

SCREENING OF CACAO CULTIVARS FOR RESISTANCE
TO *Phytophthora palmivora* IN THE COLLECTION
AT CATIE, COSTA RICA

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ABSTRACT

Screening of the CATIE cacao collection for resistance to *Phytophthora palmivora* was initiated, using point-inoculation with zoospore suspension of unwounded attached pods to evaluate cultivar response. Of the 51 cultivars tested, 9 showed a promising degree of resistance; EET 59, EET 376, Pound 7, UF 713, UF 715, Scavina 6, Scavina 12, Catongo, Diamantes 800.

INTRODUCTION

Losses in cacao due to *Phytophthora palmivora* (Butler) Butler (*Phytophthora* pod rot disease) can be reduced by cultural methods and by the use of fungicides. However, these practices, especially fungicide applications, are often costly in relation to the quantity of cacao beans saved and many growers regard them as economically unfeasible, particularly when

cacao prices are low. The use of resistant varieties is often the most effective and economic means of controlling plant diseases, and the replacement of susceptible cacao trees by material showing durable race non-specific resistance to *P. palmivora* would provide the ideal, long-term solution to combatting the disease.

Unfortunately, amongst those cacao cultivars in the world whose

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reaction to *P. palmivora* is known, most exhibit varying degrees of susceptibility to *Phytophthora* pod rot and so far no immune cultivars have been found, although a number in different areas have been reported to show relatively low levels of susceptibility (9, 10, 13). Consequently, the search for resistant parent material remains a basic requirement in breeding for resistance to *P. palmivora*.

The larger cacao collections of the world may provide valuable sources of resistance since the reaction to *P. palmivora* infection is still unknown for many of their accessions. For this reason, systematic screening of the CATIE collection was initiated with the purpose of identifying promising resistant cultivars which could be of use in breeding programmes. This report presents the results obtained up to July 1977.

MATERIALS AND METHODS

A previous study in Costa Rica (4) showed that the most reliable and consistent method for screening fruiting cultivars was point-inoculation with standard zoospore suspension of attached pods without wounding, the method adopted here. Pods of known age, 1 month from maturity, were used and whenever possible only one or two were selected from each tree. Ten replicate pods per cultivar were inoculated and when sufficient

pods were available each cultivar was tested at least twice at different times. Both percentage successful infection and average lesion diameters were recorded, the latter when lesion sizes on pods of UF 677, a standard, highly susceptible cultivar included in all tests, attained an average diameter of 6 cm. When cultivars were tested twice or more, percentage infection and average lesion diameters were calculated from the sum of all inoculated pods.

The same single-sporangium *P. palmivora* isolate (morphological form 1, compatibility type A2), selected on the basis of pathogenicity on pods, was used in all tests. To maintain infective potential, the isolate was passed through pod tissue every 1–2 months. Zoospore suspensions at a concentration of 2×10^5 spores/ml were prepared as described by Lawrence (4).

All cultivars examined were cloned material and, whenever possible, higher yielding cultivars or those suspected from field observations of possessing better resistance to *P. palmivora* were tested. All tests were carried out between April and December each year, a period which encompassed peaks in *P. palmivora* incidence and which coincided with the times of higher pod production and greatest rainfall.

RESULTS AND DISCUSSION

Of the 51 cultivars examined, nine demonstrated a promising degree of

resistance; EET 59, EET 376, Pound 7, UF 713, Scavina 6, Scavina 12, Catongo, Diamantes 800 and UF 715 (Table 1). Catongo was obtained as cuttings from one of the original selections in Bahia, Brazil, and Diamantes 800 is a selection from the Diamantes Experimental Station in Costa Rica.

With these nine cultivars, as well as CC 42, even when percentage infection was high, lesions developed very slowly, often ceasing expansion altogether 2-3 days after visible symp-

toms first appeared, thus, indicating resistance to post-penetration development by *P. palmivora*. On the basis of percentage infection, EET 376, Scavina 6, Scavina 12, and especially EET 338 appeared to be more resistant to epidermal and epicarp penetration by *P. palmivora*. However, when lesions formed on EET 338, they developed as rapidly as on the most susceptible cultivars. Therefore, only EET 376, Scavina 6 and Scavina 12 showed resistance to both initial penetration and post-penetration growth by *P. palmivora*.

Table 1 - Responses of cacao cultivars to point-inoculation with *P. palmivora* zoospore suspension of unwounded attached pods.

Cultivar	% successful infection*	Av lesion diam (cm)§	Cultivar	% successful infection	Av lesion diam (cm)
EET 59	100	0.4	IMC 67 ⁺	90	3.5
EET 376	50	0.5	EET 397 ⁺	100	3.5
Pound 7	70	0.6	UF 12	90	3.6
UF 713	90	0.6	UF 668	85	3.8
Scavina 6	40	0.65	UF 168 ⁺	95	4.3
Scavina 12	55	0.7	UF 10 ⁺	100	4.6
Catongo	95	0.7	Pound 12	80	5.0
Diamantes 800	80	0.75	P 16 ⁺	100	5.1
UF 715	70	0.8	UF 29	100	5.1
UF 704	75	1.0	UF 708 ⁺	95	5.2
CC 42	85	1.0	UF 122	95	5.2
CC 38 ⁺	90	1.2	UF 650	100	5.4
UF 613	95	1.2	EET 75 ⁺	100	5.4
SIC 433 ⁺	100	1.5	UF 676	100	5.5
EET 156 ⁺	70	1.9	UF 667	95	5.6
UF 36 ⁺	100	2.5	UF 221	100	5.7
UF 601	95	2.6	UF 677	90	6.0
UF 707 ⁺	85	2.9	R 56 ⁺	100	6.1
CAS 3 ⁺	100	2.9	R 13 ⁺	100	6.1
UF 296	95	3.0	R 10	90	6.2
CC 41	100	3.0	GS 36 ⁺	100	6.2
UF 93 ⁺	100	3.1	R 52 ⁺	95	6.3
CC 45 ⁺	90	3.2	EET 338	35	6.5
UF 701 ⁺	90	3.2	SGU 71 ⁺	100	7.1
CC 10	100	3.3	EET 353 ⁺	100	8.0
UF 654	95	3.4			

* 2 opposite, lateral inoculum points on each of 10 replicate pods per test.

§ measured when av lesion diam on the "standard" susceptible cultivar UF 677, included in each test, attained 6cm.

+ cultivar tested only once.

With respect to pod losses under natural conditions, resistance to epidermal and epicarp penetration alone may be a less important character than resistance to post-penetration, as exemplified by EET 59 and EET 338. Although infection may be low with EET 338, whenever it does occur the pods rot quickly. With EET 59, proportionately many more pods may be infected but probably fewer become rotted before harvest. The net result, therefore, is that, other things being equal, EET 338 probably suffers greater pod losses than EET 59. Field observations tended to support this hypothesis but pod or bean loss data were not available to confirm it.

Nevertheless, post-penetration resistance which retards the rate of pod tissue colonization by *P. palmivora* and which, consequently, reduces the risk of bean infection before harvest, is a more desirable form of resistance than that to initial penetration alone. Whenever this latter type of resistance is overcome by the pathogen, there is no further resistance to growth within pericarp tissues and rapid rotting of the pod ensues.

Responses to *P. palmivora* infection of a number of the cultivars have been reported previously, from Costa Rica and elsewhere, evaluation being either by natural infection in the field or by artificial inoculation methods (1, 2, 3, 5, 6, 7, 8, 11, 12, 14, 15, 16, 17). With most of these cultivars there is good agreement in their responses

to *P. palmivora* between previous reports and the present results. However, some notable differences exist. CC 41 and UF 29 were reported as resistant under field conditions in the Atlantic Zone of Costa Rica (1, 15) but these two cultivars show disease escape in that area (1) and their intrinsic susceptibility has been established (1,4).

Measuring development of *P. palmivora* mycelium in liquid media incorporating pod-husk tissue, Orellana (7) in Costa Rica graded UF 12 as resistant, in contrast to the moderately susceptible reaction reported here. However, methods utilizing pod-tissue extracts fail to take into account possible physical and chemical resistance mechanisms imparted by or present in intact epidermal and pericarp tissues, so that differences in cultivar response between these methods and inoculations of intact pods could be expected.

Using a stem-inoculation method, Zentmyer (17) reported that UF 715 was highly susceptible. Since this cultivar was tested with a Costa Rican A2 isolate from cacao, the discrepancy with the present results is hard to explain. Stem inoculations and inoculations of attached pods have been shown to be similarly reliable and consistent as methods for assessing resistance to *P. palmivora* (4), so such drastic differences in cultivar response between the two methods would not be expected. So far, all *P. pal-*

mivora isolates from cacao in Costa Rica have been identified as morphological form 1, so it seems unlikely that the discrepancy was due to the use of different morphological forms.

Of the nine most resistant cultivars mentioned here, responses to *P. palmivora* of only four others in addition to UF 715 have been reported previously, all being classified as resistant; Pound 7 (8), Scavina 6 (3, 8, 11, 12, 16, 17), Scavina 12 (11, 16) and Catongo (5, 6, 12, 14, 17). In future screening of the CATIE collection it is recommended that the following potentially promising cultivars be

examined: EET 19, 48, 62 and 64; CC 9, 17, 34, 48, 69, 107, 124, 137, 152 and 178; CAS 1 and 2; PA 169; CATIE 1000.

It should be emphasized that the reaction to *P. palmivora* infection of all cultivars, including those reported here, only applies to those areas where they were tested and to those strains of *P. palmivora* with which they were infected. Cacao types reported as more resistant may well be much more susceptible in other cacao-growing regions where different environmental conditions might prevail and where other morphological forms and races of *P. palmivora* might be present.

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RESUMO

Seleção para Resistência a *Phytophthora palmivora* em Cultivares de Cacao da Coleção de CATIE, Costa Rica

Foi iniciada a seleção para resistência a *P. palmivora*, na coleção de cacao de CATIE, usando-se inoculação pontual com suspensão de zoósporos em frutos não destacados e sem ferimentos para avaliação da resposta dos cultivares. Dos 51 cultivares testados, nove apresentaram grau de resistência promissor, a saber: EET 59, EET 376, Pound 7, UF 713, UF 715, Scavina 6, Scavina 12, Catongo, Diamantes 800.

