

**EFFECTS OF ELEVATED TROPOSPHERIC OZONE  
ON BIOCHEMICAL ACTIVITIES AND YIELD OF  
SELECTED INDICA RICE PLANTS**

**AZRIN BINTI SUROTO**

**MASTER OF SCIENCE  
UNIVERSITI MALAYSIA TERENGGANU**

**2015**

**AZRIN BINTI SUROTO  
MASTER OF SCIENCE  
2015**

**EFFECTS OF ELEVATED TROPOSPHERIC OZONE ON BIOCHEMICAL  
ACTIVITIES AND YIELD OF SELECTED INDICA RICE PLANTS**

**By**

**AZRIN BINTI SUROTO**

**Thesis submitted to the School of Marine and Environmental Science,  
Universiti Malaysia Terengganu, in fulfilment of the requirement of the  
Degree of Master of Science**

**July 2015**

## Dedication

This thesis is dedicated to my families and friends..

***"A journey that teaches the meaning of  
sincerity..patience ..determination ..strength ..grateful ..and life .. "***

From the beginning of this journey ..  
I never walk alone ..  
Spirit and prayer of from the people around ..  
Always accompany this journey ..  
Through up and down..  
Thick and thin of me..  
They remain on my side ..  
Never tired of giving support and encouragement ..  
To ensure success at the end of the journey ..

Finally ..  
This journey gave something special for all of you ..  
For the loves, infinite gratitude for your support and prayers that have been sent ..  
May you be in HIS mercy ..

To my beloved husband,  
***Mr. Muhamad Iqmal bin Muhammad Shafiq,***  
thank you very much for being with me through thick and thin..  
Always there for me..

To my lovely and very supportive father, mother and my elder sister..  
***Mr.Suroto bin Ahamad, Madam Zainon binti Samad, Madam Heti binti Suroto and family,***  
Infinite appreciation to all of you for never giving up support and pray for my success..

To my beloved family-in-law,  
***Colonel. Hj. Muhammad Shafiq bin Jahudi, Madam Hjh. Rabiah binti Mohd Kassim,  
Muhammad Ikram bin Muhammad Shafiq and Nur Aqilah binti Muhammad Shafiq,***  
thank you for your prayers and support from you guys ..

To all my friends, thank you very much for always be with me..  
We cried and laughed together..  
And made our friendship become stronger..

Thank you Allah..

***"I never walk alone .."***

Abstract of thesis presented to the Senate of Universiti Malaysia Terengganu in fulfilment of the requirement for the degree of Master of Environmental Technology and Management

EFFECTS OF ELEVATED TROPOSPHERIC OZONE STRESS ON BIOCHEMICAL  
ACTIVITIES AND YIELD OF SELECTED INDICA RICE PLANTS

(*Oryzae sativa. L*)

By

AZRIN BINTI SUROTO

2015

Chairperson : Associate Professor Marzuki bin Hj. Ismail, Ph.D.

School : Marine Science and Environment

Ozone had been recognized as one of the major threats towards crops, including rice by giving the adverse effects on biochemical activities, physiological performance and yield production. In Malaysia, anthropogenic sources are rapidly increasing and this condition had caused increased ozone formation. Domestic rice consumption is projected to be high due to population increase. High production of rice is targeted from the existing rice planting areas. Since there is no plan by the government to increase the area for rice cultivation, there is an urgent need to identify the most tolerant cultivar to ozone. In this study, prior to exposure of ozone to rice cultivars, microclimatic conditions (i.e. temperature and relative humidity) in greenhouse, close-top chambers and ambient, Accumulated Exposure of Ozone Threshold at 60 ppb and 100 ppb (AOT60 and AOT100), and time series analysis by using Autoregressive Integrated Moving Average (ARIMA) model were determined. Effects of ozone on anti-oxidative enzyme activities and yield of four selected Malaysian local rice cultivars (i.e. Mahsuri, MR84, MR219 and MR263) were then determined by exposing the cultivars to different elevated ozone concentrations, i.e. 60 parts per billion and 120 parts per billion (ppb) in close-top chamber (CTC). From this study, it was shown that temperature and relative humidity in greenhouse,

CTCs and ambient are in the range of 26.8 to 39.4°C and 32.3 to 91.8% with there is no significant different between them ( $P > 0.05$ ). Results for AOT60 and AOT100 showed that there is ozone excess over the limit of 60 ppb at four major rice growing areas (MADA, KADA, Seberang Perak and Sabak Bernam). Meanwhile, for AOT100, ozone excess only occurred at MADA area. For biochemical activities (SOD and GR), results clearly showed that there were significant effects ( $P < 0.05$ ) of elevated ozone on anti-oxidative enzyme (SOD and GR) activities and significant reduction on yield of four selected rice cultivar in the range of 5% to 15%. From that, Mahsuri was identified as the best cultivar because it is the most resistant rice cultivar followed by MR84, MR263 while MR219 was the least tolerant towards ozone stress. Futher study is needed before Mahsuri can be proposed as the best to be used in ozone-exposed planting area.

Abstrak tesis yang dikemukakan kepada Senat Universiti Malaysia Terengganu sebagai memenuhi keperluan ijazah Sarjana Teknologi dan Pengurusan Alam Sekitar

KESAN PENINGKATAN OZON TROPOSFERA KE ATAS AKTIVITI BIOKIMIA DAN  
HASIL TUMBUHAN PADI INDICA TERPILIH  
(*Oryzae sativa L.*)

Oleh

AZRIN BINTI SUROTO

2015

Pengerusi : Profesor Madya Marzuki bin Hj. Ismail, Ph.D.

Pusat Pengajian : Sains Marin dan Sekitaran

Ozon telah dikenalpasti sebagai salah satu ancaman utama terhadap tanaman, termasuk padi dengan memberi kesan buruk kepada aktiviti biokimia, prestasi fisiologi dan pengeluaran hasil. Di Malaysia, sumber antropogenik semakin berkembang dengan pesat dan keadaan ini telah menyebabkan peningkatan pembentukan ozon. Penggunaan beras dalam negeri diunjurkan menjadi tinggi disebabkan oleh peningkatan penduduk. Pengeluaran yang tinggi beras disasarkan dari kawasan penanaman padi yang sedia ada. Kerana tidak ada rancangan kerajaan untuk meningkatkan kawasan untuk penanaman padi, terdapat keperluan yang mendesak untuk mengenal pasti kultivar yang paling berdaya tahan kepada ozon. Dalam kajian ini, keadaan iklim mikro (iaitu suhu dan kelembapan relatif) dalam rumah hijau, kebuk tertutup dan sekitaran. Pendedahan Terkumpul Ambang Ozon pada 60 ppb dan 100 ppb (AOT60 dan AOT100), analisis siri masa dengan menggunakan "*Autoregression Integrated Moving Average (ARIMA model)*" telah ditentukan. Kesan ozon pada aktiviti enzim anti-pengoksidaan dan hasil empat dipilih

kultivar padi tempatan Malaysia (iaitu Mahsuri, MR84, MR219 dan MR263) ditentukan dengan mendedahkan kultivar kepada kepekatan ozon berbeza tinggi, iaitu 60 bahagian per bilion dan 120 bahagian per bilion (ppb) di kebuk tertutup (CTC). Dari kajian ini, suhu dan kelembapan dalam rumah hijau, CTC dan sekitaran adalah dalam lingkungan 26.8 hingga 39.4°C dan 32.3-91.8% dengan tiada perbezaan yang ketara di antara mereka ( $P > 0.05$ ). Keputusan untuk AOT60 dan AOT100 menunjukkan bahawa terdapat lebih ozon yang melebihi had 60 ppb di empat kawasan penanaman padi utama (MADA, KADA, Seberang Perak dan Sabak Bernam). Sementara itu, bagi AOT100, lebih ozon hanya berlaku di kawasan MADA. Untuk aktiviti biokimia (SOD dan GR), keputusan jelas menunjukkan bahawa terdapat kesan yang signifikan ( $P < 0.05$ ) ozon tinggi pada aktiviti enzim anti-pengoksidaan (SOD dan GR) dan pengurangan yang ketara kepada hasil empat kultivar padi dipilih dalam lingkungan 5% kepada 15%. Oleh itu, Mahsuri telah dikenal pasti sebagai kultivar yang terbaik kerana ia adalah kultivar beras yang paling berdaya tahan diikuti oleh MR84, MR263 manakala MR219 adalah yang paling kurang berdaya tahan terhadap tekanan ozon. Kajian selanjutnya diperlukan sebelum Mahsuri dicadangkan sebagai kultivar yang terbaik untuk di tanam di kawasan yang terdedah dengan ozon.