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The Relationship between Organic Matter in Subsoil and Fusarium Wilt of Banana

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Original Research Article

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Abstract: Fusarium wilt of banana is a soil-borne disease. Soil quality is an important factor in banana growth as it may affect the occurrence and severity of the disease. This study investigated the relationship between organic matter in soil and fusarium wilt of banana by using subsoil as a base matrix amended with either banana pseudo stem or sugarcane leaves in a pot system. The disease symptoms did not develop in pot systems with pure subsoil, regardless of whether the soil was inoculated or not with fusarium wilt. In contrast, the addition of banana pseudo stems to soil exacerbated the risk of fusarium wilt, whereas sugarcane leaves were not favorable to the disease. Therefore, a sample of pure subsoil could be used for the evaluation of the effects on soil-borne disease effectively.
Keywords: Fusarium wilt of banana; Subsoil; Disease index.

INTRODUCTION

Fusarium wilt of banana in Asia is caused by the soil-borne fungus, *Fusarium oxysporum* f. sp. *cubense* race 4. There are limited options for managing the disease and they are largely restricted to excluding the pathogen from non-infested areas [1]. The key indicators of “healthy” soils include soil structure, permeability, mineral content, and microbial attributes [2]. Recently, the application of “healthy” soils, that sustain plant growth while still maintaining the environmental quality, attracted the interest of banana producers. However, the mechanisms underlying disease suppression in healthy soils remain unknown.

MATERIALS AND METHODS

This study aimed to determine the relationship between organic matter in soils and fusarium wilt of banana. *Fusarium oxysporum* f. sp. *cubense* race 4 used in the experiments was provided by the Department of Plant Pathology, South China Agricultural University, Guangzhou, China [3]. The pathogen was maintained in Petri dishes containing potato dextrose agar (PDA) and incubated for 7 d at 28°C. The banana cultivars to be tested were tissue culture-derived banana plantlets (Cavendish banana, AAA) at the 5–6 leaf stage provided by the Guangdong Academy of Agricultural Sciences, Guangzhou, China. Subsoil from an uncultivated upland field collected at a depth of 40 to 50 cm was used as base matrix (pH 4.3; soil type latosols; organic matter ≤ 0.5%; N ≤ 0.05 g kg^{-1}, P ≤ 2.65 g kg^{-1}; K ≤ 12.28 g kg^{-1}). The organic matter comprised banana pseudo stem and sugarcane leaves that were cut from the plants, chopped into about 5-cm chips, and dried to constant weight at 105°C for 30 min and at 80°C for over 8 h. The dried matter was ground in a Pulverizer (1000-Y,2; 8000 r min^{-1}, 30 mesh; Guangzhou Leimai Machinery Equipment Co., Ltd., Guangzhou, China). The plantlets were planted in 16 × 18 cm plastic pots containing subsoil (2.5 kg) mixed with organic matter, while pure subsoil (100%) with no inoculation was used as a negative control and with inoculation as a positive control (Table 1). Disease severity was evaluated for each pot system for 3 months [4].The disease index was calculated according to Li *et al*. [5]. The pathogen was re-isolated from all the subsoil matrices after 3 months and transferred onto fresh PDA media containing streptomycin. The isolates were identified by using the combination of morphological and molecular analyses [6].

RESULTS

The results showed that the treatments with both types of the control displayed no symptoms. The same results were observed in treatments with subsoil + banana pseudo stem 1% (T1) and subsoil + sugarcane leaves 1% (T6), 2% (T7), and 4% (T8). The treatment subsoil + banana pseudo stem 2% (T2) exhibited slight symptoms of the disease (disease index 4.28), whereas the treatments subsoil + banana pseudo stem 4% (T3), 8% (T4), and 16% (T5) resulted in significantly stronger disease symptoms and higher disease index (69.33, 72.38, and 85.6, respectively). Meanwhile, the disease symptoms in treatments subsoil + sugarcane leaves 8% (T9) and 16% (T10) were with lower disease index (7.33 and 9.33, respectively) (Fig. 1). The disease indices were significantly higher when the organic matter originated from banana pseudo stem than from sugarcane leaves. Treatment T5 resulted in the most severe symptoms of fusarium wilt in banana, as indicated by the highest disease index; the disease index was not significantly different from that in T3 and T4 treatments, but it was significantly different from that in T2, T9, and T10 treatments. The pathogen was re-isolated from all the subsoil matrices, except from the control with no inoculation, and identified as the original pathogen. Therefore, we concluded that subsoil was unfavorable for growth of fusarium wilt, even after inoculation with the pathogen.

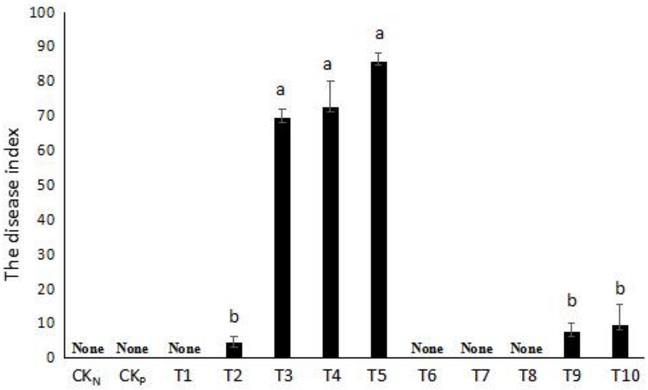

Fig-1: Disease index of different treatments in the greenhouse

Table-1: The experimental design Treatment

			No.
Subsoil +	Banana pseudo-stem	1%	T1
		2%	T2
		4%	T3
		8%	T4
		16%	T5
	Sugarcane leaves	1%	T6
		2%	T7
		4%	T8
		8%	T9
		16%	T10
Subsoil 100%	No inoculation as negative control		CK_N
	Inoculation as positive control		CK_P

CONCLUSION

The results suggest that banana pseudo stem sustains disease development—the disease index increased with increasing content of banana pseudo stem. However, the disease was not induced at low levels of organic matter originating from banana pseudo stem. In contrast, the disease was not induced significantly even at high levels of sugarcane leaves. This study revealed that accumulation of banana pseudo stem in soil would exacerbate the risk of fusarium wilt to some extent. Simple, pure subsoil could be used effectively in the evaluation of factors on soil-borne diseases. Thus, currently our laboratory is evaluating the effects of different fertilizers on fusarium wilt, using subsoil.

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