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SHORT COMMUNICATION

Diversity of *Fusarium* species in cultivated soils in Penang

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ABSTRACT

Fusarium species were isolated from 12 cultivated soil planted with different crops in Penang. A total of 42 *Fusarium* isolates were recovered in which four *Fusarium* species were identified namely, *F. solani, F. semitectum, F. equiseti* and *F. oxysporum*. The most prevalent *Fusarium* species recovered was *F. solani* (84%), followed by *F. semitectum* (7%), *F. equiseti* (7%) and *F. oxysporum* (2%). The present study showed that *Fusarium* populations are diverse within cultivated soils and could be potential inoculum to infect certain agriculture crops.

Keywords: diversity, *Fusarium*, cultivated soil

INTRODUCTION

Fusarium species are ubiquitous in soil and have been isolated from various soil types in tropical and temperate regions from desert soil to artic and alpine soils. However, the majority of *Fusarium* species were recovered in cultivated soils especially near the soil surface. *Fusarium* species occurred widely in cultivated soils and often associated with plant roots either as parasites or saprophytes (Booth, 1971). Many economically important crops are infected by pathogenic *Fusarium* species causing various types of diseases such as vascular wilt of banana, root rot and stem rot on vegetables and ornamentals, and fruit decay. The disease can cause economic losses as yield will be reduced if proper control methods are not taken. However, little is known about the distribution and diversity of *Fusarium* species in cultivated soil in Peninsula Malaysia. Therefore, the objective of this preliminary study was to observe *Fusarium* species diversity in several cultivated soils in Penang.

MATERIAL AND METHODS

Soil Sample

Soil samples were collected from several cultivated soil planted with different crops as listed in Table 1. The method used for isolation of *Fusarium* species was direct inoculation method. The soils were taken from a depth of 10 – 12 cm and stored in paper bag. In the lab, the soils were air dried at room temperature for 24 – 48 h after which the soil samples were passed through 200 µm sieve. For each soil samples, approximately 1- 2 g were spread over peptone chloro-nitro benzene (PCNB) media, with four replicates. The plates were incubated at room temperature for 5 – 7 days or until visible sign of colony growth. The plates were observed under a binocular microscope and the colonies formed were then transferred onto potato sucrose agar (PSA). The media used and description of *Fusarium* species was according to classification system of Nelson *et al*. (1981). The cultivated soil samples were also analysed for their texture, pH and moisture. Soil texture was determined using feel method described by Brady and Weil (1999).

Table 1: The crops and location of soil samples collected

Crops	Location
Lettuce (*Lactuca* sp.)	Relau
Papaya (*Carica papaya*)	Relau
Rubber (*Hevea brasiliensis*)	Relau
Starfruit (*Averrhoa carambola*)	Relau
Cabbage (*Brassica oleracea*)	Relau
Kangkung (*Ipomoea aquatica*)	Relau
Paddy (*Oryza sativa*)	Balik Pulau
Oil palm (*Elaies guineensis*)	Balik Pulau
Banana (*Musa* sp.)	Balik Pulau
Dragon fruit (*Hylocereus undatus*)	Seberang Perai
Longan (*Euphoria longana*)	Seberang Perai
Limau kasturi (*Citrus microcarpa*)	Seberang Perai

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Soil moisture was expressed by percentage of dry weight basis by the formula:

$$\% \text{ moisture (dry weight)} = \frac{\text{fresh weight} - \text{dry weight}}{\text{dry weight}} \times 100\%$$

10 g of the soil samples were weight and dried at 105 ^{o}C for 24 – 48h, depending on the soil texture. After drying, the soil samples were reweighed and the percentage was calculated.

Soil pH was measured by weighing 30 g of the soil samples and put in a beaker. 50 mL of distilled water were added. The beaker was shaken for 2 – 3 min and then the soils were allowed to settle. pH value was measured using a pH meter (Beckman).

RESULTS

A total of 42 *Fusarium* isolates were recovered from the 12 soil samples in which four *Fusarium* species were identified namely, *F. solani, F. semitectum, F. equiseti* and *F. oxysporum*. The most prevalent *Fusarium* species recovered was *F. solani* (84%), followed by *F. semitectum* (7%), *F. equiseti* (7%) and *F. oxysporum* (2%). Table 2 shows the morphological characteristics of the four *Fusarium* species isolated from the soil samples in different locations in Penang. The *Fusarium* species successfully isolated, the soil texture, pH and moisture are shown in Table 3.

Table 2: Morphological characteristics of *Fusarium* species isolated from 12 soil samples of agricultural crops

Characteristic	Species			
	F. solani	***F. semitectum***	***F. equiseti***	***F. oxysporum***
Microconidia	abundant in aerial mycelial, single-celled, 1 – 2 septa, oval to kidney-shaped	scarce, 0 – 1 septate, pyriform	absent	abundant in aerial mycelial, oval to kidney-shaped, aerial mycelial with false heads, 0 septate
Macroconidia	abundant in sporodochia, stout, thick-walled, 4 – 7 septa, wide and stout, rounded basal cell, blunt and rounded apical cell	abundant in sporodochia, 4 - 5 septa, slender and spindle shaped, slightly curved, foot shaped basal cell, curved apical cell	abundant in sporodochia, 5 – 7 septa, long and slender, foot shaped basal celled, elongated apical cell,	abundant in sporodochia, 3 septa, short to medium length, slightly curved, thin walled, foot shaped basal cell, curved apical cell
Conidiophore	long monophialides	monophialides and polyphialides	monophialides	short monophialides
Chlamydospore	present in pairs and singly	present	present in chains and singly	present singly and in pairs
Pigmentation	whitish yellow, colourless	brown to darker brown	pale brown to dark brown	pale violet to dark violet

Table 3: Characteristics of soil samples and *Fusarium* species isolated

Crops / soil samples	Texture	pH	% moisture	*Fusarium* species
Lettuce	sandy loam	5.2	0.24	*F. solani* *F. equiseti* *F. semitectum*
Papaya	silty clay loam	3.8	0.18	*F. solani*
Rubber	silty clay loam	3.8	0.24	*F. solani*
Starfruit	sandy loam	6.1	0.19	*F. solani*
Cabbage	silty loam	5.6	0.26	*F. solani*
'Kangkung'	sandy loam	6.4	0.24	*F. solani*
Paddy	silty clay loam	6.0	0.19	*F. solani* *F. semitectum*
Oil palm	silty loam	3.9	0.75	*F. solani* *F. equiseti* *F. semitectum* *F. oxysporum*
Banana	sandy loam	4.9	0.19	*F. solani*
Dragon fruit	silty clay	4.9	0.23	*F. solani* *F. equiseti*
'Longan'	silty clay	4.7	0.21	*F. solani*
'Limau kasturi'	silty clay	5.9	0.23	*F. solani*

33% of the *Fusarium* species were recovered from sandy loam soil which was planted with lettuce, starfruit, 'kangkung' and banana. The *Fusarium* species isolated were *F. solani, F. semitectum* and *F. equiseti*. From silty clay soil, planted with dragon fruit, 'longan' and 'limau kasturi', 26% of *Fusarium* species was recovered namely, *F. solani* and *F equiseti.* 24% of *Fusarium* species comprising *F. solani, F. semitectum, F. oxyporum* and *F. equiseti* were recovered from silty loam soil which was planted with cabbage and oil palm. Two *Fusarium* species, *F. solani* and *F. semitectum* were isolated from silty clay loam soils planted with rubber and paddy.

In the present study, *Fusarium* species were presence in acidic condition ranging from pH 3.8 – 6.4. From silty loam soil with pH 3.9, four *Fusarium* species namely, *F. solani, F. semitectum, F. equiseti* and *F. oxysporum* were isolated. Most of the *F. solani* isolates were isolated in acidic condition of pH 3.8 to 3.9.

Highest percentage of moisture of 75% was obtained from silty loam soil planted with oil palm. With high moisture content, all the four *Fusarium* species were isolated. In contrast, lowest moisture content of 18% – 19%, only *F. solani* was isolated.

DISCUSSION

Soil type is likely to influence the structure on microbial communities. The highest percentage of *Fusarium* isolates was recovered from sandy loam soil. Generally, sandy texture has lower water holding capacity. However, with frequent watering, the soil will always have enough water content to support microbial growth.

In the present study, the soil pH where the *Fusarium* isolates were recovered was at pH 3.8 to 6.1 which was suitable for many fungal growths. According to Alexopoulous *et al.* (1996), generally, many types of fungi grow best at pH level of 4 to 7.

The *Fusarium* species recovered in the present study are common in soils. *Fusarium* species occur widely in the soil and exist as colonizers of living plants or plant debris within the soil or adjacent to the soil surface (Burgess, 1981). In the soil, *Fusarium* species are able to persist as mycelium, chlamydospore and conidia (Booth, 1971; McMullan and Stack, 1983).

F. solani was the most prevalent species isolated and was recovered in all the 12 soil samples. The species was found in all the four soil types i.e. sandy loam, silty clay loam, silty loam and silty clay soils. *F. solani* is common soil-borne fungi and a pathogen to many agriculture crops such as citrus (Nemec, 1987), peppers (Fletcher, 1994) and beans (Silbernagel and Mills, 1990). *F. solani* is widely distributed in numerous native soils such as in sub tropical, semi-arid and grassland soils (Burgess and Summerell, 1992) and desert soil (El Gindy and Saad, 1990). Therefore, in this study, it was not surprising that *F. solani* was the most frequent species isolated from the four soil types. Lim and Chew (1970) reported that *F. solani* was also prevalent and widespread in cultivated soils in Singapore.

F. semitectum and *F. equiseti* were commonly isolated from soil as reported by Burgess *et al*. (1988) and Leslie *et al*. (1990), and most probably exist as soil inhabitants. Both species are not regarded as important plant pathogens although the species have been reported to cause diseases on several crops (Dhingra and Muchovej, 1979; Adams *et al*., 1987; McGovern, 1994; Elmer, 1996). According to Leslie and Summerell (2006), F. *semitectum* and *F. equiseti* have limited pathogenic capabilities and widely distributed as saprophytes in soils as well as on diseased tissues.

F. oxysporum is a well known plant pathogen causing various types of plant diseases and is common in the soil, however, in this study, *F. oxysporum* was only found in silty loam soil planted with oil palm. In a similar study by Lim and Chew (1970), *F. oxysporum* was not recovered from several cultivated soils in Singapore. The low percentage of *F. oxysporum* may be attributed to the soil type as soil type can influence the population structure of *F. oxysporum* as the species is particularly adapted to a specific abiotic environment or other environmental factor (Edel *et al*., 2001).

In conclusion, the present study showed that *Fusarium* populations are diverse within cultivated soils and could be potential inoculum to infect certain agriculture crops. The ecological significance and genetic diversity of each *Fusarium* species need to be further investigated as the study will give more information on the distribution and population structure of *Fusarium* species in the soil.

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