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RESEARCH ARTICLE

EPIDEMICS OF LEAF BLOTCH DISEASE (*Phaeodactylium alpiniae)* OF SMALL CARDAMOM

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ABSTRACT

Leaf blotch disease of small Cardamom (*Elettaria cardamomum*) caused by the fungal pathogen *Phaeodactylium alpiniae* was reported first in the year 1969. The disease appears during monsoon months at mild levels and never occurred at epidemic proportions. However there was an unusual and serious incidence of leaf blotch disease during 2010 and 2011 at various Cardamom plantations in Idukki Dist, Kerala. A detailed survey of leaf blotch disease was made at 31 localities. The disease incidence was found to be high in Mali region (92.1%) and least in Cumbummettu (15.8%). Various accessions maintained at ICRI germplasm were screened for disease incidence. The disease incidence was highest in accession MCC86 (39.87%) and lowest in accession MCC161 (6.25%). The popular land race Njallani recorded 34.7% disease incidence. Out of the 139 accessions observed, 17 had disease incidence in the range of 1-10%; 72 had incidence in the range of 11-20%; 40 had disease incidence in the range of 21-30% and the rest 10 had the incidence in the range of 31-40%. Under artificial conditions the pathogen was able to infect leaves which are intact or injured. Besides, the pathogen was able to infect pseudostems and also on capsules which is the first report of its kind. Under field conditions, Bordeaux mixture (1.0%) recorded followed by the fungicide, Propiconazole (0.1%). The fungicides, Trifloxystrobin+Tebuconazole (0.1%), Thiophanate Methyl (0.2%), Mancozeb (0.2%) and Tebuconazole (0.1%) were also effective and were on par with each other.

INTRODUCTION

Leaf blotch disease of small cardamom caused by the fungal pathogen *Phaeodactylium alpiniae* is generally considered as a minor disease occurring during monsoon months (Jospeh Thomas and Susheela Bhai, 2002). However, during the recent past there has been unusual and widespread occurrence of this disease in the High ranges of Kerala. The severely affected plants exhibited defoliation and decline in their yield levels. As little is known about the pathogen and the disease it was sought to investigate the pathogenicity, the level of disease incidence at various localities and among various accessions in the germplasm and also to evaluate various fungicides for disease control.

MATERIALS AND METHODS

Disease assessment and survey

A total of 31 localities have been surveyed during August to October. In each locality six plantations were selected and from every hectare, twelve plants were randomly selected. All the tillers were observed and a tiller is considered as infected even if a leaf with active lesion of leaf blotch disease is present. The percent infected tillers against healthy tiller are represented as percent disease incidence. Besides field survey, various accessions maintained at ICRI conservatory for Cardamom germplasm were screened for the disease incidence.

Pathogenicity studies

The pathogen was isolated from actively growing lesions using water agar and was brought into pure culture in PDA. A total of sixteen isolates were obtained and two isolates from the most disease prone area was selected for further studies. Using agar blocks from 5day old culture, Koch's postulates were proved using eight months old nursery plants under laboratory conditions. The pathogenicity of leaf blotch pathogen was studied on capsules and also on pseudostem using detached panicles and young plants respectively. In all the cases the inoculation was performed with and without injuring the plant tissue.

Fungicide evaluation

The fungicides were evaluated *in vitro* against *P.alpiniae* by poisoned food technique. Inhibition of vegetative growth of the pathogen was calculated using the following formula (Sundar *et al*., 1995).

Percent Inhibition = ((X – Y)/X) × 100

Where, X is colony diameter of the fungus on control plate and Y is that on treated plate.

Eleven fungicides were tested against leaf blotch disease under field condition. The experiment was in RBD with 12 plants in each treatment replicated three times. Six plants in each plot were tagged in each replicate and % disease incidence was calculated as mentioned above. The fungicides were sprayed at monthly intervals during July to November. The cumulative data is presented.

RESULTS AND DISCUSSION

The disease incidence in various localities is presented in Table 1. The disease incidence was found to be highest in Mali region (92.1%) followed by Pooppara (44.3%), Udumbanchola (42.8) and lowest in Cumbummettu (15.8%). The variation of disease incidence in various localities could be attributed to the variation in agro climatological situation of the particular area. (Mehrothra and Agarwal, 2003)

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Table 1. Incidence of leaf blotch in various localities

S. No.	Locality	Leaf blotch Incidence (%)
1.	Murikkadi	32.0
2.	Vellaramkunnu	27.3
3.	Kadamakuzhy	25.7
4.	Anavilasom	32.9
5.	Mali	92.1
6.	Chittampara	42.7
7.	Santhanpara	38.6
8.	Pooppara	44.3
9.	Rajakumari	36.7
10.	Khajanappara	29.3
11.	Bison valley	27.1
12.	Chemmannar	22.9
13.	Thookkupalam	19.8
14.	Chettukuzhy	41.3
15.	Myladumpara	32.3
16.	Manjapetty	17.9
17.	Udumbanchola	42.8
18.	Pampadumpara	32.9
19.	Vattappara	30.8
20.	Pushpakandam	34.2
21.	Balagram	29.1
22.	Mary Kulam	31.3
23.	Mattu Katta	34.8
24.	Rajakkad	39.1
25.	Murikkassery	24.2
26.	Thopramkudy	19.8
27.	Pathumury	28.8
28.	Cumbamamettu	15.8
29.	Nariampara	24.9
30.	Vattappara	31.2
31.	Erattayar	19.8

Among the 139 germplasm accessions screened, the disease incidence was lowest in accession MCC161 (6.25%) and highest in accession MCC86 (39.87%). The popular land race Njallani recorded 34.7% disease incidence. Out of the 139 accession assessed, 17 had disease incidence in the range of 1-10%; 72 had incidence in the range of 11-20%; 40 had disease incidence in the range of 21-30% and the rest 10 had the incidence in the range of 31-40% (Table 2). The variation in the disease incidence among various accessions can be due to the variations in their morphological, anatomical, biochemical and genetic makeup that determine their resistance or susceptibility to the disease (Sharma, 2006).

On injured leaves, the initial symptom of disease appeared as irregular water soaked spot on 3rd day of inoculation, whereas, the symptom development was delayed on Intact leaves as it appeared on 6th day of inoculation (Table 3). Appearance of fungal growth on under side of leaves was seen on 9th day in injured leaf where as it was on 12th day in intact leaves. There was progressive development of symptoms as days progressed until blackening of the affected area. Later decaying started on 18th Day in injured leaves. In the case of intact leaves the blackening started on 18th day followed by decay on 21st day. In general, the growth of Isolate LB 1 was faster to LB 2 in both injured and intact leaves. The isolate LB 1 was used for further pathogenicity studies. In the case of intact Pseudostem the water soaked symptom appeared on 4th day after inoculation while it was 2days in the case of injured tissue. Later brownish coloration developed on injured tissue on 5th day while it was on 7th day in the case of intact tissue. The blackening of tissue started on 9th day in injured tissue and it was on 11th day in the case of intact tissue (Table 4). In the case of healthy capsules no infection could be established. On the other hand, the injured capsules were vulnerable to infection. Here, the injured tissue inoculated with pathogen turned necrotic on 2nd day. On 3rd day there was development of water soaked lesions

Table 2. Leaf blotch disease incidence in various accessions under field conditions

Accession	DI (%)	Accession	DI (%)	Accession	DI (%)	Accession	DI (%)
MCC1	18.35	MCC43	19.58	MCC78	26.49	MCC123	31.52
MCC2	25.59	MCC44	16.13	MCC79	24.97	MCC124	21.70
MCC3	16.62	MCC45	21.54	MCC80	28.72	MCC125	20.12
MCC4	24.45	MCC46	25.02	MCC81	28.30	MCC126	13.80
MCC5	25.66	MCC47	18.84	MCC82	26.34	MCC128	20.26
MCC6	30.35	MCC48	20.78	MCC83	7.86	MCC129	17.44
MCC7	30.62	MCC49	18.33	MCC84	17.14	MCC130	16.33
MCC8	20.38	MCC50	23.38	MCC85	28.24	MCC131	28.32
MCC9	27.57	MCC51	20.83	MCC86	39.87	MCC132	23.93
MCC10	27.50	MCC52	20.04	MCC87	27.53	MCC133	24.66
MCC11	29.52	MCC53	17.10	MCC88	28.40	MCC137	24.14
MCC12	26.78	MCC54	7.71	MCC89	23.70	MCC138	36.36
MCC13	28.18	MCC55	20.71	MCC90	16.61	MCC142	23.88
MCC14	19.77	MCC56	9.36	MCC91	23.09	MCC143	31.03
MCC15	23.00	MCC57	10.51	MCC92	14.59	MCC144	27.62
MCC16	32.07	MCC58	12.83	MCC93	14.43	MCC145	18.55
MCC19	17.85	MCC59	11.99	MCC94	11.51	MCC146	20.37
MCC20	13.99	MCC60	11.76	MCC95	21.83	MCC147	19.66
MCC21	13.79	MCC61	10.85	MCC98	19.76	MCC148	15.06
MCC24	19.23	MCC62	12.76	MCC99	14.36	MCC149	14.55
MCC27	16.42	MCC63	10.64	MCC103	10.73	MCC150	15.69
MCC28	23.50	MCC64	12.61	MCC104	14.87	MCC152	7.09
MCC29	22.32	MCC65	10.72	MCC105	15.28	MCC153	8.40
MCC30	17.95	MCC66	8.61	MCC106	11.43	MCC154	14.63
MCC31	31.85	MCC67	10.83	MCC107	13.67	MCC155	18.49
MCC32	15.82	MCC68	23.86	MCC108	16.18	MCC156	16.67
MCC34	20.45	MCC69	36.34	MCC109	15.92	MCC157	7.18
MCC35	29.30	MCC70	32.35	MCC111	17.10	MCC159	11.05
MCC36	27.31	MCC71	16.50	MCC112	10.53	MCC160	10.36
MCC37	19.31	MCC72	18.32	MCC113	14.51	MCC161	6.25
MCC38	19.05	MCC73	22.02	MCC114	14.43	MCC162	14.61
MCC39	26.53	MCC74	38.18	MCC115	13.27	MCC163	16.84
MCC40	18.90	MCC75	20.97	MCC117	22.77	MCC164	10.21
MCC41	14.29	MCC76	11.00	MCC119	17.42	Njallani	34.70
MCC42	23.74	MCC77	12.27	MCC120	19.77		

Table 3. Pathogenicity of *Pheodactylium alpineae* on leaves

Day of Inoculation and observation	Development of disease symptom			
	Injured leaf		Intact leaf	
	LB 1	LB 2	LB 1	LB 2
Day 1	No symptom	No symptom	No symptom	No symptom
Day 3	Irregular small water soaked spot (0.5cm)	Irregular small water soaked spot (0.4cm)	No symptom	No symptom
Day 6	Lesion (3.1cm)	Lesion (2.8cm)	Irregular small water soaked spot (0.4cm)	Irregular small water soaked spot (0.3cm)
Day 9	Lesion (4.4cm) (fungal growth-under side of leaf)	Lesion (4.1cm) (fungal growth-under side of leaf)	Lesion (1.5cm)	Lesion (1.3cm)
Day 12	Well developed lesion (5.9cm)	Well developed lesion (5.2cm)	Lesion (4.2cm) (fungal growth under side of leaf)	Lesion (3.9cm) (fungal growth under side of leaf)
Day 15	Blackening of affected area	Blackening of affected area	Well developed lesion (5.6cm)	Well developed lesion (5.1cm)
Day 18	Decay	Decay	Blackening of affected area	Blackening of affected area
Day 21	-	-	Decay	Decay

which on the subsequent days started yellowing and decay. On 10day, there was intense browning and decay of tissue, and capsules started dropping out from panicles (Table 5). From the studies on pathogenicity on leaves and pseudostem it is clear that the leaf blotch pathogen can invade healthy tissue. The injury hastened the process of infection. In the case of capsules, the pathogen could not invade healthy capsules. This is interesting and any morphological feature of capsule resisting pathogen infection may be looked upon. The ability of pathogen to infect pseudostem and capsules is the first report of its kind. It's worth while to investigate the presence of pathogen from these plant parts collected from field grown cardamom plants and to ascertain its relevance. Eleven fungicides were tested against leaf blotch pathogen *in vitro* by poisoned food technique. The results are given in Table 6. Six fungicides viz., Bordeaux mixture (1.0%), Fenamidone + Mancozeb (Sectin 60WP) - 0.2%, Trifloxystrobin +Tebuconazole (Nativo 75WP) - 0.1 Ipovalicarb+Cymoxanil (Melody Duo66.75 WP) - 0.2%, Indofil M45 (Mancozeb 75WP) - 0.2%, Tebuconazole (Folicur 25EC) - 0.1% were able to completely inhibit the growth of the pathogen. This was followed by Propiconazole (Tilt 25EC) - 0.1%, Hexaconazole + Pot. Phosphonate (Samarth 2SC)-0.1%, Thiophanate Methyl (Roko 70WP) - 0.2% and Potassium Phosphonate (Phytophos) - 0.3%. The fungicide Carbendazim (Bavistin 50WP) - 0.2% was the inferior to all.

Table 4. Pathogenicity of *Pheodactylium alpineae* on pseudostem

Intact	Injured
Water soaked Lesion (4th day)	Water soaked lesion (2nd day)
Brownish Coloration (7day)	Brownish coloration (5day)
Blackening/decay (11th day)	Blackening/decay (9th day)

Table 5. Pathogenicity of *Pheodactylium alpineae* on Capsules (Injured)

Day 2: Necrotic spot
Day 3: Appearance of water soaked symptom
Day 6: Decay and yellowing
Day 8: Decay and yellowing
Day 10: Decay and Browning & Dropping of capsules

Table 6. Effect of fungicides on radial growth of *Phaeodactylium in vitro*

Fungicides and concentration	% inhibition on radial growth
Bordeaux mixture - 1.0%	100
Carbendazim (Bavistin 50WP) - 0.2%	17.8
Potassium Phosphonate (Phytophos) - 0.3%	33.6
Hexaconazole + Pot. Phosphonate (Samarth 2SC) -0.1%	82.8
Thiophanate Methyl (Roko 70WP) - 0.2%	71.3
Propiconazole (Tilt 25EC) - 0.1%	88.4
Fenamidone + Mancozeb (Sectin 60WP) - 0.2%	100
Trifloxystrobin +Tebuconazole (Nativo 75WP) - 0.1%	100
Ipovalicarb+Cymoxanil (Melody Duo66.75 WP) - 0.2%	100
Indofil M45 (Mancozeb 75WP) - 0.2%	100
Tebuconazole (Folicur 25EC) - 0.1%	100
CD at P = 0.05	3.2

Table 7. Evaluation of fungicides against leaf blotch under field condition

Treatments	Disease Incidence (%)*
Bordeaux mixture - 1.0%	4.6^{a}
Carbendazim (Bavistin 50WP) - 0.2%	15.5^{ef}
Potassium Phosphonate (Phytophos) - 0.3%	16.4^{ef}
Hexaconazole + Pot. Phosphonate (Samarth 2SC) -0.1%	13.7^{bcde}
Thiophanate Methyl (Roko 70WP) - 0.2%	9.2^{bc}
Propiconazole (Tilt 25EC) - 0.1%	8.5^{b}
Fenamidone + Mancozeb (Sectin 60WP) - 0.2%	11.0^{bcd}
Trifloxystrobin +Tebuconazole (Nativo 75WP) - 0.1%	8.6^{bc}
Ipovalicarb+Cymoxanil (Melody Duo66.75 WP) - 0.2%	11.9^{bcd}
Indofil M45 (Mancozeb 75WP) - 0.2%	9.2^{bc}
Tebuconazole (Folicur 25EC) - 0.1%	9.5^{bc}
Control	18.1^{f}

* Figures followed by common letter do not differ significantly according to Duncan's multiple range test at *P 0.05*

In field, Bordeaux mixture - 1.0% recorded the least disease incidence and was statistically superior to all other fungicides. This was followed by Propiconazole (Tilt 25EC) - 0.1%. The fungicides, Trifloxystrobin +Tebuconazole (Nativo 75WP) - 0.1%, Thiophanate Methyl (Roko 70WP) - 0.2%, Indofil M45 (Mancozeb 75WP) - 0.2% and Tebuconazole (Folicur 25EC) - 0.1% were effective and were on par with each other. The fungicides, Carbendazim (Bavistin 50WP) - 0.2% and Potassium Phosphonate (Phytophos) - 0.3%were inferior. The *in vitro* effect and the field performance of fungicides were different. Six fungicides that totally inhibited the pathogen *in vitro*, was not on par with each other in their field performance. Bordeaux

mixture performed consistently well in both the conditions and occupied the first place. Propiconazole, which gave only 88.8 % inhibition *in vitro*, performed next to Bordeaux mixture in field. This could be attributed to the various factors that affect the field performance of fungicides like rain fastness, deposition on the target surface and translocation into the various plant parts (Nene and Thapliyal, 1993).

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