UNIVERSITI PUTRA MALAYSIA

EFFECTS OF FOLIAR AND ROOT APPLICATION OF SILICON ON RICE BLAST FUNGUS IN MR219 RICE

FARNAZ ABED ASHTIANI

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By

FARNAZ ABED ASHTIANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfillment of the Requirements for the Degree of Master of Agricultural Science

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Dedication

This Thesis is dedicated to

My Most Beloved Father, Yousef

My Gracious Mother, Saphoura

My Lovely Sister, Sarvnaz

Without your love, patience, understanding, financial and emotional support this work could never been completed. Likewise, many faced problems during this study were a lot ease through your compassion.

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia
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EFFECTS OF FOLIAR AND ROOT APPLICATION OF SILICON ON RICE BLAST FUNGUS IN MR219 RICE

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Chairman: Associate Professor Jugah B Kadir, PhD

Faculty : Agriculture

Rice blast caused by fungus *Magnaporthe grisea* (Hebert) Barr [teleomorph] *Pyricularia oryzae* Cavara is among the most devastating diseases of rice worldwide. In modern agricultural practices it is highly important to manage diseases and pests using efficient methods with minimum harm to the environment. Although silicon has been reported to significantly reduce foliar diseases in crops, its application has not been widely adopted in Malaysia. Hence studies were conducted to determine the effects of silicon on *Pyricularia oryzae*. Rice variety MR219 was grown in the glasshouse and the function of silica gel and sodium silicate in conferring resistance against blast was investigated. Silica gel was applied to soil prior to planting (0, 60, 120, 180 g/5 kg of soil) while sodium silicate was used as foliar spray (0, 1,

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2, 3 mL/L). The treatments were arranged in a completely randomized design with three replications. The severity of disease and silicon content of leaves were compared between the non-amended controls and rice plants receiving the different rates and sources of silicon. Silicon at all rates of application significantly (α=0.05) reduced the severity of disease with the highest reduction (75%) recorded in treatments receiving 120 g of silica gel. The relationship between leaf blast severity (Y) and amount of silicon applied to the plants (X) could be explained by the exponential decay curve using equation $y=Ae^{-bx}$ indicating that leaf blast severity was lower with higher rates of silicon application. Scanning Electron Microscopic observations showed that there were two types of silicified cells on the adaxial surface of rice leaves which included dumbbell-shaped and small scattered silica cells. The X-ray spectra analysis demonstrated a significant difference in weight concentration of silicon in silica cells on the leaf epidermis between silicon treated (25.79%) and non treated plants (7.87%) as well as among plants treated with different rates of silica gel and sodium silicate, indicating that silicon-fertilization resulted in higher deposition of silicon in both kinds of silica cells. Application of silicon also led to a significant increase (25.3 g/kg) in silicon content of leaves compared to non-treated plants (6.28 g/kg). The rate of photosynthesis of silicon treated plants (11.98 $\mu molm^{-2}s^{-1}$) was significantly higher than plants in the control group (6.36 $\mu molm^{-2}s^{-1}$). Shoot dry weight of rice plants increased significantly (1.50 g) with silicon fertilization as compared to non-treated plants (0.90 g). Contrast procedures indicated higher efficiency of silica gel in comparison to

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sodium silicate in almost all parameters assessed. The results suggest that mitigated levels of disease were associated with fortification of rice leaf epidermal cells through silicon fertilization. Although both foliar and root application of silicon were effective in decreasing the intensity of blast, greater effectiveness was achieved through root application. In conclusion, the study supports the hypothesis that silicon is able to confer resistance against blast disease. This could make silicon a useful tool for managing rice diseases, possibly in conjunction with reduced rate of fungicide, and may provide alternative to rice growers in areas where blast resistant cultivars have become susceptible.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagi memenuhi keperluan untuk ijazah Master Sains Pertanian

KESAN APLIKASI BAJA SILIKON MELALUI PENYEMBURAN DAUN DAN AKAR TERHADAP PENYAKIT KULAT KARAH PADA PADI MR 219

Oleh

FARNAZ ABED ASHTIANI

Oktober 2012

Pengerusi: Profesor Madya Jugah B Kadir, PhD

Fakulti : Pertanian

Penyakit karah yang disebabkan oleh kulat *Magnaporthe grisea* (Herbert) Barr [teleomorph] *Pyricularia oryzae* Cavara merupakan antara penyakit padi paling serius di seluruh dunia. Dalam amalan pertanian moden, pengurusan penyakit dan perosak dengan menggunakan kaedah yang dapat memberi perlindungan kepada tumbuhan secara maksimum di samping mengurangkan kerosakan kepada alam sekitar amat dititikberatkan. Walaupun banyak kajian tentang silikon telah menunjukkan pengurangan pelbagai jenis penyakit daun, namun pengunaan nutrien tersebut masih tidak dipraktikan secara meluas di Malaysia. Dengan itu, kajian telah dijalankan untuk mengkaji kesan silikon dari sumber yang berlainan terhadap *Pyricularia oryzae.* Kajian dijalankan di rumah kaca UPM dengan menggunakan silika gel dan sodium silikat untuk mengkaji kesan sumber silikon yang berlainan terhadap penyakit karah pada padi varieti

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MR219. Silika gel dicampurkan dengan tanah sebelum penanaman padi dengan kadar 0, 60, 120, 180g/5kg tanah manakala sodium silikat disemburkan pada daun dengan kadar 0, 1, 2, 3 mL/L. Severiti penyakit dan kandungan silika pada daun dibandingkan antara tanaman kawalan dan tanaman yang mendapat aplikasi silikon. Kesemua aplikasi silikon (α=0.05) dapat mengawal penyakit secara berkesan dengan pengurangan keterukan penyakit tertinggi (75%) untuk kadar aplikasi 120g silika gel. Hubungan antara keterukan penyakit karah (Y) dan kadar aplikasi silika pada padi (X) dapat dirumuskan dengan 'exponential decay curve' dengan mengunakan persamaan $y=Ae^{-bx}$ (di mana A dan b adalah pemalar dalam regresi yang tidak linear). Cerapan melalui imbasan mikroskop elektron menunjukkan bahawa terdapat dua jenis sel silika pada permukaan daun padi iaitu, bentuk "dumbbell" dan taburan sel silika yang kecil. Analisis spektrum sinar-X menunjukkan perbezaan yang signifikan bagi kepekatan berat silikon dalam sel silika pada epidermis daun yang dirawat dengan silikon (25.79%) dan juga tanaman kawalan (7.87%). Perbezaan yang signifikan juga boleh diperhatikan bagi tanaman yang dirawat dengan pelbagai kadar silika gel dan sodium silikat. Hal ini menunjukkan bahawa baja silikon menyebabkan peningkatan kandungan silikon pada kedua-dua jenis silika sel berbanding dengan tanaman kawalan. Berbanding dengan tanaman kawalan (6.28 g/kg), aplikasi silikon juga menyebabkan peningkatan kandungan silikon pada daun dengan mengunakan kaedah kolorimetrik molybdenum biru. Kadar fotosintetik padi yang dirawat dengan silikon (11.98 $\mu molm^{-2}s^{-1}$) jelas lebih tinggi berbanding tanaman kawalan (6.36 $\mu molm^{-2}s^{-1}$). Berat padi yang dikeringkan secara signifikannya meningkat (1.50g) dengan aplikasi baja

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silikon berbanding dengan tanaman kawalan (0.90g). Kaedah statistik bandingan menunjukkan silika gel adalah lebih efektif berbanding dengan sodium silikat dalam semua parameter yang diuji. Hasil kajian ini mencadangkan bahawa pengurangan kadar penyakit dikaitkan dengan kandungan silika yang tinggi dan ketahanan sel daun epidermis padi terhadap penyakit karah. Walaupun aplikasi silikon melalui penyemburan daun dan akar adalah berkesan, namun aplikasi silikon pada akar adalah lebih efektif. Secara keseluruhannya, kajian ini menyokong hipotesis bahawa silikon dapat meningkatkan daya pertahanan terhadap penyakit karah. Hal ini menunjukkan bahawa silikon berpotensi dalam pengurusan penyakit padi. Dalam masa yang sama, penggunaan racun kulat boleh dikurangkan di samping menjadi sumber alternatif kepada petani di mana kultivar padi yang rintang penyakit karah menjadi kultivar yang rentan kepada penyakit tersebut.

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I certify that a Thesis Examination Committee has met on 5 October 2012 to conduct the final examination of Farnaz Abed Ashtiani on her thesis entitled "Effects of Foliar and Root Application of Silicon on Rice Blast Fungus in MR219 Rice" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Master of Agricultural Science.

Members of the Thesis Examination Committee were as follows:

Kamaruzaman bin Sijam, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Ganesan A/L Vadamalai, PhD
Senior Lecturer
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Abdul Shukor bin Juraimi, PhD
Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Internal Examiner)

Latiffah binti Zakaria, PhD
Associate Professor
School of Biological Sciences
Universiti Sains Malaysia
(External Examiner)

SEOW HENG FONG, PhD
Professor and Deputy Dean
School of Graduate Studies
Universiti Putra Malaysia

Date: 29 November 2012

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master of Agricultural Science. The members of the Supervisory Committee were as follows:

Jugah bin Kadir, PhD
Associate Professor
Faculty of Agriculture
Universiti Putra Malaysia
(Chairman)

Ahmad bin Selamat, PhD
Senior Consultant Fellow
Faculty of Agriculture
Universiti Putra Malaysia
(Member)

Ahmad Husni bin Mohd Haniff, PhD
Associate Professor
Faculty of Agriculture
University Putra Malaysia
(Member)

BUJANG BIN KIM HUAT, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:

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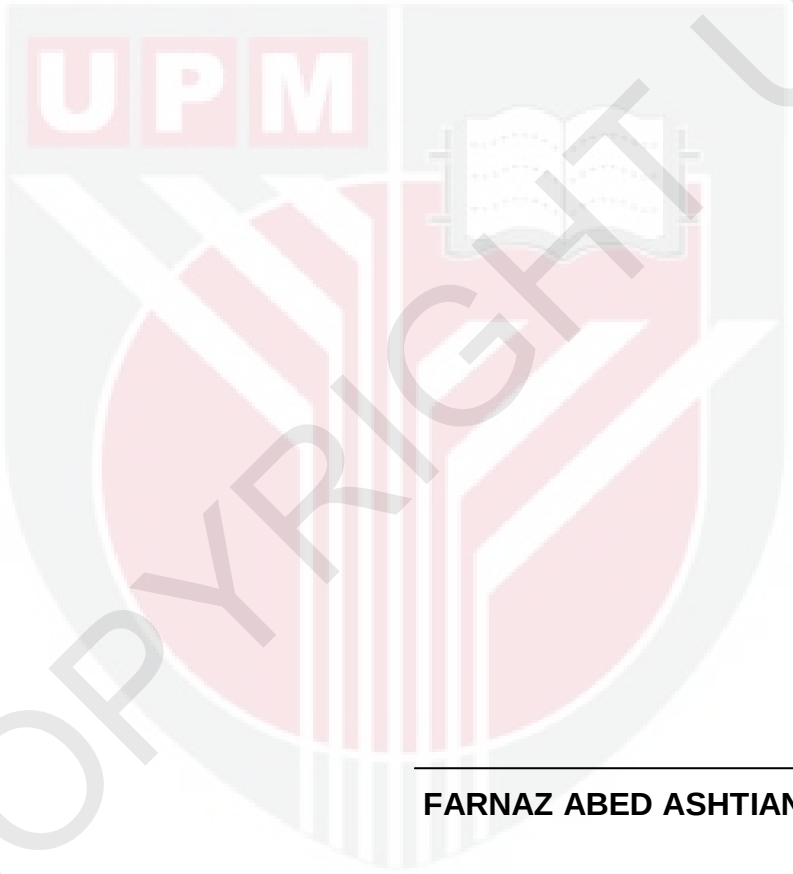
DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.



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