Induction of suppressive soil in the management of Fusarium wilt of banana

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Introduction

Banana is the second most important fruit crop in Malaysia, accounting for 20% of the total hectarage of fruit plantations. However, land use for banana cultivation has declined over the years from 40 000 ha in 1993 to 39 0000 in 2000. The emergence of Fusarium wilt disease, threatened to diminish the banana industry. Two races (R1 and R4) of the pathogen *Fusarium oxysporum f.sp cubense* (Foc) have been identified to be pathogenic to most of the commercially-grown banana varieties . To date, Fusarium wilt has yet to be controlled effectively as the pathogen is a variable soil-inhabiting fungus with high surviving chlamydospores in the soil. Control methods like flood-fallowing, use of chemicals and breeding for resistance varieties, were relatively expensive, time consuming, high-skilled, labour intensive and short-lived. New methods have to be developed to control Fusarium wilt, especially since the resistant Cavendish varieties has now succumb to FocR4. One such alternative is through the use of suppressive soil. Suppressive soil can be *induced* by inoculating antagonistic microorganism(s) or adding soil amendments into the soil, which inhibits the sporulation of the pathogen and disease development. Hence, banana seedlings treated with suppressive soil, prior to planting in the field, will be able to have some sort of defense mechanisms against *Fusarium.* This project aim to establish soil suppressiveness through the use of antagonistic microorganism and soil amendment and to evaluate its effect on disease incidence and development.

Materials and Methods

The potential of using artificially "induced" suppressive soil to suppress the development of Fusarium wilt was conducted on susceptible tissue-cultured banana seedlings cultivar Intan and race 4 of the *Fusarium oxysporum f sp cubense* (FocR4). *Trichoderma harzianum* (UPM 40) was selected as the microbial antagonist, and calcium nitrate ($Ca(N0_3)_2$) as the soil amendment. Both biotic and abiotic components, respectively, were incorporated into the soil to provide the environment of naturally-existing *Fusarium* suppressive soil. The potential of UPM 40 as a biocontrol agent was confirmed from a series of antagonism tests *in vitro*. To evaluate the efficacy of the *induced* suppressive soil in suppressing Fusarium wilt, a factorial experiment with 8 treatments arranged in a Completely Randomized Design was conducted

Results and Discussion

UPM 40 is antagonistic towards FocR4 as shown by positive inhibition of growth based on lysis, antibiosis and mycoparasitism tests. *In vitro* tests determined that UPM 40 required early establishment prior to challenge with FocR4, to ensure effective antagonistic activity. Soil pH was not affected by $Ca(N0_3)_2$ application, indicating compatibility of inoculating UPM 40 together with $Ca(NO_3)_2$ application. When tested on 8-9 week-old seedlings, treatment with $Ca(NO_3)_2$ alone recorded low disease incidence of 51% as compared to 59% and 69% from combined treatments and UPM 40 alone, respectively, 8 weeks after inoculation. This gave disease reduction of 48.6% for treatment with $Ca(NO_3)_2$, 41.4% for combined treatment and 31.4% for UPM 40 . Calcium reduced the population of FocR4, promoted plant growth, and induced host resistance through increased peroxidase and polyphenloxidase activity, and phenol content. Increased in enzymatic activities and phenol content was related to cell wall lignification as revealed by histological observations, resulting in resistance to FocR4 hyphal penetration. The formation of Ca-pectate also contributed to host resistance. Biocontrol efficacy of UPM 40 was dependent on soil environment, as the glasshouse trial did not suppress disease incidence, contrary to the antagonistic effect in *in vitro* tests. UPM 40 did not induce host resistance, instead predisposed the seedlings to infection by increasing root growth and infection sites. UPM 40 was poor in rhizosphere competency as the population recovered from root rhizospheres decrease with time of sampling. Disease suppression achieved through treatment with $Ca(NO_3)_2$ was dependent on Ca^{2+} availability in the soil and Ca^{2+} content in the plant tissues. A more frequent/regular application using suitable rates is suggested as follow-up studies.

Conclusions

Suppression of Fusarium wilt could be achieved by using biotic and abiotic soil amendments. However, since the efficiency and continuous suppressive effect on *Fusarium* development is dependent on availability of Ca^{2+} in the soil and persistency in the host tissues, repeated application of $Ca(NO_3)_2$ has to be evaluated in relation to the nitrogen requirement of banana. UPM 40 was low in rhizosphere competency and did not give significant disease suppression, when used singly suggesting the possible occurrence of soil fungistasis. Studies are being proposed to improve the efficiency of suppressive soil by combining with host-plant resistance and using endophytic microorganism(s) to overcome the fungistasis effect

Benefits from the study

Technology for the management of Fusarium wilt which is eco-friendly and sustainable. Integrated with host resistance increase durable resistance for field plantings.
Training of expertise in biological control and plant pathology.

Literature cited in the text :

Nil

Project Publications in Refereed Journals

1. Sariah, M. and Omar, D. 2000. Pest and Disease Management of fruits and vegetables: Issues,challenges and future options. *Trans. Malay. Soc. Plant Physiology* 9: 193-199.

2. Adeline. S. Y. Ting, Sariah, M, Jugah, K. and Anuar, R. 2000. Effect of induced suppressive soil to *Fusarium* development. *Trans. Malay. Soc. Plant Physiology* 9: 351-354.

3. Tarig, S.A., Sariah, M., Sijam, K. and Marziah,M. 2000. Induced biochemical responses in banana seedlings to *Fusarium* inoculant. Trans. Malay. Soc. Plant Physiology 9: 328-322.

Graduate Thesis:

Nil

Masters Thesis
Induction of suppressive soil in the management of Fusarium wilt on banana seedlings. (completed)

Ph D thesis

Control of Fusarium wilt of banana through induced resistance. (on -going)

Project Publications in Conference Proceedings

Sariah, M. 1999. Biochemical markers as a measure of resistance to Fusarium wilt in banana seedlings. In Proceeding s of Inter. Banana Seminar: *Fusarium* Wilt Disease. INIBAP.

Tarig, S. A., Sariah, M., Sijam, K. and Marziah, M. 1998. Enhancement of growth and disease suppression by PGPF isolate, *Fusarium oxysporum* (FO4), in banana seedlings. In Proceedings of *National Banana Symp.* pp 261-268.

Expertise Development

Name of Graduate	Degree Awarded	Field of Expertise	Graduation Year
Adeline T. S Ying	M Ag Sc	Biological control/Plant Pathology	2001
Ismail Iberahim	M Ag Sc	Biological Control/Plant Pathology	2001

Hendry Joseph	**M Ag Sc**	**Biological Pathology**	**Control/Plant**	**2000**
Wong Mui Yun	**M Ag Sc**	**Biological Pathology**	**Control/Plant**	**1999**
S.S. El -Ammarri	**PhD**	**Seed Pathology**	**Pathology/Plant**	**1996**

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