

Screening of cocoa types against *Phytophthora* pod rot disease

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ABSTRACT

The reaction of 225 different cocoa types maintained at Cadbury-Kerala Agricultural University Co-operative Cocoa Research Project, College of Horticulture, Vellanikkara against *Phytophthora* pod rot was evaluated by artificial inoculation of the pathogen *Phytophthora palmivora* on detached cocoa pods. Observations on the per cent pod area infection recorded eight days after inoculation revealed that, none of the cocoa types screened were immune to the disease. However, the cocoa types differed with each other in the percentage of pod area infection. Based on this eight cocoa types viz., G VI 14, G VI 73, G VI 77, G VI 124, G VI 138, G VI 154, G VI 279, G VI 284 which showed less than 50 per cent pod area infection were categorized as moderately resistant to the disease. Moderately susceptible reaction was recorded with 64 cocoa types and the rest were susceptible.

Key words: Cocoa, *Phytophthora palmivora*, Pod rot.

INTRODUCTION

Cocoa (*Theobroma cacao* L.), a beverage crop, is mainly grown as a mixed crop in the existing arecanut and coconut gardens in Kerala, Karnataka and Tamil Nadu states of India. Cocoa is prone to the attack of many diseases. Among the various diseases, *Phytophthora* pod rot (PPR) is the most serious one inflicting heavy crop losses during rainy periods. Though, the use of chemicals offers satisfactory control of the disease, their indiscriminate use possesses many environmental problems. Hence, it is necessary to locate a source resistance to be used in the integrated management practice of the disease to reduce the crop losses. Screening of cocoa types for PPR resistance using detached cocoa pods was carried out by many workers which resulted in the identification of moderately resistant types like EET 59, EET 376, SCA 6, SCA 12, DR 16, ICS 6, C 78 (Lawrence, 1978; Chandramohan, 1982; Sri-Sukamoto and Mawardi, 1986). Abraham *et al.* (2001) evaluated the reaction of 166 cocoa types to PPR and reported moderately resistant reaction in four cocoa types. The Cadbury-Kerala Agricultural University Co-operative Cocoa Research Project, College of Horticulture, Vellanikkara is collecting and maintaining a large number of cocoa types from the place of origin of crops and other cocoa growing countries of the world. Thus, the present investigation was carried out for locating a source of resistance against PPR among the available genetic resources of cocoa maintained in the project.

MATERIALS AND METHODS

Detached cocoa pods of half maturity from 225

cocoa types maintained at the Cadbury-Kerala Agricultural University Co-operative Cocoa Research Project, College of Horticulture, Vellanikkara were used for the screening by artificial inoculation with a virulent *Phytophthora palmivora* isolate. Pods were collected and a well of 10mm diameter was made on the middle portion of the pod using a sterile cork borer to a depth of 3 mm. Mycelial discs of 10 mm diameter of the pathogen grown on Carrot Agar medium were taken from seven day old culture and were placed in the well and covered with cotton moistened with sterile water. The inoculated pods were incubated in polythene bags with a pad of cotton wetted with sterile water in order to provide high humidity. Three replications were maintained for each cocoa type. Observations on the length and breadth of lesion developed were recorded daily for eight days. The per cent pod area infection was calculated as given below.

$$\text{Percentage of pod area infection} = \frac{\text{Length} \times \text{breadth of lesion}}{\text{Length} \times \text{breadth of pod}} \times 100$$

Based on the percentage of pod area infection, the cocoa types were grouped into four categories.

- R – Resistant - < 25 per cent pod area infected
- MR – Moderately resistant - > 25 to < 50 per cent pod area infected
- MS – Moderately susceptible - > 50 to < 75 per cent pod area infected
- S – Susceptible - > 75 per cent pod area infected

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Table 1: Reaction of cocoa types against *Phytophthora* pod rot

S. No.	Cocoa type	Per cent pod area infection		
		4 DAI	8 DAI	Reaction
1	G VI 2	25.5	100.0	S
2	G VI 3	35.5	92.0	S
3	G VI 4	6.2	55.5	MS
4	G VI 5	7.8	77.8	S
5	G VI 6	28.5	80.2	S
6	G VI 8	26.0	85.4	S
7	G VI 9	20.2	93.3	S
8	G VI 10	24.8	80.4	S
9	G VI 11	23.57	100.0	S
10	G VI 13	27.3	100.0	S
11	G VI 14	6.1	33.6	MR
12	G VI 16	17.7	89.8	S
13	G VI 17	24.0	73.6	MS
14	G VI 19	22.9	79.9	S
15	G VI 20	19.6	83.9	S
16	G VI 21	21.7	90.0	S
17	G VI 22	25.8	57.5	MS
18	G VI 24	29.1	91.7	S
19	G VI 25	13.7	62.0	MS
20	G VI 26	19.3	73.1	MS
21	G VI 27	19.5	87.4	S
22	G VI 28	18.5	70.2	MS
23	G VI 29	25.9	79.8	S
24	G VI 30	13.4	66.7	MS
25	G VI 31	14.9	100.0	S
26	G VI 33	12.9	91.4	S
27	G VI 34	19.5	90.0	S
28	G VI 35	43.3	83.9	S
29	G VI 36	27.4	100.0	S
30	G VI 37	21.9	96.8	S
31	G VI 38	24.6	62.5	MS
32	G VI 39	19.4	90.3	S
33	G VI 40	18.3	89.3	S
34	G VI 41	21.1	100.0	S
35	G VI 42	15.2	84.1	S
36	G VI 43	19.9	100.0	S
37	G VI 44	22.5	60.2	MS
38	G VI 45	10.3	57.5	MS
39	G VI 46	20.0	92.8	S
40	G VI 48	32.5	76.7	S
41	G VI 49	25.0	100.0	S
42	G VI 50	11.5	72.0	MS
43	G VI 51	19.7	89.4	S
44	G VI 52	18.2	91.3	S
45	G VI 53	8.9	55.3	MS
46	G VI 54	20.8	100.0	S
47	G VI 55	11.3	73.1	MS

Contd....

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S. No.	Cocoa type	Per cent pod area infection		
		4 DAI	8 DAI	Reaction
48	G VI 56	16.5	88.1	S
49	G VI 57	20.3	90.3	S
50	G VI 60	18.6	72.8	MS
51	G VI 61	36.6	100.0	S
52	G VI 64	28.2	92.5	S
53	G VI 67	20.1	100.0	S
54	G VI 68	25.3	88.8	S
55	G VI 71	27.3	82.5	S
56	G VI 73	8.9	46.5	MR
57	G VI 75	22.8	81.2	S
58	G VI 77	7.2	47.0	MR
59	G VI 78	22.5	76.7	S
60	G VI 79	25.7	88.5	S
61	G VI 80	22.1	78.3	S
62	G VI 82	9.5	63.9	MS
63	G VI 84	19.6	100.0	S
64	G VI 85	10.3	85.3	S
65	G VI 86	25.3	91.6	S
66	G VI 87	21.4	72.3	MS
67	G VI 89	17.0	73.3	MS
68	G VI 92	13.7	52.9	MS
69	G VI 94	15.8	90.6	S
70	G VI 96	18.3	86.2	S
71	G VI 98	32.1	85.0	S
72	G VI 100	10.5	99.4	S
73	G VI 101	20.6	73.0	MS
74	G VI 102	17.4	70.3	MS
75	G VI 103	28.2	89.0	S
76	G VI 104	18.4	74.3	MS
77	G VI 105	16.9	79.6	S
78	G VI 106	13.3	90.3	S
79	G VI 107	25.7	100.0	S
80	G VI 108	11.1	76.0	S
81	G VI 109	26.0	81.4	S
82	G VI 110	22.0	89.7	S
83	G VI 111	16.7	73.8	MS
84	G VI 112	14.9	76.5	S
85	G VI 113	32.7	100.0	S
86	G VI 114	24.2	100.0	S
87	G VI 115	36.3	100.0	S
88	G VI 117	27.8	86.3	S
89	G VI 118	10.7	63.4	MS
90	G VI 120	17.1	89.1	S
91	G VI 122	64.1	100.0	S
92	G VI 123	18.0	70.3	MS
93	G VI 124	8.6	41.1	MR
94	G VI 125	16.9	67.2	MS
95	G VI 126	39.3	100.0	S

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S. No.	Cocoa type	Per cent pod area infection		
		4 DAI	8 DAI	Reaction
96	G VI 127	22.3	90.2	S
97	G VI 128	20.4	100.0	S
98	G VI 129	14.1	73.7	MS
99	G VI 130	26.8	85.4	S
100	G VI 131	14.3	84.7	S
101	G VI 132	19.5	65.5	MS
102	G VI 133	31.3	76.9	S
103	G VI 134	25.2	69.9	MS
104	G VI 135	23.5	100.0	S
105	G VI 136	19.1	88.0	S
106	G VI 137	15.0	57.0	MS
107	G VI 138	6.7	48.2	MR
108	G VI 139	13.2	66.7	MS
109	G VI 140	13.6	71.7	MS
110	G VI 141	23.6	91.8	S
111	G VI 142	15.3	84.0	S
112	G VI 143	15.5	82.1	S
113	G VI 144	21.7	91.8	S
114	G VI 145	18.0	68.1	MS
115	G VI 146	13.4	50.3	MS
116	G VI 147	10.3	56.8	MS
117	G VI 148	26.3	100.0	S
118	G VI 149	22.0	88.8	S
119	G VI 150	17.3	70.9	MS
120	G VI 151	18.4	68.2	MS
121	G VI 152	39.5	95.8	S
122	G VI 153	34.6	91.1	S
123	G VI 154	11.2	49.5	MR
124	G VI 155	26.7	70.6	MS
125	G VI 156	19.1	73.1	MS
126	G VI 157	12.9	83.7	S
127	G VI 158	44.3	100.0	S
128	G VI 159	15.4	81.0	S
129	G VI 160	31.8	95.0	S
130	G VI 161	31.4	89.1	S
131	G VI 162	23.1	82.2	S
132	G VI 163	26.4	80.1	S
133	G VI 164	19.0	86.4	S
134	G VI 165	21.7	100.0	S
135	G VI 167	15.5	62.9	MS
136	G VI 168	17.5	81.6	S
137	G VI 169	16.5	71.1	MS
138	G VI 170	16.9	58.0	MS
139	G VI 171	24.9	88.5	S
140	G VI 172	18.4	67.9	MS
141	G VI 173	19.9	79.1	S
142	G VI 174	23.4	100.0	S
143	G VI 175	17.9	82.2	S

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S. No.	Cocoa type	Per cent pod area infection		
		4 DAI	8 DAI	Reaction
144	G VI 176	23.5	92.3	S
145	G VI 177	12.0	92.0	S
146	G VI 178	14.1	71.4	MS
147	G VI 181	16.7	60.7	MS
148	G VI 182	16.6	88.7	S
149	G VI 183	29.0	100.0	S
150	G VI 185	20.7	100.0	S
151	G VI 186	20.9	84.1	S
152	G VI 187	16.5	81.3	S
153	G VI 188	18.3	75.0	MS
154	G VI 189	25.2	100.0	S
155	G VI 190	17.2	67.5	MS
156	G VI 191	31.5	91.5	S
157	G VI 192	29.0	88.3	S
158	G VI 193	20.8	83.0	S
159	G VI 194	19.1	84.3	S
160	G VI 195	12.7	80.0	S
161	G VI 196	18.0	79.2	S
162	G VI 197	16.7	78.0	S
163	G VI 198	9.3	59.7	MS
164	G VI 199	10.4	54.3	MS
165	G VI 202	19.2	100.0	S
166	G VI 204	16.8	73.9	MS
167	G VI 205	49.7	100.0	S
168	G VI 214	34.0	92.1	S
169	G VI 224	21.7	62.4	MS
170	G VI 225	20.7	76.5	S
171	G VI 227	14.1	84.0	S
172	G VI 229	21.7	100.0	S
173	G VI 232	23.3	65.1	MS
174	G VI 234	24.5	67.6	MS
175	G VI 235	8.7	57.0	MS
176	G VI 236	6.2	76.3	S
177	G VI 237	7.8	80.8	S
178	G VI 239	34.6	96.8	S
179	G VI 241	15.0	84.4	S
180	G VI 242	31.0	95.0	S
181	G VI 243	20.5	88.0	S
182	G VI 246	28.7	95.1	S
183	G VI 247	18.6	53.1	MS
184	G VI 249	32.5	87.5	S
185	G VI 250	17.3	74.3	MS
186	G VI 251	8.2	54.8	MS
187	G VI 252	39.0	82.8	S
188	G VI 253	46.2	100.0	S
189	G VI 254	27.6	87.8	S
190	G VI 255	13.2	99.4	S
191	G VI 256	26.8	73.5	MS

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S.	Cocoa type	Per cent pod area infection		
		4 DAI	8 DAI	Reaction
192	G VI 257	9.9	73.5	MS
193	G VI 258	9.9	70.7	MS
194	G VI 259	10.8	92.3	S
195	G VI 260	26.0	100.0	S
196	G VI 261	16.7	78.1	S
197	G VI 262	26.2	90.1	S
198	G VI 264a	16.4	66.6	MS
199	G VI 264b	10.0	67.0	MS
200	G VI 265a	9.6	90.5	S
201	G VI 265b	22.0	96.8	S
202	G VI 266	8.6	68.0	MS
203	G VI 267	22.7	92.4	S
204	G VI 268	13.8	76.2	S
205	G VI 269	34.7	100.0	S
206	G VI 270	15.1	83.8	S
207	G VI 271	12.8	85.2	S
208	G VI 272	22.7	100.0	S
209	G VI 273	17.1	91.3	S
210	G VI 274	12.8	71.0	MS
211	G VI 275	8.8	50.2	MS
212	G VI 276	33.1	94.4	S
213	G VI 277	19.3	100.0	S
214	G VI 279	12.2	48.2	MR
215	G VI 280	15.5	100.0	S
216	G VI 281	15.7	95.0	S
217	G VI 282	30.0	91.4	S
218	G VI 283	24.8	83.8	S
219	G VI 284	17.0	48.0	MR
220	G VI 287	10.2	75.7	S
221	G VI 287	10.2	75.7	S
222	G VI 289	43.4	100.0	S
223	G VI 289	45.3	100.0	S
224	G VI 291	35.9	93.3	S
225	G VI 295	26.7	95.6	S

Mean of three replications

- R – Resistant - < 25 per cent pod area infected
 MR – Moderately resistant
 MS – Moderately susceptible
 S – Susceptible

DAI – Days after inoculation

- > 25 to < 50 per cent pod area
 - > 50 to < 75 per cent pod area
 - > 75 per cent pod area infected

RESULTS AND DISCUSSION

The results on the reaction of 225 cocoa types maintained in Cadbury-Kerala Agricultural University Co-operative Cocoa Research Project, College of Horticulture, Vellanikkara against *Phytophthora* pod rot

are presented in Table 1. After four days of inoculation, all the cocoa types screened except G VI 122 recorded less than 50 per cent pod area infection. Further, it was noted that 163 cocoa types showed less than 25 per cent pod area infection. Among these, 18 exhibited less than 10 per cent pod area infection with minimum in type G VI 14. A pod area infection between 25 and 50 per cent was recorded on other 61 cocoa types.

Data on the per cent pod area infection on the eight day after inoculation showed that the cocoa types G VI 14, G VI 73, G VI 77, G VI 124, G VI 138, G VI 154, G VI 279 and G VI 284 recorded less than 50 per cent pod area infection with the minimum of 33.6 per cent in type G VI 14. Hence, based on the criteria used in this study, eight cocoa types were categorized as moderately resistant to *P. palmivora*. A per cent pod area infection between 50 to 75 was observed in 64 cocoa types indicating moderately susceptible reaction. Among them, 15 types recorded pod area infection of less than 60 per cent with least values of 50.2 and 50.3 per cent in G VI 275 and G VI 146 respectively. More than 75 per cent pod area infection was observed in 153 cocoa types indicating susceptible reaction. Among them, 38 types showed cent per cent infection. Hence, based on the study it was evident that, among the 225 cocoa types screened only 3.55 per cent types showed moderately resistant reaction and moderately susceptible reaction was showed by more than 28 per cent types (Table 2).

Such different reactions of cocoa types towards *P. palmivora* have been reported from different countries (Lawrence, 1978; Sri-Sukamoto and Mawardi, 1986; Thrower, 1960 and Pinto *et al.*, 1999). From India, tolerant reaction of cocoa types towards *P. palmivora* was reported by Chandramohan (1982) and Abraham *et al.* (2001), with limited number of cocoa types. As none of the cocoa types evaluated in the present study showed absolute resistance, the eight moderately resistant types

identified can be utilized for large-scale multiplication and distribution in the endemic areas, provided they possess desirable agronomic traits. Moreover, these types can be used for further genetic improvement following appropriate manipulation tools.

Table 2 : Percentage of cocoa types grouped under different categories

S.No.	Reaction	Percentage of cocoa types	
		4 DAI	8 DAI
1	Resistant	72.44	-
2	Moderately resistant	27.11	3.55
3	Moderately susceptible	0.44	28.44
4	Susceptible	-	68.00

DAI – Days after inoculation

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