

CHAPTER 2

Isolation and Morphological Characterisation of *Colletotrichum* spp. Causing Mango Anthracnose

2.1 Introduction

Anthracnose is one of the most serious mango disease, especially in growing areas where it rains during the flowering and fruit set stages. The pathogen is caused by the fungus *Colletotrichum gloeosporioides* (also known as perfect stage *Glomerella cingulata*). It is one of the most important disease in the pre- and post-harvest stages of Thai mango production (Mills *et al.*, 1992; Afanador-Kafuri *et al.*, 2003; Yenjit *et al.*, 2004; Akem, 2006). Spore production by this fungus is favourable in wet or humid weather, and spore dispersal mostly in rain and wind. This enables spread of the disease over relatively short distances. In areas where rain is prevalent during flowering and fruit set, anthracnose can cause destruction of inflorescences, and young fruits. Occasionally, anthracnose lesions are seen in green fruit and most commonly in ripening fruits. The anthracnose fungus has the ability to produce latent infection. This means that it is able to penetrate green fruit and remain dormant there until the fruit ripens. Then, the anthracnose fungus re-activates in response to physiological changes that are associated with ripening and this results in lesion development, with subsequent spoilage of the fruit (Mills *et al.*, 1992; Arauz, 2000; Afanador-Kafuri *et al.*, 2003; Akem, 2006).

The objectives of this chapter were as follows:-

1. To isolate *Colletotrichum* spp., the causal agent of mango anthracnose disease.
2. To describe morphological characterisation of *Colletotrichum* spp. that causes mango anthracnose.

2.2 Materials and Methods

2.2.1 Collection and isolation of the pathogen

Naturally infected mango fruit and leaf samples that showed typical anthracnose symptoms were collected from various markets and orchards. Tissues showing anthracnose symptom was observed under stereo microscope using a free hand section. Tissue transplantation was performed to isolate the pathogen. The plant tissue between the diseased and healthy areas were cut into pieces of approximately 5 x 5 mm, and then surface sterilized by soaking in 10% Clorox (sodium hypochlorite, NaOCl) solution for 1-2 min. Subsequently, the pieces of tissue were rinsed twice in sterile distilled water for 2-3 min, and blotted dry on sterile paper towels in a laminar flow cabinet. The dried tissues were then placed on a Petri dish containing ¼-strength potato dextrose agar (¼PDA), and the cultures were incubated at a room temperature (RT) of approximately 28-30°C. The cultures were observed the colony growth daily. The hyphal tips were transferred to a PDA Petri dish after 1-3 days of culture, and incubated at room temperature to get pure culture.

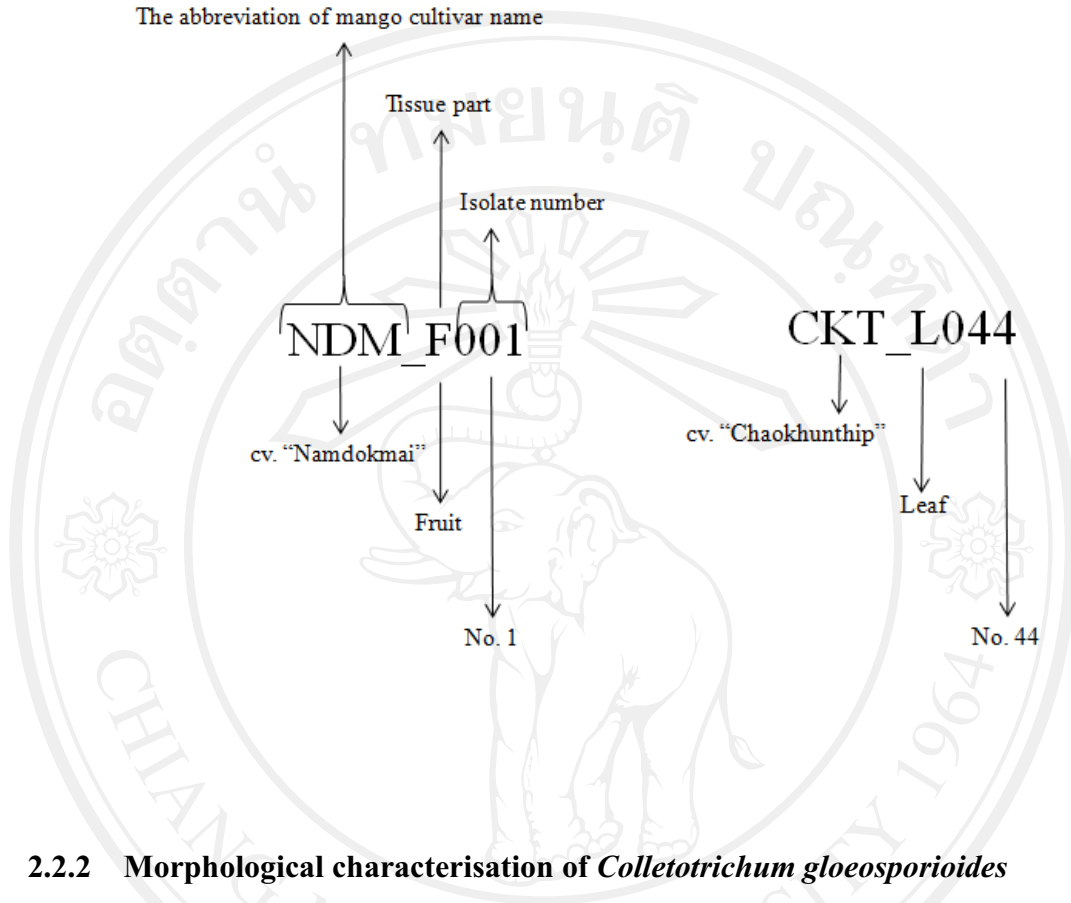
Single spore isolation

A 0.5 ml conidial suspension (10^3 conidia/ml) of each isolate was spread with a sterile glass rod on the surface of a water agar (WA) Petri dish, and incubated for 12 hr at room temperature. A light compound microscope was used to observe a single colony. A piece of agar containing a single colony was then removed and transferred to a new PDA Petri dish. Each isolate was transferred onto PDA slants and preserved at 4°C for further use.

Isolate designations

The isolates were coded by using the acronym of the host cultivar as follows:- 'Chaokhunthip' (CKT), 'Chokanan' (CAN), 'Falun' (FL), 'Kaew' (K), 'Khiaomorakod' (KMK), 'Khiaosawoey' (KSW), 'Linnguhao' (LNH), 'Mahacharnok' (MCN), 'Mankhunsi' (MKS), 'Namdokmai' (NDM), 'Nareeluemrang' (NLR), 'Okrong' (OR), 'Phetbanlat' (PBL), 'Phimsen' (PS), 'Raet' (R), 'Salaya' (SLY) and 'Talapnak' (TLN), followed by tissue part as follows:- fruit (F) or leaf (L), and the isolate number (1, 2, 3, up to 150). The diagrams are shown as follows.

Diagram for coding the isolates



2.2.2 Morphological characterisation of *Colletotrichum gloeosporioides*

Each isolate was cultured by transferring the mycelial discs (5 mm diameter) onto PDA at room temperature for seven days. The morphological characteristics of colony types and reproductive structures were daily observed. Colony diameter was measured daily for seven days. Its growth rate was calculated from an average mean of seven days of daily growth (mm per day). The colony colour of all isolates was recorded after ten days. The conidia were measured after fourteen days using micrometer at 400x magnification (10x ocular, 40x objectives). Identification of the *Colletotrichum* species was based on Sutton (1992) and the published description (Cannon *et al*, 2009).

A basic key for *Colletotrichum gloeosporioides* is basically recored as colony colour very (white cottony, greyish white cottony, dark grey cottony, conidia hyaline, one-celled , straight , cylindrical, 9-24 x 3-4.5 μm (Sutton, 1992).

2.3 Results

2.3.1 Collection and isolation of the pathogen

Mango leaf and fruit samples showing typical anthracnose symptoms were collected from markets and orchards in Chiang Mai, Lamphun, Nakhon-nayok and Phitsanulok from October 2007 to May 2008. One hundred and fifty isolates were isolated successfully from 17 mango cultivars using the tissue transplanting technique. Each isolate was purified by single spore isolation and the culture preserved at 4^oC for this study.

Anthracnose symptom on mango leaves from 16 cultivars were collected from orchards (Figure 2.1). Forty six isolates were obtained including one from cv. ‘Chaokhunthip’ (CKT_L004), 4 from cv. ‘Chokanan’ (CAN_L080, CAN_L081, CAN_L090, CAN_L105), 2 from cv. ‘Falun’ (FL_L079, FL_L111), 3 from cv. ‘Kaew’ (K_L053, K_L120, K_L124), 5 from cv. ‘Khiaomorakod’ (KMK_L041, KMK_L051, KMK_L055, KMK_L058, KMK_L088), 4 from cv. ‘Khiaosawoey’ (KSW_L004, KSW_L062, KSW_L085, KSW_L119), one from cv. ‘Linguhao’ (LNG_L031), 9 from cv. ‘Mahacharnok’ (MCN_L013, MCN_L049, MCN_L052, MCN_L056, MCN_L059, MCN_L070, MCN_L075, MCN_L089, MCN_L121), 2 from cv. ‘Mankhunsi’ (MKS_L034, MKS_L086), 6 from cv. ‘Namdokmai’ (NDM_L057, NDM_L067, NDM_L068, NDM_L071, NDM_L078, NDM_L096), 2 from cv. ‘Nareluemrang’ (NLR_L047, NLR_L048), one from cv. ‘Okrong’

(OR_L040), 2 from cv. ‘Phimsen’ (PS_L032, PS_L082), one from cv. ‘Raet’ (R_L087), one from cv. ‘Salaya’ (SLY_L017) and two from cv. ‘Talapak’ (TLN_L060, TLN_L065) (Figure 2.3).

Anthracnose symptom on mango fruits from 8 cultivars were collected from markets and orchards (Figure 2.2). One hundred and four isolates were obtained including 19 from cv. ‘Chokanan’ (CAN_F093, CAN_F094, CAN_F095, CAN_F097, CAN_F098, CAN_F123, CAN_F125, CAN_F139, CAN_F140, CAN_F141, CAN_F142, CAN_F143, CAN_F144, CAN_F145, CAN_F146, CAN_F147, CAN_F148, CAN_F149, CAN_F150), 2 from cv. ‘Falun’ (FL_F003, FL_F066), 5 from cv. ‘Kaew’ (K_F069, K_F099, K_F100, K_F101, K_F103), 7 from cv. ‘Khiaomorakod’ (KMK_F132, KMK_F133, KMK_F134, KMK_F135, KMK_F136, KMK_137, KMK_138), 53 from ‘Namdokmai’ (NDM_F001, NDM_F002, NDM_F005, NDM_F006, NDM_F007, NDM_F008, NDM_F009, NDM_F010, NDM_F011, NDM_F012, NDM_F014, NDM_F015, NDM_F016, NDM_F018, NDM_F019, NDM_F020, NDM_F021, NDM_F022, NDM_F023, NDM_F024, NDM_F025, NDM_F026, NDM_F027, NDM_F028, NDM_F029, NDM_F035, NDM_F036, NDM_F037, NDM_F038, NDM_F039, NDM_F042, NDM_F043, NDM_F045, NDM_F046, NDM_F050, NDM_F061, NDM_F063, NDM_F072, NDM_F104, NDM_F106, NDM_F107, NDM_F108, NDM_F109, NDM_F110, NDM_F112, NDM_F115, NDM_F116, NDM_F117, NDM_F118, NDM_F127, NDM_F128, NDM_F129, NDM_F130), one from cv. ‘Okrong’ (OR_F126), 13 from cv. ‘Phetbanlat’ (PBL_F030, PBL_F033, PBL_F054, PBL_F064, PBL_F076, PBL_F077, PBL_F083, PBL_F084, PBL_F091, PBL_F092, PBL_F102, PBL_F113,

PBL_F131), 4 from cv. 'Phimsen' (PS_F073, PS_F074, PS_F114, PS_F122) (Figure 2.3). The collection date and location of each isolate is shown in Table 2.1.

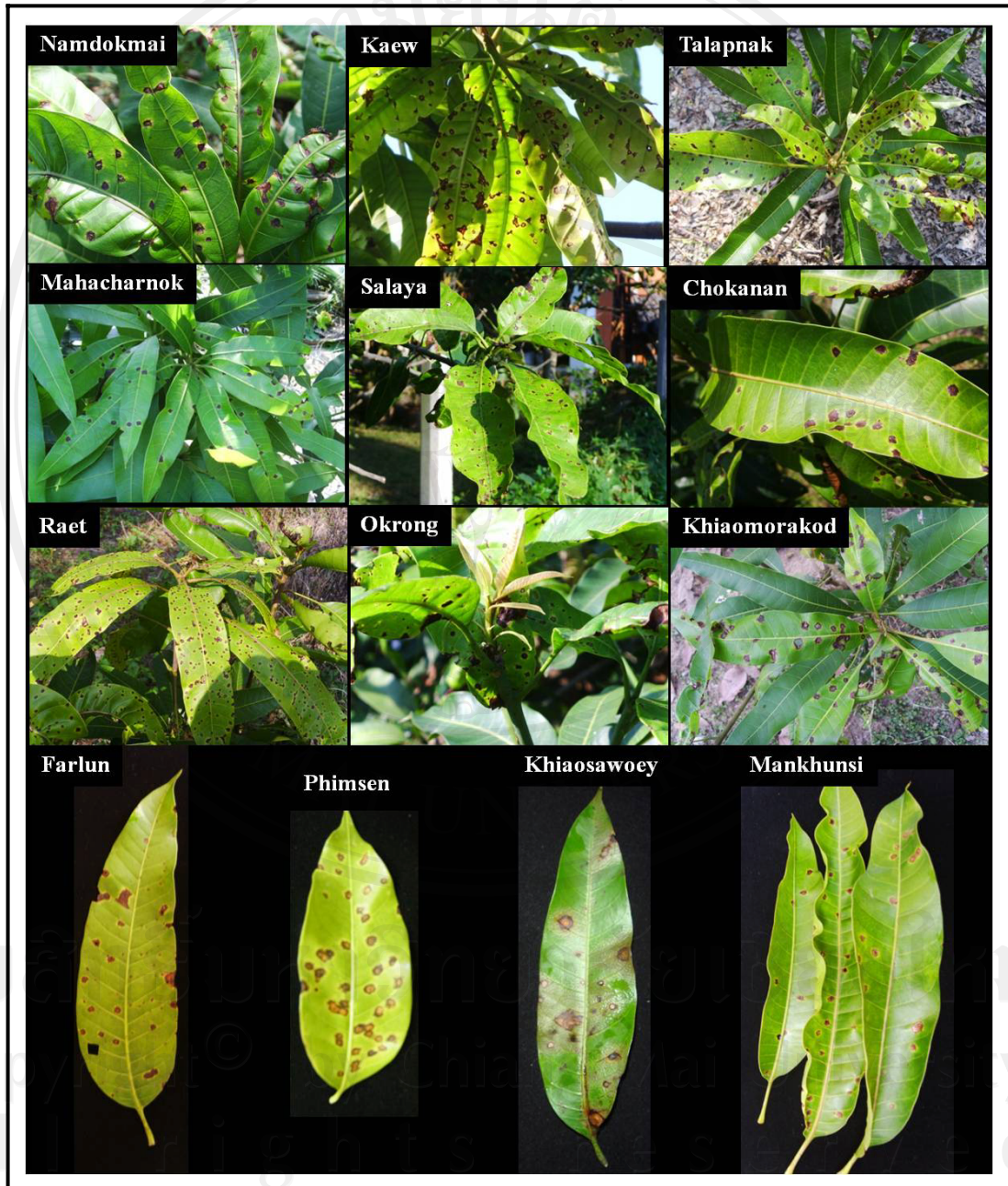


Figure 2.1 Anthracnose symptoms on naturally-infected leaves in various mango cultivars.

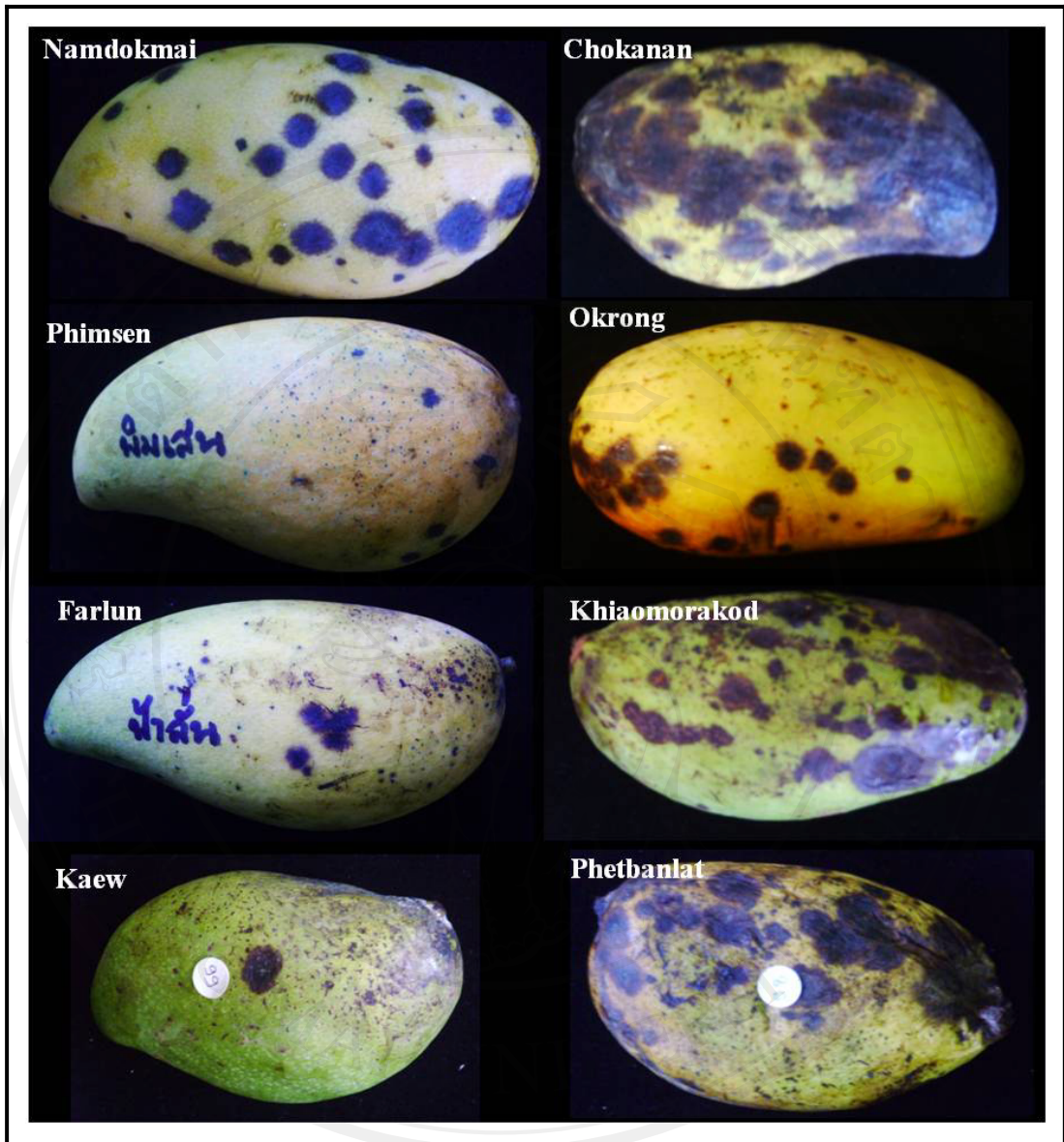


Figure 2.2 Anthracnose symptoms on naturally-infected fruits in various mango cultivars.

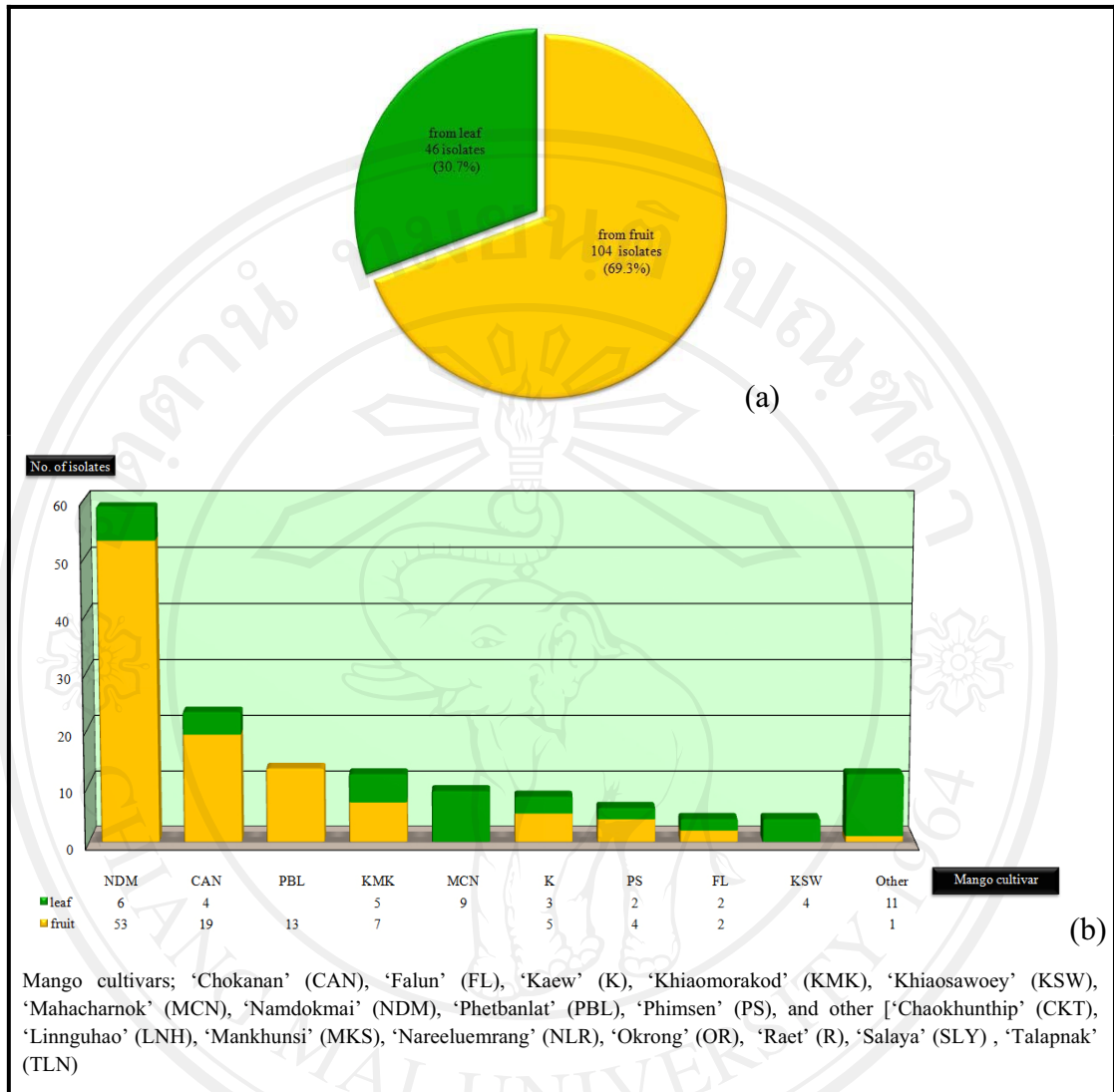


Figure 2.3 Numbers of *Colletotrichum* spp. isolates causing mango anthracnose; grouped by host tissue parts (a), mango cultivars (b).

Table 2.1 List of *Colletotrichum* spp. isolates causing anthracnose on fruits and leaves of various mango cultivars from markets and orchards

No.	Isolate code	Collection date (month/year)	Tissue	Location
<i>1. Chaokhunthip cultivar (CKT) = 1 isolate</i>				
1.	CKT_L044	12/2007	leaf	T. Ban Hong, A. Ban Hong, Lamphun
<i>2. Chokanan cultivar (CAN) = 23 isolates</i>				
1.	CAN_L080	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
2.	CAN_L081	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
3.	CAN_L090	03/2008	leaf	T. Pa-nai, A. Phrao, Chiangmai
4.	CAN_F093	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
5.	CAN_F094	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
6.	CAN_F095	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
7.	CAN_F097	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
8.	CAN_F098	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
9.	CAN_L105	04/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
10.	CAN_F123	04/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
11.	CAN_F125	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
12.	CAN_F139	05/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
13.	CAN_F140	05/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
14.	CAN_F141	05/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
15.	CAN_F142	05/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
16.	CAN_F143	05/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
17.	CAN_F144	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
18.	CAN_F145	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
19.	CAN_F146	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
20.	CAN_F147	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
21.	CAN_F148	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
22.	CAN_F149	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
23.	CAN_F150	05/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
<i>3. Farlun cultivar (FL) = 4 isolates</i>				
1.	FL_F003	11/2007	fruit	Tesco lotus express, T. Suthap, A. Mueang, Chiangmai
2.	FL_F066	01/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
3.	FL_L079	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
4.	FL_L111	04/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
<i>4. Kaew cultivar (K) = 8 isolates</i>				
1.	K_L053	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
2.	K_F069	01/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
3.	K_F099	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
4.	K_F100	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
5.	K_F101	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai

Table 2.1 Continued

No.	Isolate code	Collection date (month/year)	Tissue	Location
6.	K_F103	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
7.	K_L120	04/2008	leaf	T. Makham-luang, A. San Pa Tong, Chiangmai
8.	K_L124	04/2008	leaf	Multiple Cropping Center (MCC), Faculty of agriculture, Chiangmai university, Chiangmai
5. <i>Khiaomorakod cultivar (KMK)</i> = 12 isolates				
1.	KMK_L041	12/2007	leaf	T. Ban Hong, A. Ban Hong, Lamphun
2.	KMK_L051	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
3.	KMK_L055	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
4.	KMK_L058	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
5.	KMK_L088	03/2008	leaf	T.Ping Khong, A. Chiang Dao, Chiangmai
6.	KMK_F132	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
7.	KMK_F133	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
8.	KMK_F134	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
9.	KMK_F135	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
10.	KMK_F136	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
11.	KMK_F137	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
12.	KMK_F138	04/2008	fruit	Research & development service section, Faculty of Agriculture, T. Lao-yao , A. Ban Hong, Lamphun
6. <i>Khiasawoey cultivar (KSW)</i> = 4 isolates				
1.	KSW_L004	11/2007	leaf	T.Ping Khong, A. Chiang Dao, Chiangmai
2.	KSW_L062	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
3.	KSW_L085	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
4.	KSW_L119	04/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
7. <i>Linnguhao cultivar (LNH)</i> = 1 isolate				
1.	LNG_L031	11/2007	leaf	T.Ping Khong, A. Chiang Dao, Chiangmai
8. <i>Mahacharnok cultivar (MCN)</i> = 9 isolates				
1.	MCN_L013	11/2007	leaf	T. Choeng-doi, A. Doi-saket, Chiangmai
2.	MCN_L049	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
3.	MCN_L052	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
4.	MCN_L056	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
5.	MCN_L059	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
6.	MCN_L070	01/2008	leaf	T. Phrommani, A. Mueang, Nakhon-nayok
7.	MCN_L075	02/2008	leaf	T. Nam-dip, A. Pa-sang, Lamphun
8.	MCN_L089	03/2008	leaf	T.Ping Khong, A. Chiang Dao, Chiangmai
9.	MCN_L121	04/2008	leaf	Multiple Cropping Center (MCC), Faculty of agriculture, Chiangmai university, Chiangmai

Table 2.1 Continued

No.	Isolate code	Collection date (month/year)	Tissue	Location
<i>9. Mankhunsii cultivar (MKS) = 2 isolates</i>				
1.	MKS_L034	11/2007	leaf	T.Ping Khong, A. Chiang Dao, Chiangmai
2.	MKS_L086	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
<i>10. Namdokmai cultivar (NDM) = 59 isolates</i>				
1.	NDM_F001	10/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
2.	NDM_F002	10/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
3.	NDM_F005	11/2007	fruit	Faculty of agriculture, Chiangmai university, Chiangmai
4.	NDM_F006	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
5.	NDM_F007	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
6.	NDM_F008	11/2007	fruit	Varorot Market, T. Sripoom, A. Mueang, Chiangmai
7.	NDM_F009	11/2007	fruit	Varorot Market, T. Sripoom, A. Mueang, Chiangmai
8.	NDM_F010	11/2007	fruit	Varorot Market, T. Sripoom, A. Mueang, Chiangmai
9.	NDM_F011	11/2007	fruit	Varorot Market, T. Sripoom, A. Mueang, Chiangmai
10.	NDM_F012	11/2007	fruit	Varorot Market, T. Sripoom, A. Mueang, Chiangmai
11.	NDM_F014	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
12.	NDM_F015	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
13.	NDM_F016	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
14.	NDM_F018	11/2007	fruit	Rim Ping Supermarket, A. Mueang, Chiangmai
15.	NDM_F019	11/2007	fruit	Rim Ping Supermarket, A. Mueang, Chiangmai
16.	NDM_F020	11/2007	fruit	Rim Ping Supermarket, A. Mueang, Chiangmai
17.	NDM_F021	11/2007	fruit	Tesco lotus supermarket, A. Mueang, Chiangmai
18.	NDM_F022	11/2007	fruit	Tesco lotus supermarket, A. Mueang, Chiangmai
19.	NDM_F023	11/2007	fruit	Tesco lotus supermarket, A. Mueang, Chiangmai
20.	NDM_F024	11/2007	fruit	Tesco lotus supermarket, A. Mueang, Chiangmai
21.	NDM_F025	11/2007	fruit	Tesco lotus supermarket, A. Mueang, Chiangmai
22.	NDM_F026	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
23.	NDM_F027	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
24.	NDM_F028	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
25.	NDM_F029	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
26.	NDM_F035	11/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
27.	NDM_F036	11/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
28.	NDM_F037	11/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
29.	NDM_F038	11/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
30.	NDM_F039	11/2007	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
31.	NDM_F042	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
32.	NDM_F043	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
33.	NDM_F045	12/2007	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
34.	NDM_F046	12/2007	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
35.	NDM_F050	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
36.	NDM_L057	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
37.	NDM_F061	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
38.	NDM_F063	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
39.	NDM_L067	01/2008	leaf	T. Wat-bot, A. Wat-bot, Phitsanulok
40.	NDM_L068	01/2008	leaf	T. Mae-taeng, A. Mae-taeng, Chiangmai
41.	NDM_L071	01/2008	leaf	T. Phrommani, A. Mueang, Nakhon-nayok
42.	NDM_F072	01/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai

Table 2.1 Continued

No.	Isolate code	Collection date (month/year)	Tissue	Location
43.	NDM_L078	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
44.	NDM_L096	04/2008	leaf	T. Pa-nai, A. Phrao, Chiangmai
45.	NDM_F104	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
46.	NDM_F106	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
47.	NDM_F107	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
48.	NDM_F108	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
49.	NDM_F109	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
50.	NDM_F110	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
51.	NDM_F112	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
52.	NDM_F115	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
53.	NDM_F116	04/2008	fruit	Tesco lotus supermarket, , A. Mueang, Chiangmai
54.	NDM_F117	04/2008	fruit	Tesco lotus supermarket, , A. Mueang, Chiangmai
55.	NDM_F118	04/2008	fruit	Tesco lotus supermarket, , A. Mueang, Chiangmai
56.	NDM_F127	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
57.	NDM_F128	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
58.	NDM_F129	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
59.	NDM_F130	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
<i>11. Nareeluemrang cultivar (NLR) = 2 isolates</i>				
1.	NLR_L047	12/2007	leaf	T. Ban Hong, A. Ban Hong, Lamphun
2.	NLR_L048	12/2007	leaf	T. Ban Hong, A. Ban Hong, Lamphun
<i>12. Okrong cultivar (OR) = 2 isolates</i>				
1.	OR_L040	12/2007	leaf	T. Ban Hong, A. Ban Hong, Lamphun
2.	OR_F126	04/2008	fruit	Sompath Market, T. Chang Klan, A. Mueang, Chiangmai
<i>13. Phetbanlat cultivar (PBL) = 13 isolates</i>				
1.	PBL_F030	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
2.	PBL_F033	11/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
3.	PBL_F054	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
4.	PBL_F064	12/2007	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
5.	PBL_F076	02/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
6.	PBL_F077	02/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
7.	PBL_F083	03/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
8.	PBL_F084	03/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
9.	PBL_F091	03/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
10.	PBL_F092	03/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
11.	PBL_F102	04/2008	fruit	Ton Payom Market, T. Suthap, A. Mueang, Chiangmai
12.	PBL_F113	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
13.	PBL_F131	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai

Table 2.1 Continued

No.	Isolate code	Collection date (month/year)	Tissue	Location
<i>14. Phimsen cultivar (PS) = 6 isolates</i>				
1.	PS_L032	11/2007	leaf	T.Ping Khong, A. Chiang Dao, Chiangmai
2.	PS_F073	01/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
3.	PS_F074	01/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
4.	PS_L082	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
5.	PS_F114	04/2008	fruit	Meung Mai Market, T. Chang-moi, A. Mueang, Chiangmai
6.	PS_F122	04/2008	fruit	Changphueak Market, T. Changphueak, A. Mueang, Chiangmai
<i>15. Raet cultivar (R) = 1 isolate</i>				
1.	R_L087	03/2008	leaf	T. Nam-phrae, A. Phrao, Chiangmai
<i>16. Salaya cultivar (SLY) = 1 isolate</i>				
1.	SLY_L017	11/2007	leaf	Multiple Cropping Center (MCC), Faculty of agriculture, Chiangmai university, Chiangmai
<i>17. Talapnak cultivar (TLN) = 2 isolates</i>				
1.	TLN_L060	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun
2.	TLN_L065	12/2007	leaf	T. Lao Khao, A. Ban Hong, Lamphun

2.3.2 Morphological characterisation of *Colletotrichum gloeosporioides*

All isolates were observed for morphological characterisation by growing on PDA for 10 days. The colony characteristics of all isolates were divided into 3 categories as follows:- white cottony colony (W) (83.33%), greyish-white cottony colony (WG) (12%) and dark grey cottony colony (G) (4.67%) (Figure 2.4a). The initial colour of colonies on PDA was white, then became greyish-white and then dark grey with aging.

Growth rates of the colonies ranged between 8.60-14.69 mm/day in diameter at an average of 9.97 ± 0.81 mm/day. Mycelia were branched, septate, and hyaline. They formed a one-celled hyaline, straight, cylindrical conidia with an average $16.46-18.65 \times 3.94-4.47 \mu\text{m}$ (Figure 2.4 b).

Each colony colour category was randomly selected to observe the appressoria characterisation, and they presented the clavate appressoria (Figure 2.4 c). Some of the isolates grew bright orange slimy spore masses outward from the centre of the colony. The older cultures developed black sclerotia around the centre of the colony on PDA (Figure 2.4 d). No setae were observed. Detail information of the colony and conidium characterizations of each isolate are shown in Table 2.2. These morphological characteristics were identified as *C. gloeosporioides*.

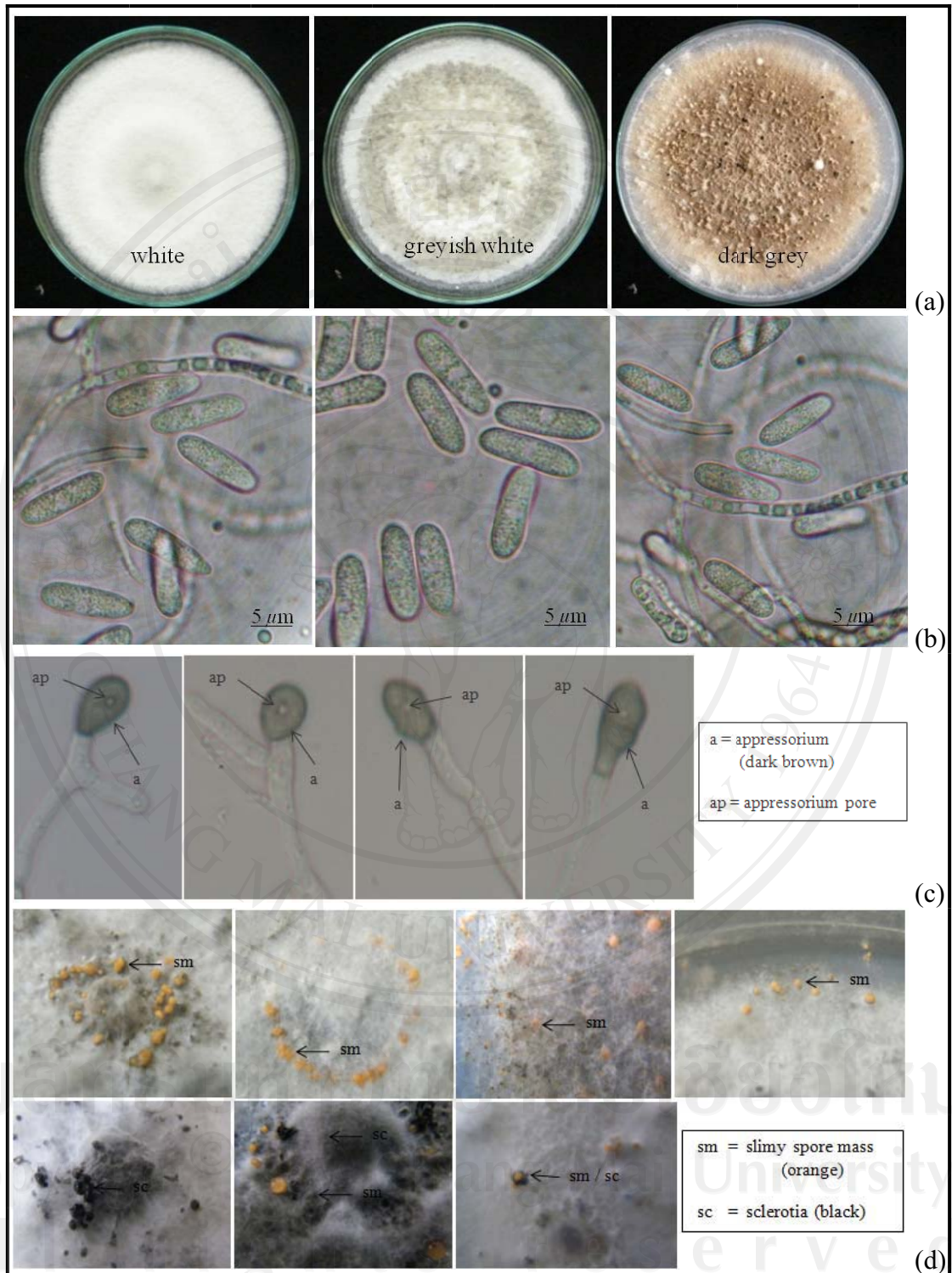


Figure 2.4 Morphological characterizations of *Colletotrichum* spp. isolates causing mango anthracnose; colony colour on PDA at 10 days (a), conidia (b), appressorium (c), and slimy spore mass and sclerotia (d).

Table 2.2 Morphological characterizations of *Colletotrichum* spp. isolates

No. Isolate code	Colony ^{1/}		After 14 days					Slimy spore mass ^{6/}	Sclerotia
	Color ^{3/}	Growth rate (mm/day)	Conidia ^{2/}			Mean size (µm)			
			Color ^{4/}	Shape ^{5/}	Length	Width			
<i>1. Chaokhunthip cultivar (CKT) = 1 isolate</i>									
Leaf									
1. CKT_L044	W	10.14±0.10	Hya	Cyl	17.11±0.12	4.17±0.08	+	+	
<i>2. Chokanan cultivar (CAN) = 23 isolates</i>									
Leaf									
1. CAN_L080	Gw	8.77±0.08	Hya	Cyl	16.95±0.11	4.16±0.12	+	+	
2. CAN_L081	W	9.77±0.13	Hya	Cyl	17.36±0.26	4.18±0.11	-	-	
3. CAN_L090	W	9.06±0.19	Hya	Cyl	18.18±0.15	4.35±0.08	+	-	
4. CAN_L105	W	10.17±0.19	Hya	Cyl	17.69±0.14	4.24±0.11	+	+	
Fruit									
5. CAN_F093	W	9.06±0.13	Hya	Cyl	17.56±0.16	4.21±0.13	-	-	
6. CAN_F094	W	11.14±0.10	Hya	Cyl	17.77±0.13	4.26±0.12	-	-	
7. CAN_F095	W	9.91±0.13	Hya	Cyl	18.07±0.09	4.33±0.12	-	+	
8. CAN_F097	W	10.09±0.16	Hya	Cyl	16.75±0.11	4.01±0.12	+	-	
9. CAN_F098	W	10.31±0.19	Hya	Cyl	17.35±0.18	4.16±0.10	+	-	
10. CAN_F123	W	8.63±0.13	Hya	Cyl	16.46±0.22	3.94±0.13	+	+	
11. CAN_F125	W	9.63±0.22	Hya	Cyl	16.95±0.11	4.06±0.10	+	+	
12. CAN_F139	W	9.46±0.12	Hya	Cyl	17.19±0.15	4.12±0.11	-	+	
13. CAN_F140	W	9.91±0.16	Hya	Cyl	17.86±0.11	4.28±0.12	-	-	
14. CAN_F141	W	10.09±0.08	Hya	Cyl	17.54±0.20	4.20±0.09	-	+	
15. CAN_F142	W	10.40±0.21	Hya	Cyl	16.95±0.16	4.06±0.12	-	+	
16. CAN_F143	W	8.83±0.19	Hya	Cyl	17.08±0.18	4.09±0.13	-	+	
17. CAN_F144	W	8.63±0.16	Hya	Cyl	17.47±0.12	4.19±0.12	-	-	
18. CAN_F145	W	9.17±0.19	Hya	Cyl	17.16±0.20	4.11±0.09	-	+	
19. CAN_F146	W	10.11±0.12	Hya	Cyl	17.46±0.25	4.18±0.11	+	+	
20. CAN_F147	W	9.00±0.10	Hya	Cyl	16.95±0.11	4.06±0.11	-	-	
21. CAN_F148	W	9.37±0.13	Hya	Cyl	18.36±0.21	4.40±0.11	-	+	
22. CAN_F149	W	10.86±0.14	Hya	Cyl	16.86±0.14	4.04±0.10	-	+	
23. CAN_F150	W	9.69±0.12	Hya	Cyl	17.39±0.13	4.17±0.13	-	+	
<i>3. Farlun cultivar (FL) = 4 isolates</i>									
Leaf									
1. FL_L079	G	10.17±0.19	Hya	Cyl	18.26±0.16	4.37±0.11	+	+	
2. FL_L111	W	9.23±0.16	Hya	Cyl	17.43±0.15	4.18±0.13	-	-	
Fruit									
3. FL_F003	Gw	12.94±0.16	Hya	Cyl	16.89±0.15	4.05±0.13	+	+	
4. FL_F066	W	14.69±0.12	Hya	Cyl	17.55±0.16	4.20±0.13	+	+	

^{1/}, ^{2/} Five, ten replications, respectively.^{3/} Colony color: W = white, Gw = grayish white, G = dark gray^{4/}, ^{5/} Conidia color: Hya = hyaline, conidia shape: Cyl = cylindrical, respectively.^{6/} Slimy spore mass or sclerotia production on PDA; + = present, - = absent.

Table 2.2 Continued

No. Isolate code	Colony ^{1/}		After 14 days				Slimy spore mass ^{6/}	Sclerotia	
	Color ^{3/}	Growth rate (mm/day)	Conidia ^{2/}		Mean size (µm)				
			Color ^{4/}	Shape ^{5/}	Length	Width			
4. <i>Kaew cultivar (K)</i> = 8 isolates									
Leaf									
1.	K_L053	W	13.94±0.16	Hya	Cyl	16.83±0.15	4.03±0.12	+	+
2.	K_L120	W	10.20±0.16	Hya	Cyl	18.24±0.14	4.37±0.12	+	+
3.	K_L124	W	9.14±0.23	Hya	Cyl	17.92±0.12	4.29±0.13	-	-
Fruit									
4.	K_F069	W	10.97±0.19	Hya	Cyl	16.87±0.13	4.04±0.12	-	+
5.	K_F099	W	8.89±0.12	Hya	Cyl	17.46±0.16	4.18±0.11	-	-
6.	K_F100	W	10.37±0.16	Hya	Cyl	18.19±0.18	4.36±0.13	+	-
7.	K_F101	W	10.06±0.16	Hya	Cyl	17.67±0.12	4.23±0.13	-	-
8.	K_F103	W	9.40±0.12	Hya	Cyl	18.37±0.15	4.40±0.12	+	+
5. <i>Khiaomorakod cultivar(KMK)</i> = 13 isolates									
Leaf									
1.	KMK_L041	W	10.14±0.10	Hya	Cyl	17.88±0.18	4.28±0.12	-	-
2.	KMK_L051	W	9.83±0.12	Hya	Cyl	17.84±0.15	4.27±0.12	-	-
3.	KMK_L055	W	9.03±0.12	Hya	Cyl	18.1±0.24	4.34±0.15	-	-
4.	KMK_L058	W	8.60±0.12	Hya	Cyl	17.57±0.17	4.21±0.12	+	+
5.	KMK_L088	Gw	9.29±0.14	Hya	Cyl	16.87±0.18	4.04±0.13	+	+
Fruit									
6.	KMK_F132	W	8.94±0.16	Hya	Cyl	18.16±0.16	4.35±0.12	-	-
7.	KMK_F133	W	9.86±0.10	Hya	Cyl	17.94±0.14	4.30±0.12	-	-
8.	KMK_F134	W	10.11±0.12	Hya	Cyl	17.74±0.16	4.25±0.13	-	-
9.	KMK_F135	W	10.83±0.12	Hya	Cyl	17.81±0.09	4.27±0.12	+	+
10.	KMK_F136	W	9.14±0.17	Hya	Cyl	16.87±0.24	4.04±0.13	+	+
11.	KMK_F137	W	9.74±0.06	Hya	Cyl	17.65±0.27	4.23±0.08	-	-
12.	KMK_F138	W	10.66±0.16	Hya	Cyl	16.96±0.15	4.06±0.13	-	-
6. <i>Khiaosawoey cultivar (KSW)</i> = 4 isolates									
Leaf									
1.	KSW_L004	W	8.97±0.06	Hya	Cyl	18.25±0.20	4.37±0.09	-	-
2.	KSW_L062	W	10.97±0.12	Hya	Cyl	17.61±0.11	4.22±0.13	+	+
3.	KSW_L085	W	10.37±0.08	Hya	Cyl	17.78±0.08	4.26±0.11	+	+
4.	KSW_L119	W	9.34±0.16	Hya	Cyl	16.83±0.11	4.03±0.11	-	-
7. <i>Lin Nguhao cultivar (LNH)</i> = 1 isolate									
Leaf									
1.	LNG_L031	Gw	9.09±0.22	Hya	Cyl	16.83±0.08	4.03±0.12	+	+

^{1/}, ^{2/} Five, ten replications, respectively.^{3/} Colony color: W = white, Gw = grayish white, G = dark gray^{4/}, ^{5/} Conidia color: Hya = hyaline, conidia shape: Cyl = cylindrical, respectively.^{6/} Slimy spore mass or sclerotia production on PDA; + = present, - = absent.

Table 2.2 Continued

No. Isolate code	Colony ^{1/}		After 14 days					Slimy spore mass ^{6/}	Sclerotia
	Color ^{3/}	Growth rate (mm/day)	Conidia ^{2/}			Mean size (µm)			
			Color ^{4/}	Shape ^{5/}	Length	Width			
<i>8. Mahacharnok cultivar (MCN) = 9 isolates</i>									
Leaf									
1. MCN_L013	W	9.23±0.13	Hya	Cyl	17.37±0.12	4.16±0.13	-	+	
2. MCN_L049	W	10.00±0.10	Hya	Cyl	17.94±0.11	4.30±0.11	-	-	
3. MCN_L052	W	9.91±0.08	Hya	Cyl	17.59±0.14	4.21±0.10	-	-	
4. MCN_L056	Gw	10.94±0.16	Hya	Cyl	17.83±0.08	4.27±0.11	+	+	
5. MCN_L059	W	10.23±0.13	Hya	Cyl	16.86±0.10	4.04±0.10	+	+	
6. MCN_L070	Gw	8.83±0.12	Hya	Cyl	17.34±0.08	4.15±0.13	+	+	
7. MCN_L075	W	9.57±0.10	Hya	Cyl	16.89±0.11	4.05±0.10	-	-	
8. MCN_L089	W	10.46±0.12	Hya	Cyl	17.45±0.12	4.18±0.13	-	-	
9. MCN_L121	W	10.34±0.08	Hya	Cyl	17.35±0.17	4.16±0.14	+	+	
<i>9. Mankhunyi cultivar (MKS) = 2 isolates</i>									
Leaf									
1. MKS_L034	W	9.20±0.16	Hya	Cyl	18.16±0.	4.35±0.13	-	-	
2. MKS_L086	W	9.71±0.10	Hya	Cyl	17.80±0.	4.26±0.13	+	+	
<i>10. Namdokmai cultivar (NDM) = 59 isolates</i>									
Leaf									
1. NDM_L057	G	9.09±0.08	Hya	Cyl	18.14±0.16	4.35±0.14	+	+	
2. NDM_L067	Gw	10.20±0.16	Hya	Cyl	17.82±0.13	4.27±0.13	+	+	
3. NDM_L068	G	10.31±0.12	Hya	Cyl	18.28±0.15	4.38±0.13	+	+	
4. NDM_L071	G	10.74±0.12	Hya	Cyl	17.61±0.13	4.22±0.13	+	+	
5. NDM_L078	W	9.54±0.06	Hya	Cyl	18.14±0.12	4.35±0.13	+	+	
6. NDM_L096	Gw	9.80±0.16	Hya	Cyl	17.54±0.12	4.20±0.12	+	+	
Fruit									
7. NDM_F001	W	9.60±0.12	Hya	Cyl	17.78±0.15	4.26±0.14	-	-	
8. NDM_F002	W	10.06±0.16	Hya	Cyl	17.95±0.11	4.30±0.13	+	+	
9. NDM_F005	W	9.49±0.08	Hya	Cyl	18.08±0.21	4.33±0.14	-	-	
10. NDM_F006	Gw	10.23±0.13	Hya	Cyl	16.95±0.14	4.06±0.12	+	+	
11. NDM_F007	W	9.80±0.13	Hya	Cyl	18.20±0.15	4.36±0.10	-	-	
12. NDM_F008	W	10.14±0.10	Hya	Cyl	18.10±0.11	4.34±0.12	-	-	
13. NDM_F009	W	9.97±0.12	Hya	Cyl	18.37±0.08	4.40±0.12	-	+	
14. NDM_F010	W	10.31±0.06	Hya	Cyl	18.35±0.14	4.40±0.12	-	-	
15. NDM_F011	W	9.71±0.10	Hya	Cyl	17.91±0.10	4.29±0.11	-	-	
16. NDM_F012	W	10.57±0.10	Hya	Cyl	17.89±0.14	4.29±0.14	+	+	
17. NDM_F014	G	9.91±0.08	Hya	Cyl	18.12±0.11	4.34±0.13	+	+	
18. NDM_F015	W	9.97±0.12	Hya	Cyl	17.65±0.20	4.23±0.15	-	-	
19. NDM_F016	W	10.29±0.14	Hya	Cyl	17.92±0.10	4.29±0.12	-	-	
20. NDM_F018	W	10.00±0.10	Hya	Cyl	17.66±0.15	4.23±0.12	+	+	
21. NDM_F019	W	9.86±0.10	Hya	Cyl	17.83±0.13	4.27±0.12	-	-	
22. NDM_F020	W	10.91±0.16	Hya	Cyl	16.89±0.17	4.05±0.13	-	-	

^{1/}, ^{2/} Five, ten replications, respectively.

^{3/} Colony color: W = white, Gw = grayish white, G = dark gray

^{4/}, ^{5/} Conidia color: Hya = hyaline, conidia shape: Cyl = cylindrical, respectively.

^{6/} Slimy spore mass or sclerotia production on PDA; + = present, - = absent.

Table 2.2 Continued

No.	Isolate code	Colony ^{1/}		After 14 days					Slimy spore mass ^{6/}	Sclerotia
		Color ^{3/}	Growth rate (mm/day)	Conidia ^{2/}			Mean size (μm)			
				Color ^{4/}	Shape ^{5/}	Length	Width			
23	NDM_F021	W	9.89±0.12	Hya	Cyl	16.79±0.29	4.02±0.14	-	+	
24	NDM_F022	W	10.14±0.10	Hya	Cyl	17.49±0.13	4.19±0.12	-	-	
25	NDM_F023	W	10.49±0.16	Hya	Cyl	18.04±0.08	4.32±0.12	-	-	
26	NDM_F024	W	9.97±0.12	Hya	Cyl	17.54±0.13	4.20±0.13	+	-	
27	NDM_F025	W	10.34±0.13	Hya	Cyl	18.08±0.16	4.33±0.11	-	-	
28	NDM_F026	W	9.00±0.14	Hya	Cyl	17.86±0.21	4.28±0.15	+	+	
29	NDM_F027	Gw	9.83±0.12	Hya	Cyl	18.09±0.15	4.33±0.13	+	+	
30	NDM_F028	W	10.03±0.19	Hya	Cyl	18.16±0.17	4.35±0.12	-	-	
31	NDM_F029	W	9.43±0.10	Hya	Cyl	17.45±0.14	4.18±0.12	-	-	
32	NDM_F035	W	10.97±0.12	Hya	Cyl	17.37±0.29	4.16±0.14	+	+	
33	NDM_F036	W	10.63±0.08	Hya	Cyl	17.61±0.18	4.22±0.13	-	-	
34	NDM_F037	W	10.86±0.14	Hya	Cyl	17.67±0.16	4.23±0.13	-	-	
35	NDM_F038	Gw	9.26±0.12	Hya	Cyl	18.21±0.15	4.36±0.12	+	+	
36	NDM_F039	W	9.63±0.08	Hya	Cyl	17.72±0.14	4.25±0.14	-	-	
37	NDM_F042	W	10.31±0.12	Hya	Cyl	17.66±0.33	4.23±0.14	-	-	
38	NDM_F043	W	10.77±0.16	Hya	Cyl	17.89±0.26	4.29±0.13	-	+	
39	NDM_F045	W	9.94±0.08	Hya	Cyl	17.67±0.17	4.23±0.11	-	-	
40	NDM_F046	W	10.60±0.12	Hya	Cyl	17.85±0.22	4.28±0.15	+	-	
41	NDM_F050	W	10.49±0.08	Hya	Cyl	18.21±0.33	4.36±0.12	-	-	
42	NDM_F061	W	10.06±0.16	Hya	Cyl	17.48±0.20	4.19±0.14	+	+	
43	NDM_F063	W	9.66±0.08	Hya	Cyl	17.76±0.27	4.25±0.13	+	+	
44	NDM_F072	W	10.14±0.10	Hya	Cyl	17.80±0.27	4.26±0.12	+	+	
45	NDM_F104	W	9.31±0.12	Hya	Cyl	17.37±0.23	4.15±0.11	-	-	
46	NDM_F106	W	9.51±0.19	Hya	Cyl	17.48±0.29	4.19±0.14	+	+	
47	NDM_F107	W	9.97±0.12	Hya	Cyl	16.70±0.23	4.00±0.11	-	-	
48	NDM_F108	W	10.17±0.12	Hya	Cyl	18.41±0.26	4.41±0.16	-	-	
49	NDM_F109	W	9.20±0.16	Hya	Cyl	17.66±0.37	4.23±0.09	-	-	
50	NDM_F110	W	9.74±0.12	Hya	Cyl	18.65±0.19	4.47±0.13	+	+	
51	NDM_F112	Gw	10.89±0.06	Hya	Cyl	18.30±0.37	4.38±0.08	+	+	
52	NDM_F115	Gw	10.29±0.00	Hya	Cyl	18.12±0.23	4.34±0.11	+	+	
53	NDM_F116	Gw	10.03±0.12	Hya	Cyl	17.61±0.33	4.22±0.12	+	+	
54	NDM_F117	W	10.20±0.08	Hya	Cyl	17.42±0.20	4.17±0.13	-	-	
55	NDM_F118	W	9.57±0.14	Hya	Cyl	17.79±0.14	4.26±0.11	+	+	
56	NDM_F127	Gw	9.97±0.12	Hya	Cyl	17.58±0.19	4.21±0.10	-	-	
57	NDM_F128	Gw	10.14±0.10	Hya	Cyl	18.05±0.12	4.32±0.12	-	+	
58	NDM_F129	Gw	10.03±0.12	Hya	Cyl	17.86±0.13	4.28±0.12	-	-	
59	NDM_F130	Gw	9.91±0.08	Hya	Cyl	17.78±0.21	4.26±0.12	+	+	
11. <i>Naree Luemrang cultivar (NLR) = 2 isolates</i>										
Leaf										
1.	NLR_L047	G	10.17±0.06	Hya	Cyl	17.69±0.25	4.24±0.13	+	+	
2.	NLR_L048	W	9.34±0.16	Hya	Cyl	18.27±0.18	4.38±0.14	+	+	

^{1/}, ^{2/} Five, ten replications, respectively.

^{3/} Colony color: W = white, Gw = grayish white, G = dark gray

^{4/}, ^{5/} Conidia color: Hya = hyaline, conidia shape: Cyl = cylindrical, respectively.

^{6/} Slimy spore mass or sclerotia production on PDA; + = present, - = absent.

Table 2.2 Continued

No.	Isolate code	Colony ^{1/}		After 14 days				Slimy spore mass ^{6/}	Sclerotia
		Color ^{3/}	Growth rate (mm/day)	Conidia ^{2/}		Mean size (µm)			
				Color ^{4/}	Shape ^{5/}	Length	Width		
<i>12. Okrong cultivar (OR) = 2 isolates</i>									
Leaf									
1.	OR_L040	W	10.06±0.08	Hya	Cyl	18.33±0.24	4.39±0.15	+	+
Fruit									
2.	OR_F126	W	9.34±0.13	Hya	Cyl	17.93±0.22	4.30±0.13	+	+
<i>13. Phetbanlat cultivar (PBL) = 13 isolates</i>									
Fruit									
1.	PBL_F030	W	10.86±0.10	Hya	Cyl	18.25±0.21	4.37±0.10	-	-
2.	PBL_F033	W	10.46±0.12	Hya	Cyl	17.85±0.19	4.28±0.13	+	+
3.	PBL_F054	W	10.66±0.13	Hya	Cyl	17.98±0.16	4.31±0.13	-	-
4.	PBL_F064	W	9.34±0.08	Hya	Cyl	17.58±0.20	4.21±0.09	-	-
5.	PBL_F076	W	9.71±0.20	Hya	Cyl	17.84±0.13	4.27±0.13	+	+
6.	PBL_F077	W	10.06±0.16	Hya	Cyl	17.67±0.18	4.23±0.10	-	-
7.	PBL_F083	W	9.77±0.13	Hya	Cyl	17.78±0.21	4.26±0.13	-	+
8.	PBL_F084	W	10.91±0.08	Hya	Cyl	17.85±0.17	4.28±0.12	+	-
9.	PBL_F091	W	9.37±0.08	Hya	Cyl	18.21±0.23	4.36±0.11	-	-
10.	PBL_F092	W	10.03±0.12	Hya	Cyl	18.15±0.18	4.35±0.11	-	-
11.	PBL_F102	W	9.23±0.08	Hya	Cyl	17.60±0.27	4.22±0.15	+	+
12.	PBL_F113	W	9.86±0.10	Hya	Cyl	17.80±0.12	4.26±0.09	-	+
13.	PBL_F131	W	10.11±0.12	Hya	Cyl	18.07±0.27	4.33±0.10	+	+
<i>14. Phimsen cultivar (PS) = 6 isolates</i>									
Leaf									
1.	PS_L032	W	9.06±0.16	Hya	Cyl	17.81±0.21	4.27±0.11	+	+
2.	PS_L082	G	10.09±0.13	Hya	Cyl	18.17±0.07	4.35±0.12	+	+
Fruit									
3.	PS_F073	W	9.66±0.13	Hya	Cyl	17.89±0.16	4.29±0.10	-	+
4.	PS_F074	W	9.86±0.10	Hya	Cyl	18.11±0.12	4.34±0.11	-	-
5.	PS_F114	W	10.20±0.08	Hya	Cyl	17.92±0.25	4.29±0.08	+	+
6.	PS_F122	W	10.23±0.08	Hya	Cyl	18.05±0.20	4.32±0.10	-	+
<i>15. Raet cultivar (R) = 1 isolate</i>									
Leaf									
1.	R_L087	W	10.31±0.12	Hya	Cyl	18.09±0.23	4.33±0.10	+	+
<i>16. Salaya cultivar (SLY) = 1 isolate</i>									
Leaf									
1.	SLY_L017	W	9.20±0.26	Hya	Cyl	17.66±0.12	4.23±0.12	+	+
<i>17. Talabnak cultivar (TLN) = 2 isolates</i>									
Leaf									
1.	TLN_L060	W	10.03±0.12	Hya	Cyl	17.74±0.14	4.25±0.13	+	+
2.	TLN_L065	W	9.51±0.16	Hya	Cyl	18.20±0.22	4.36±0.09	+	+

^{1/} ^{2/} Five, ten replications, respectively.

^{3/} Colony color: W = white, Gw = grayish white, G = dark gray

^{4/} ^{5/} Conidia color: Hya = hyaline, conidia shape: Cyl = cylindrical, respectively.

^{6/} Slimy spore mass or sclerotia production on PDA; + = present, - = absent.

2.4 Discussion

Anthracnose is normally affected the quality and quantity of mangoes in almost all mango producing areas of Thailand. The causing agent was isolated from the symptoms on various mango cultivars which collected from markets and orchards identified as *C. gloeosporioides*. Great losses of this fruit have been reported due to damage caused by this disease, which is characterized by blackening of the peel and serious harm to the foliage (Ploetz and Prakash, 2000). This situation is similar to that in other mango producing countries such as Australia, India, Sri Lanka, etc., where the fungus, *C. gloeosporioides*, has been reported to cause anthracnose (Rawal, 1997; Arauz, 2000; Ploetz, 2003; Akem, 2006; Rivera-Vargas *et al.*, 2006; Nelson, 2008). Rivera-Vargas *et al.* (2006) reported that the *Colletotrichum* spp. isolates from anthracnose found in mangoes imported from Mexico, Brazil, and Nicaragua, and sold in Florida markets, were identified as *C. gloeosporioides*. In Australia, *C. gloeosporioides* var. *minor* has been reported as responsible for this disease (Ploetz and Prakash, 2000). Nevertheless, many studies reported several *Colletotrichum* species associated with mango anthracnose. Jayasinghe and Fernando (2009) reported that *C. acutatum* caused mango anthracnose in Sri Lanka. Furthermore, *C. acutatum* has been reported to play a small role as a causal agent of anthracnose in Australia, India, and the USA (Fitzell, 1979; Rivera-Vargas *et al.*, 2006). Traditionally, characterization of *Colletotrichum* species has been based on morphological characteristics, such as size and shape of conidia, colony colour, and growth. Such criteria are, however, not always adequate for species identification because of an overlap in morphological characteristics and phenotypic variation among species where environmental conditions influence the stability of many morphological traits.

However, *C. gloeosporioides* causing mango anthracnose has been reported in many commercial mango cultivars of Thailand, such as ‘Chok Anan’, ‘Namdokmai’, ‘Rad’, ‘Kaew’, ‘Kaew Juk’, ‘Keaw Sawaey’, ‘Keaw Moragot’, ‘Mahajanake’, ‘Okrang’, ‘Tongdum’ and ‘Nang Klang Wan’ (Sangchote, 1987; Kumpoun and Boonyakiat, 2010). In addition, in this research findings found that *C. gloeosporioides* were successfully isolated from cv. ‘Chaokhunthip’, ‘Falun’, ‘Kaew’, ‘Linnguhao’, ‘Mankhunyi’, ‘Nareeluemrang’, ‘Phetbanlat’, ‘Phimsen’, ‘Salaya’ and ‘Talapanak’ other than previous reports.

2.5 Conclusion

The 150 isolates of *C. gloeosporioides* were obtained from tissue transplanting technique on fruits and leaves anthracnose of 17 mango cultivars. Generally, all isolates showed white, greyish-white, and dark grey cottony colony on PDA after 10 days. The growth rate of the colonies was between 8.60-14.69 mm/day in diameter, at an average of 9.97 ± 0.81 mm/day. They formed one-celled hyaline straight cylindrical conidia that were $16.46-18.65 \times 3.94-4.47$ μm . Some isolates produced orange slimy spore mass or black sclerotia. The appressoria were clavate-shaped.