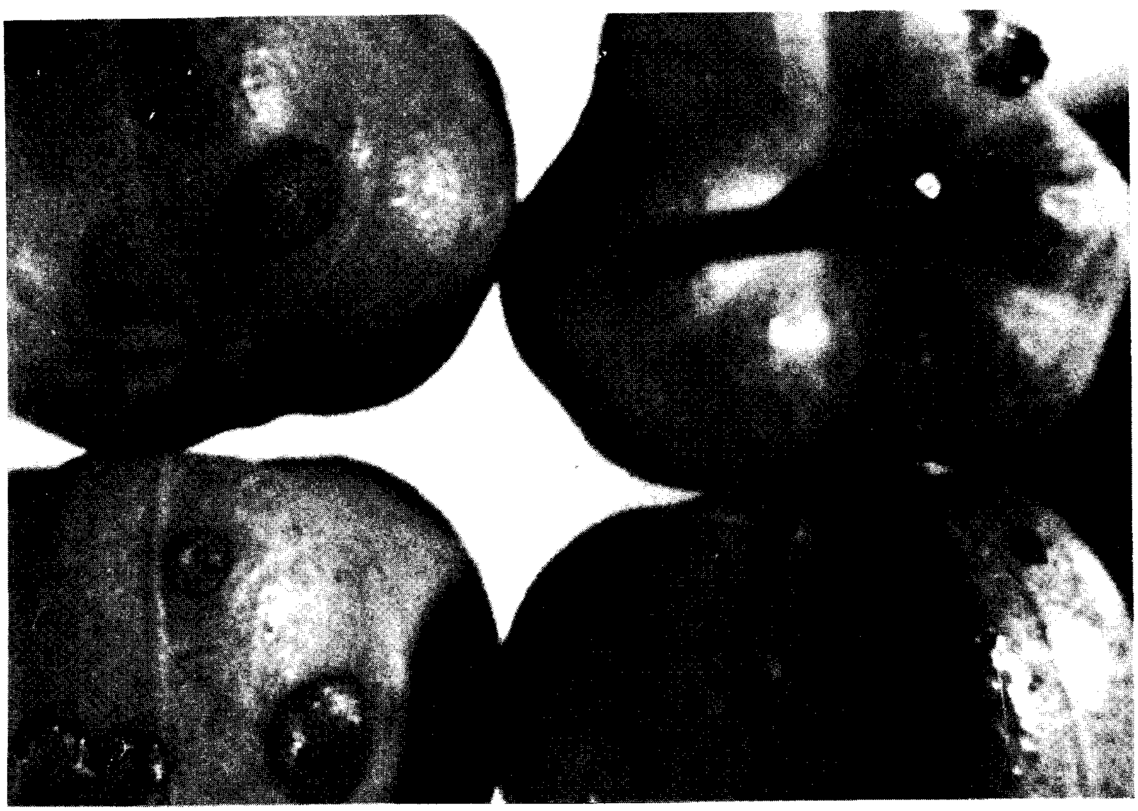

Plate 2 Rubber Fruit infected with South American Leaf Blight (SALB)

Plate 3 Uninfected (left) and infected (right) mature rubber branches with South American Leaf Blight (SALB)

Plate 4 A typical rubber plantation in South America invaded by South American Leaf Blight (SALB)

Plate 5. Q-Tagging

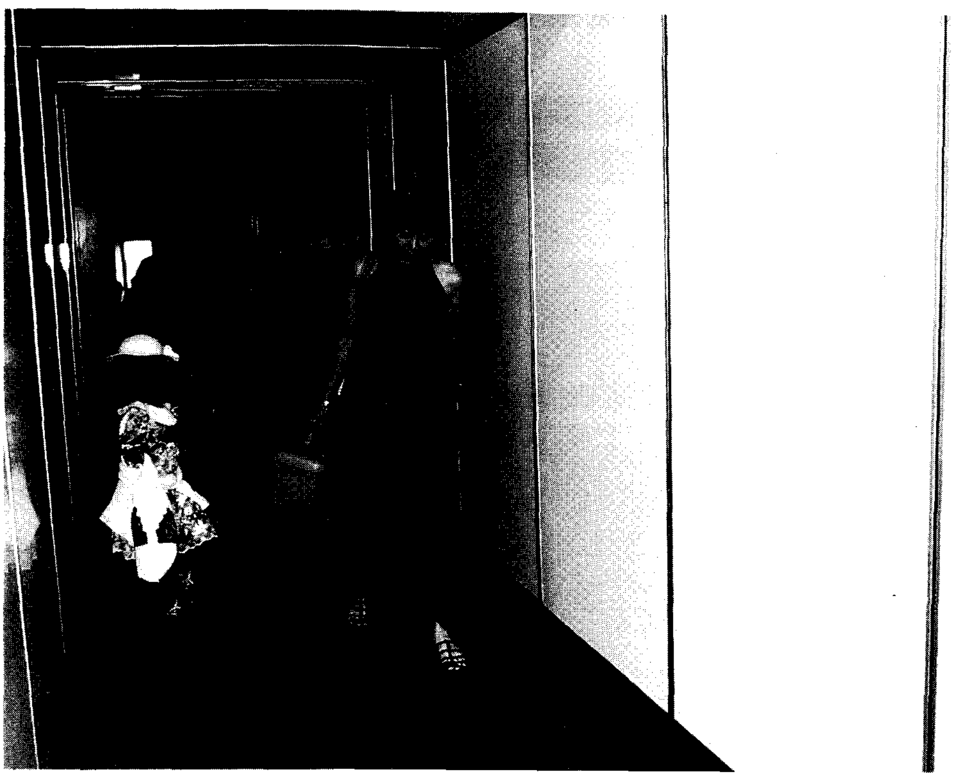

Plate 6. Mat wetted with disinfectant

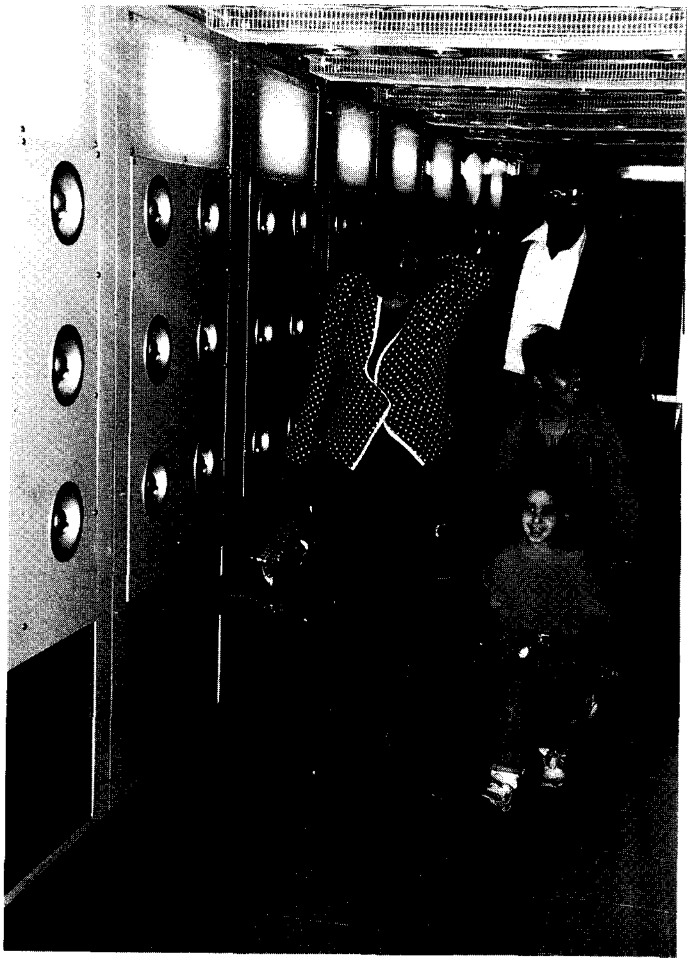

Plate 7. Wind tunnel

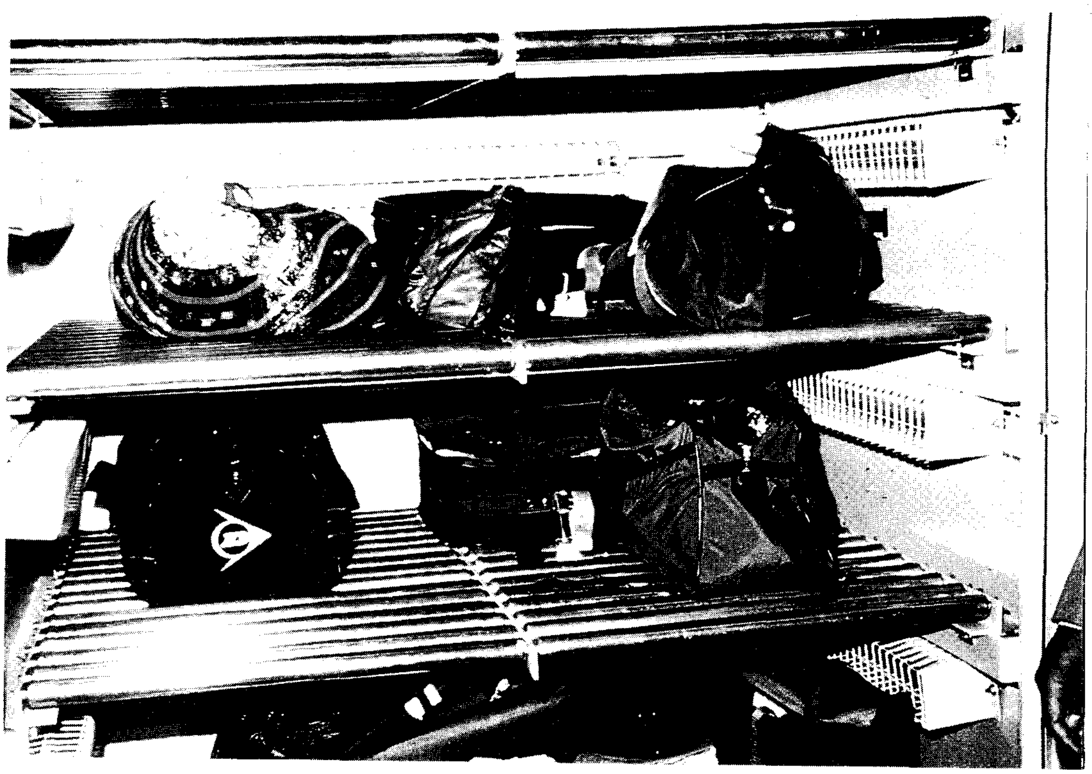

Plate 8. Luggages treated with Ultraviolet light

Plate 9. Disinfection of container from endemic region