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Reaction of Hevea *Clones to Races of* Microcyclus ulei *in Brazil*

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Over one hundred selections of Hevea brasiliensis, H. benthamiana, H. pauciflora, H. carmagoana *and their crosses from Brazil were tested* in vitro *for their reaction to South American leaf blight* (Microcyclus ulei). *Of the twelve clones recommended for commercial-scale planting, MDX 42 was resistant, while FX 2261 and FX 3864 were less susceptible to the five races of* M. ulei *tested, clone FX 2261 was susceptible to only* Race 1, *clone FX 985 to* Races 7 *and* 9, *whereas FX 3864 was susceptible to all the five races. Many of the experimental clones and clones in the national clonal competition trial were resistant.*

The main constraint to the cultivation of rubber (*Hevea brasiliensis* Muell. Arg.) in Brazil is South American leaf blight (SALB) caused by *Microcyclus ulei* (P. Henn.) Arx. Chemical control is possible but costly. The various methods of disease prevention include planting rubber in areas where the trees largely escape the disease – *i.e.* in the states of Sao Paulo, Rio de Janeiro, Espirito Santo, Minas Geraes, South Mato Grosso, Goias and north of Parana. These so called 'non-traditional' areas for rubber cultivation do not have optimal soil and climatic conditions but the winter is sufficiently cold and dry to prevent serious infection of SALB. A second approach to disease prevention is crown budding with *H. pauciflora,* which is immune to SALB. *H. pauciflora* clone PA 31 (among others) has been found to be suitable, since it does not appear to depress the yield of trunk clones. The third approach lies in breeding for disease resistance. A wide selection of material, including many high-yielding clones, is available in the National Centre of Rubber Research in Manaus and in the EMBRAPA/CEPLAC Station (EDJAB) in Una, Bahia. This paper reports the results of resistance screening tests carried out with this and other clonal material against the five races of *M. ulei* known to be present in Bahia from our work now in progress. Conidial populations of *M. ulei* from various clones when inoculated on leaf discs of different *Hevea* clones showed

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that the reaction was either positive or negative, enabling five races to be identified.

MATERIALS AND METHODS

The method of preparing the inoculum and leaf discs for *in vitro* screening tests was as described by Chee[1]. Conidial inoculum for the five races of *M. ulei* was obtained from the EMBRAPA Station in Una from clones IAN 873 *(Race 1)*, FX 3864 *(Race 6)*, FX 985 *(Race 7)*, FX 2804 *(Race 8)* and FX 3846 *(Race 9)*. Most clones were tested against only four races because conidia of *Race 8* were not available. Young leaves for the screening tests were picked from the Station. Discs were incubated at 24°C under continuous light (2600 lux) for six days. Ten discs of each clone were tested on three occasions. Disease development was assessed by estimating the size of fifty lesions selected at random from ten discs, using the dot scale shown in *Figure 1*. No reaction (NR) indicates no lesion formation; where infection was observed, the average lesion size is given. The lesion sizes were grouped into five classes thus:

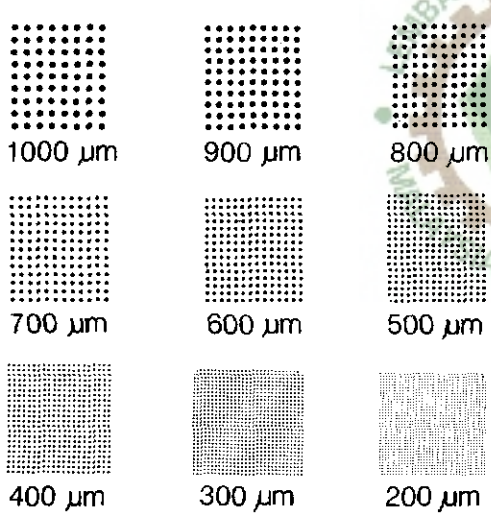

Figure 1. Scale for assessing lesion size on leaf discs of H. brasiliensis *six days after inoculation with* M. ulei.

Class	Lesion size (µm)	Resistance/ susceptibility
1	0 – 250	HR
2	251 – 350	R
3	351 – 450	MR
4	451 – 550	S
5	551	HS

HR = Highly resistant
R = Resistant
MR = Moderately resistant
S = Susceptible
HS = Highly susceptible

The clones tested bear the following prefixes: F (Ford), FX (Ford hybrid), IAN (Instituto de Pesquisas Agropecuárias do Norte), MDX (Madre de Dios hybrid), SIAL (Selecão do Instituto Agronômico do Leste), CNS–AM, –RO, –AC (Centro Nacional de Pesquisa da Seringueira – Amazonas, – Rondonia, – Acre), RRIM (Rubber Research Institute of Malaysia), IAC (Instituto Agronômico de Campinas), PFB (Pé Franco Belterra), M (Matriz), GT (Gondang Tapen), TP (Três Pancadas), GA (General Administration), EEU (Estacão Experimental de Una), A (Acre), P (Pauciflora), PA (Pauciflora Amazonas), and BD (Bodjong Datar).

Field susceptibility of the clones was based on field observations[2] as well as on the degree of leaf area necrosis in the clonal garden[1].

RESULTS

The results of the tests on clones currently recommended for commercial planting[3] are presented in *Table 1*, on clones in the national clonal competition trial in *Table 2* and others in *Table 3*.

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TABLE 1. SUSCEPTIBILITY OF *HEVEA* CLONES CURRENTLY RECOMMENDED FOR COMMERCIAL PLANTING IN BRAZIL TO FIVE RACES OF *M. ULEI*

Clone	Parentage	Disease reaction/lesion size (μm)					Mean lesion size (μm)	Susceptibility[a]	
		Race 1	Race 6	Race 7	Race 8	Race 9		Laboratory	Field
Large-scale planting									
FX 2261	F1619 x AVROS 183	526	NR	NR	NR	NR	526	4	3
FX 985	F315 x AVROS 183	NR	NR	487	NR	487	487	4	3
FX 3864	PB 86 x B 38	525	567	542	472	502	522	4	4
FX 3844	AVROS 183 x B 45	379	251	683	NR	625	486	4	3
FX 4163	Tjir 1 x F 170	483	374	502	NR	318	419	3	3
Small-scale planting									
MDF 180	Madre de Dios Firestone	716	621	362	483	468	530	4	?
FX 4098	PB 86 x B 74	334	394	517	108	569	384	3	2
IAN 873	PB 86 x FA 1717	312	481	250	NR	NR	366	3	4
FX 3846	AVROS 183 x B 45	562	490	418	NR	562	538	4	4
Experimental-scale planting									
MDX 42	AVROS 1581 x Madre de Dios	NR	NR	NR	NR	270	270	2	2
FX 25	F 351 x AVROS 49	241	506	512	431	254	389	3	3
RRIM 628	Tjir 1 x RRIM 527	272	624	580	457	613	509	4	4

Standard error of lesion size = 4.7594; $LSD_{0.05}$ = 9.3284
NR = No reaction
[a]1–5 scale of decreasing resistance

TABLE 2. SUSCEPTIBILITY OF *HEVEA* CLONES PLANTED IN NATIONAL CLONAL COMPETITION TRIAL IN BRAZIL TO FOUR RACES OF *M. ULEI*

Clone	Parentage	Disease reaction/lesion size (μm)				Mean lesion size (μm)	Susceptibility[a]
		Race 1	Race 6	Race 7	Race 9		
IAN 4488	FX 4421 x Tjir 1	NR	NR	129	144	137	1
IAN 6159	FX 43–655 x PB 186	NR	NR	125	NR	125	1
CNS AM 7721	Amazonas selection	NR	NR	NR	NR	0	Immune
SIAL 842	M 4 x IAN 6539	131	154	62	83	108	1
MDX 42	AVROS 1581 x M. de Dios	NR	NR	NR	270	270	2
MDX 96	AVROS 308 x M. de Dios	NR	107	128	318	184	1
IP 63	*H. brasiliensis*	NR	93	430	169	231	1
MDX 98	AVROS 308 x M. de Dios	325	327	478	403	383	3
IAN 6590	FX 43–651 x PB 86	238	573	313	356	370	3
TP 1	*H. brasiliensis*	NR	493	598	513	535	4
TP 749	*H. brasiliensis*	NR	660	494	544	566	5
RRIM 628	Tjir 1 x RRIM 527	272	624	580	457	483	4
FX 3649	PB 86 x B 110	302	623	584	506	504	4
CLAV 8	?	109	715	747	644	554	5
FDR 1057	?	157	531	425	570	421	3

Standard error of lesion size = 3.0721; $LSD_{0.05}$ = 6.0213
NR = No reaction
[a] 1–5 scale of decreasing resistance

TABLE 3. SUSCEPTIBILITY OF CLONES PLANTED IN ESTACÃO EXPERIMENTAL DJALMA BAHIA TO FOUR RACES OF *M. ULEI*

Clone	Parentage	Disease reaction/lesion size (μm)				Mean lesion size (μm)	Susceptibility [a]
		Race 1	Race 6	Race 7	Race 9		
FX 349	F 4542 x Tjir 1	NR	NR	NR	NR	0	Immune
FX 567	F 4542 x AVROS 368	NR	NR	NR	NR	0	Immune
FX 652	F 4542 x Tjir 1	NR	NR	NR	NR	0	Immune
FX 2804	F 4542 x Tjir 1	NR	NR	NR	NR	0	Immune
FX 3899	FX 4542 x AVROS 368	250	NR	NR	NR	250	Immune
IAN 710	PB 86 x F 409	NR	457	225	205	296	2
IAN 713	PB 86 x F 409	142	309	223	239	228	Immune
IAN 717	PB 86 x F 4542	NR	NR	NR	356	356	3
IAN 2879	FX 516 x PB 86	NR	NR	NR	NR	0	Immune
IAN 2903	FX 516 x PB 86	NR	NR	NR	NR	0	Immune
IAN 3037	FX 516 x PB 86	NR	732	136	367	412	3
IAN 3044	FX 516 x PB 86	NR	NR	NR	NR	0	Immune
IAN 3130	FX 516 x PB 86	NR	NR	NR	NR	0	Immune
IAN 3156	FX 516 x PB 86	NR	NR	372	549	461	4
IAN 3248	FX 516 x PB 86	NR	NR	NR	NR	0	Immune
IAN 3272	FX 516 x PB 86	NR	NR	NR	431	431	3
IAN 3937	Tjir 1 x FX 4374	NR	NR	NR	NR	0	Immune
IAN 6138	FX 43–446 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6139	FX 43–446 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6155	FX 43–655 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6159	FX 43–655 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6433	FX 3846 x Tjir 1	NR	NR	NR	NR	0	Immune
IAN 6475	P 10 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6488	P 10 x PB 86	NR	NR	NR	231	231	1
IAN 6490	P 10 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6538	P 10 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6540	P 10 x PB 86	NR	416	539	385	447	3
IAN 6544	P 10 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6742	FX 43–655 x PB 86	NR	NR	NR	NR	0	Immune
IAN 6750	FX 43–443 x AVROS 49	NR	NR	NR	NR	0	Immune
IAN 6897	FX 43–651 x PB 86	NR	360	462	274	425	3
SIAL 90	RRIM 509 ill	NR	NR	185	209	197	1
SIAL 167	RRIM 509 ill	NR	NR	NR	NR	0	Immune
SIAL 263	RRIM 501 ill	112	179	157	237	171	1
SIAL 288	GT 711 ill	NR	231	NR	NR	231	1
SIAL 321	GT 711 ill	NR	NR	NR	NR	0	Immune
SIAL 335	GT 711 ill	NR	783	708	501	664	5
SIAL 368	RRIM 509 ill	NR	NR	NR	NR	0	Immune
SIAL 377	GT 711 ill	NR	616	86	539	414	3
SIAL 444	PB 49 ill	NR	NR	NR	190	190	1
SIAL 514	GT 711 ill	NR	708	539	NR	624	5
SIAL 542	RRIM 501 ill	NR	530	354	NR	442	3
SIAL 622	RRIM 509 ill	262	763	671	490	547	4
SIAL 640	RRIM 501 ill	NR	311	475	NR	393	3

TABLE 3. SUSCEPTIBILITY OF CLONES PLANTED IN ESTAÇÃO EXPERIMENTAL DJALMA BAHIA TO FOUR RACES OF *M. ULEI* (CONTD)

Clone	Parentage	Disease reaction/lesion size (μm)				Mean lesion size (μm)	Susceptibility[a]
		Race 1	Race 6	Race 7	Race 9		
SIAL 649	RRIM 509 ill	NR	NR	200	554	377	3
SIAL 652	RRIM 501 ill	NR	NR	NR	NR	0	Immune
SIAL 668	RRIM 509 ill	342	610	297	321	393	3
SIAL 703	?	NR	NR	NR	NR	0	Immune
CNS AM 7665	Amazonas selection	NR	NR	NR	NR	0	Immune
CNS AM 7701	Amazonas selection	185	477	308	293	316	2
CNS AM 7717	Amazonas selection	293	203	359	367	306	2
CNS AM 7907	Amazonas selection	NR	NR	NR	NR	0	Immune
CNS RO 7808	Amazonas selection	194	582	222	302	325	2
CNS AC 7614	Amazonas selection	NR	NR	539	421	480	4
IAC 206	IAN 873 polyploid	92	585	185	246	277	2
IAC 209	IAN 873 polyploid	NR	862	NR	755	809	5
IAC 215	IAN 873 polyploid	318	816	418	755	577	5
IAC 226	IAN 873 polyploid	200	832	339	246	404	3
IAC 231	IAN 873 polyploid	419	733	624	688	616	5
RRIM 513	Pil B 16 x Pil A 44	590	598	613	411	553	5
RRIM 600	Tjir 1 x PB 86	385	257	431	405	370	3
RRIM 614	Tjir 1 x RRIM 509	354	628	470	477	482	4
GT 127	*H. brasiliensis*	372	NR	436	183	330	2
GT 711	*H. brasiliensis*	184	329	372	257	286	2
GA 255	*H. brasiliensis*	NR	NR	647	678	663	5
GA 1297	*H. brasiliensis*	NR	NR	300	400	350	2
A 2	*H. brasiliensis*	NR	NR	393	NR	393	3
A 5	*H. brasiliensis*	NR	759	NR	NR	739	5
A 8	*H. brasiliensis*	400	370	323	NR	364	3
M 1	*H. brasiliensis*	NR	862	801	123	595	5
M 7	*H. brasiliensis*	NR	NR	NR	NR	0	Immune
P 22	*H. pauciflora*	NR	NR	339	NR	339	2
PA 31	*H. pauciflora*	NR	NR	NR	NR	0	Immune
PFB 15	*H. brasiliensis?*	NR	NR	NR	NR	0	Immune
TP 2	*H. brasiliensis*	NR	NR	108	NR	108	1
BD 5	*H. brasiliensis*	NR	385	NR	123	193	1
EEU 1	*H. brasiliensis*	246	NR	293	185	241	1
F 4521	*H. benthamiana*	NR	NR	NR	NR	0	Immune
–	*H. carmagoana*	NR	NR	NR	NR	0	Immune

Standard error of lesion size = 6.3885; $LSD_{0.05}$ = 12.5215
NR = No reaction
[a]1–5 scale of decreasing resistance

All the clones recommended for commercial planting were susceptible to one or more races; FX 2261 was susceptible to only *Race 1*, MDX 42 to *Race 9* and FX 985 to *Races 7* and *9*. Among the fifteen clones in the national competition trial *(Table 2)*, four clones (IAN 4488, IAN 6159, CNS AM 7721, SIAL 842) were highly resistant to all the four races tested. MDX 42, MDX 96 and TP 63 were slightly susceptible to only one of the four races tested. *Table 3* shows that clones with F 4542 *(H. benthamiana)* parentage were resistant to most of the

four races, and that the cross, P 10 *(H. pauciflora)* x PB 86 produced both resistant (IAN 6475, IAN 6488, IAN 6490, IAN 6538, IAN 6544) and susceptible (IAN 6540) progenies.

Table 4 indicates that the frequency of infection with *Races 6, 7* and *8* was about the same, with *Race 1* being the least frequent. In terms of severity of infection, *Race 6* caused the largest lesions and *Race 1* the smallest.

DISCUSSION

Chee[1] found that the results of laboratory susceptibility tests on leaf discs correlated well with the susceptibility of the whole plant in field trials conducted in Trinidad. The *M. ulei* present in Trinidad is *Race 6* (unpublished) which causes larger lesions on the oriental clone RRIM 600 than the same race in Bahia. On the other hand, the two South American clones FX 25 and IAN 710 are more susceptible in Bahia than in Trinidad. It is possible that the Trinidad *Race 6* is better adapted to oriental clones and the Bahia race to South American clones, for in Trinidad, almost all clones are of Asian origin whereas in Bahia they are mainly South American. A race may consist of strains of different virulence [4,5] which can account for differences in pathogenicity from locality to locality.

Field data on the reaction to SALB of the materials tested in the present study are only available for clones currently recommended for commercial planting *(Table 1)*. The laboratory susceptibility rating nevertheless correlates well with field observations for most of these materials when reaction to the most pathogenic race is considered, although FX 2261 and FX 3864, rated as susceptible in the laboratory, exhibit some field resistance. Clone FX 3864 produces significantly smaller conidial lesions than other susceptible clones. Its field resistance can probably be attributed to delayed leaf fall. Nevertheless, both FX 2261 and FX 3864 sulfer severe defoliation at the height of the disease season.

Clone FX 4098 has shown high susceptibility in laboratory tests but appear to be less susceptible in the field, although it has only been studied in a few rows in our clonal garden. Clone MDF 180 is reputed to possess resistance originating from Madre de Dios, but many are suspected to have been misidentified in the Station and hence wrongly recorded as susceptible in the laboratory.

TABLE 4. FREQUENCY OF INFECTION OF 104 *HEVEA* CLONES WITH FOUR RACES OF *M. ULEI* (DATA FROM *TABLES 1 – 3*)

M. ulei	No. of clones infected	Average lesion size (μm) and standard error
Race 1	35	313 ± 30.5
Race 6	49	507 ± 25.8
Race 7	59	399 ± 23.5
Race 9	57	391 ± 23.9

$LSD_{0.05}$ = 59.78

No firm conclusions can be drawn concerning the applicability of the *in vitro* resistance scores to the behaviour of clones in the field until more information is available on the distribution of races and on the aggressiveness of local isolates of these races. However, it would be prudent to view with caution the widespread planting of clones with apparent immunity to the disease, or their extensive use for breeding purposes. If immunity is attributable to a major gene it may well be short-lived.

Disease susceptibility tests conducted in Trinidad[1] and in the South American continent[6] have shown that without exception, all the high-yielding oriental clones, descendants of Henry Wickham's seed collection from the Tapajos River, are highly susceptible to SALB. In contrast, the new Brazilian selections tested in the present study contain a high percentage of resistant clones, and will hopefully provide material for developing clones superior in resistance to the disease than those in current use.

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REFERENCES

1. CHEE, K.H. (1976) Assessing Susceptibility of *Hevea* Clones to *Microcyclus ulei*. *Ann. appl. Biol.*, **84**, 135–145.

2. SENA GOMES, A.R., FILHO, A.C.V., MARQUES, J.R.B. AND SANTOS, P.M. (1982) Avaliacão de clones de seringueira (*Hevea* sp.) no sul da Bahia. *CEPLAC.*, 17 pp.

3. CEPLAC/ EMBRAPA/ SUDHEVEA/ EMBRATER (1983) Sistema de producao de seringueira para a regiao sul da Bahia. *Convênio CEPLAC/EMBRAPA*, 48 pp.

4. LANGDON, K.R. (1966) Development of a New Medium for Culturing *Dothidella ulei* in Quantity. *Phytopathology*, **56**, 564–565.

5. LIYANAGE, A. de S. AND CHEE, K.H. (1980) The Occurrence of a Virulent Strain of *Microcyclus ulei* on *Hevea* Rubber in Trinidad. *Proc. nat. Sem. Rubb.*, **1**, 52–61.

6. LANGFORD, M.H. (1945) South American Leaf Blight of *Hevea* Rubber Trees. *Tech. Bull. U.S. Dep. Agric.*, **882**, 31 pp.