



**UNIVERSITI PUTRA MALAYSIA**

**EFFECTS OF AMBIENT OZONE (O<sub>3</sub>) CONCENTRATIONS ON THE  
GROWTH PERFORMANCE OF RICE (*ORYZA SATIVA* VAR. MR 219)  
TREATED WITH DIFFERENT NUTRIENT REGIMES IN THE MUDA  
AREA, MALAYSIA**

**SHARIFAH AZLINA BT. ALI**

**FPAS 2007 4**



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**MASTER OF SCIENCE  
UNIVERSITI PUTRA MALAYSIA**

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**By**

**SHARIFAH AZLINA BT. ALI**

**Thesis Submitted to the School of Graduate Studies, Universiti Putra  
Malaysia, in Fulfilment of the Requirement for the Degree of Master of  
Science**

**January 2007**



## DEDICATION

This thesis is especially dedicated to:

My mother and father,

*Thanks for the never-ending love*

My brother and sisters,

*Hope the future holds something wonderful for all of you*

All my relatives,

*Your help and encouragement has been so valuable to me*

All my friends,

*I'll never get this far without your support, thanks for the friendship...*



Abstract of thesis presented to the Senate of Universiti Putra Malaysia in  
fulfilment of the requirement for the degree of Master of Science

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**January 2007**

**Chairman : Associate Professor Ahmad Makmom Hj. Abdullah, PhD**

**Faculty : Environmental Studies**

Ozone (O<sub>3</sub>) is a secondary gaseous pollutant produced through photochemical reaction known to have substantial impacts on agricultural production in North America and Western Europe. In Malaysia, emissions of O<sub>3</sub> precursors such as non-methane hydrocarbons and nitrogen dioxide are rapidly increased due to urbanization, industrialization and the increasing number of motor vehicles. Furthermore climatic condition in the country is frequently favourable for the formation of high concentration of O<sub>3</sub>. It can threaten the rice production which is important to the country as it is the staple food for the vast majority of the population.

In this study, different nutrient regimes were employed to assess the impact of ozone on the growth and yield of variety of local rice (*Oryza sativa* L.) at Muda area in three different ambient ozone (O<sub>3</sub>) concentrations. A controlled experiment involving ambient ozone (non-filtered air) and filtered air treatment in



open top chambers demonstrated protective effects of nutrient against ozone. The study found that ozone significantly reduced the growth of rice plant by inhibiting photosynthetic rate, stomatal conductance, transpiration, tiller number and biomass. The result also demonstrated that the growth of rice plant was significantly increased when adding 25% of nutrient regime from normal practices. The relationship between grain dry weight, ozone dosage (AOT40) and the optimum nutrient regime expressed through a fitting linear model produced the following equation: Grain Yield Weight (N<sub>125</sub>) = (-0.00045\*AOT40)+(124.3953).



Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia  
sebagai keperluan untuk ijazah Master Sains

**KESAN KEPEKATAN OZON (O<sub>3</sub>) UDARA KASA KE ATAS PRESTASI  
PERTUMBUHAN PADI (*ORYZA SATIVA* VAR. MR219) DENGAN RAWATAN  
REJIM NUTRIEN BERBEZA DI KAWASAN MUDA, MALAYSIA**

Oleh

**SHARIFAH AZLINA ALI**

**Januari 2007**

**Pengerusi : Profesor Madya Ahmad Makmom Hj. Abdullah, PhD**

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Ozon (O<sub>3</sub>) adalah gas pencemar kedua yang terhasil melalui tindakbalas fotokimia yang diketahui dapat memberi kesan ke atas pengeluaran pertanian di Amerika Utara dan Eropah Barat. Di Malaysia, pelepasan bahan perintis O<sub>3</sub> seperti hidrokarbon bukan metana dan nitrogen dioksida meningkat dengan cepat disebabkan oleh proses urbanisasi, perindustrian dan peningkatan jumlah kenderaan bermotor. Tambahan lagi, keadaan iklim di negara ini adalah amat sesuai untuk penghasilan ozon yang tinggi. Keadaan ini boleh mengancam pengeluaran padi dalam negara yang merupakan makanan ruji bagi kebanyakan masyarakat.

Dalam kajian ini, rejim nutrien berbeza diaplikasikan untuk menilai kesan ozon ke atas pertumbuhan dan hasil padi tempatan (*Oryza sativa* L.) di kawasan MADA pada tiga kepekatan ozon udara kasa (O<sub>3</sub>) yang berbeza. Eksperimen kawalan yang melibatkan ozon udara kasa (udara tidak bertapis) dan udara bertapis di dalam kebuk fumigasi terbuka menunjukkan kesan perlindungan

nutrien daripada serangan terhadap ozon. Kajian ini membuktikan bahawa ozon memberi kesan pengurangan yang signifikan terhadap pertumbuhan pokok padi dengan mengganggu kadar fotosintesis, rintangan stomata, transpirasi, bilangan tangkai dan biojisim. Hasil kajian juga menunjukkan bahawa pertumbuhan pokok padi meningkat dengan signifikan apabila rejim nutrien ditambahkan sebanyak 25% melebihi daripada amalan pengurusan biasa. Hubungan di antara berat kering padi, dos ozon (AOT 40) dan rejim baja optimum ditunjukkan melalui model garis lurus yang menghasilkan persamaan berikut: Berat kering hasilan padi ( $N_{125}$ ) =  $(-0.00045 \cdot AOT40) + (124.3953)$ .



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I certify that an Examination Committee has met on 18<sup>th</sup> January 2007 to conduct the final examination of Sharifah Azlina Bt. Ali on her Master of Science thesis entitled “Effects of Ambient Ozone (O<sub>3</sub>) Concentrations on the Growth Performance of Rice (*Oryza sativa* Var. MR 219) Treated with Different Nutrient Regimes in the Muda Area, Malaysia” in accordance with Universiti Pertanian Malaysia (Higher Degree) Act 1980 and Universiti Pertanian Malaysia (Higher Degree) Regulations 1981. The Committee recommends that the candidate be awarded the relevant degree. Members of the Examination Committee are as follows:

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## DECLARATION

I hereby declare that the thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at UPM or other institutions.

---

**SHARIFAH AZLINA ALI**

Date: 15 MARCH 2007



## TABLE OF CONTENTS

	<b>Page</b>
<b>DEDICATION</b>	ii
<b>ABSTRACT</b>	iii
<b>ABSTRAK</b>	v
<b>ACKNOWLEDGEMENTS</b>	vii
<b>APPROVAL</b>	viii
<b>DECLARATION</b>	x
<b>LIST OF TABLES</b>	xiv
<b>LIST OF FIGURES</b>	xv
<b>LIST OF ABBREVIATIONS</b>	xviii
<b>CHAPTER</b>	
<b>1 INTRODUCTION</b>	
Background information of research	1
The need for establishment the relationships between crop growth and the atmospheric environment	4
1.3 Rice production in MADA area	8
1.4 Problem statement	9
1.5 Research objectives	13
1.6 Hypotheses	13
1.7 Significance of the study	14
1.8 Scope of the study	15
<b>2 LITERATURE REVIEW</b>	
Rice growth and production	16
Vegetative phase	16
Reproduction phase	17
Ripening phase	18
2.2 Rice varietal	18
2.3 The effects of climatic environment on rice production	19
2.3.1 Carbon dioxide (CO <sub>2</sub> )	19
2.3.2 Rainfall	19
2.3.3 Solar radiation	20
2.3.4 Day length	21
2.3.5 Temperature	22
2.3.6 Relative humidity	22
2.3.7 Wind speed	23
2.4 Soils and water condition	23
2.5 Biotic and abiotic factors	30
2.6 Source of ground-level ozone	32
2.7 The direct effects of increased O <sub>3</sub> on plants	33
2.8 Effects on plant growth and development	
2.8.1 Plant height and tiller number	36



2.8.2	Plant dry weight	37
2.8.3	Visible injury	38
2.9	Physiology of O <sub>3</sub> responses	
2.9.1	Photosynthesis	39
2.9.2	Stomatal conductance and transpiration rate	40
2.10	Evidence of nutrient-O <sub>3</sub> interactions studies	41
<b>3</b>	<b>MATERIALS AND METHODS</b>	
3.1	Site description	44
3.1.1	Temperature	47
3.1.2	Rainfall and relative humidity	48
3.1.3	Solar radiation	49
3.1.4	Wind speed	50
3.2	Plant culture	51
3.3	Experimental Procedures	
3.3.1	Design of OTCs	53
3.3.2	Experimental design	56
3.3.3	Microclimate monitoring	58
3.3.4	Ambient Ozone (O <sub>3</sub> ) concentration	60
3.3.5	Growth measurements	62
3.3.6	Harvest procedure	62
3.3.7	Physiological measurement	63
3.4	Data analysis	
3.4.1	Distribution of O <sub>3</sub> pollutant throughout growing seasons	65
3.4.2	Exposure-response relationship	66
3.5	Statistical analysis	66
<b>4</b>	<b>RESULTS</b>	
4.1	Meteorological monitoring at the study site	68
4.2	Ambient ozone (O <sub>3</sub> ) concentration	
4.4.1	O <sub>3</sub> distribution throughout years	71
4.4.2	Critical level exceedance	72
4.3	Physiological analysis	
4.3.1	Comparison between charcoal filtered and ambient air	74
4.3.2	Physiological performances of rice plant exposed to ambient air with different nutrient regime	78
4.4	Growth parameters	
4.4.1	Plant height and tiller number	80
4.4.2	Effect on dry matter partitioning	86
4.4.3	Total dry weight performances	90
4.4.4	The relationship between nutrient regime and total dry weight	94
4.4.5	Exposure-response relationship	96

<b>5</b>	<b>DISCUSSION</b>	
5.1	Assumption of factors crop yields limitation factors	99
5.2	Ambient ozone (O <sub>3</sub> ) concentration	100
5.3	The effect of ozone on physiological aspects	102
5.4	The effect of ozone on growth and biomass	106
5.5	The total dry weight performances of plants exposed to ozone	110
5.6	The role of nutrient to protect plant from ozone damage	113
<b>6</b>	<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>115</b>
	<b>REFERENCES</b>	<b>119</b>
	<b>APPENDICES</b>	<b>134</b>
	<b>BIODATA OF THE AUTHOR</b>	<b>200</b>



## LIST OF TABLES

<b>Table</b>		<b>Page</b>
2.1	Nutrient Composition and Crop DRIS Index report at study area	26
2.2	Gudelines for the effects of ozone on vegetation: critical levels	36
3.1	Rice cropping calendar in Muda area	46
3.2	Daily mean of wind speed over 9 years period (1996-2004)	50
3.3	Table of fertilization rate applied during growing season	52
3.4	Table of treatment details of the nutrient regimes experiment	52
4.1	Comparison of environmental variables monitoring at the study site in Open Top Chamber and ambient air	68
4.2	Ratio of critical level exceedance for 2000 to 2005	74
4.3	The gradient slope of the linear regression for each growth stage	93
4.4	The values of maximum total dry weight at the best nutrient regimes	95
4.5	Regression analysis of grain and AOT 40 with different nutrient regimes	96
4.6	Gradient slope of linear regression of grain weight function to ozone with different nutrient regimes	98



## LIST OF FIGURES

Figure		Page
1.1	Best Management Practices (BMP) Concept	6
1.2	Rice productions in MADA area from year 1978 until 2002	9
2.1	Soil classifications in MADA area	24
2.2	Schematic diagram of ozone formation pathway	33
3.1	Location of the experimental site	44
3.2	Muda area in Kedah and Perlis	45
3.3	Annually temperatures for Alor Star from year 1996 until 2004	47
3.4	Annually rainfall and relative humidity for Alor Star from year 1996 until 2004	48
3.5	Accumulated monthly total of solar radiation for Alor Star in year 1996 to 2004	49
3.6	Design of charcoal filter (CF) chamber	54
3.7	Design of non filter (NF) chamber	55
3.8	Photograph of Open Top Chamber (OTCs) system	55
3.9	Twenty pots of rice plant planted inside each chamber	57
3.10	Diagram of treatment and subsamples applied in study	57
3.11	Microclimatic condition inside the OTCs measurements	59
3.12	Li-Cor LI 190SA Quantum sensor for light intensity data	60
3.13	Dry weight of plant part	63
3.14	Gas exchange measurement using Portable Photosynthesis System (Li-cor, LI 6400)	65

4.1	Diurnal mean pattern of light intensity inside the chamber and ambient air	70
4.2	Total hourly O <sub>3</sub> (AOT 40) concentration during growing period for 2000 to 2005	72
4.3	Light response curve for filtered air and ambient air	76
4.4	Stomatal conductance filtered air and ambient air	77
4.5	Transpiration rates for filtered air and ambient air	77
4.6	Light response curve for treatment exposed to ambient air	79
4.7	Stomatal conductance for treatment exposed to ambient air	79
4.8	Transpiration rates for treatment exposed to ambient air	80
4.9	Distribution of plant height throughout growing season for N <sub>75</sub>	81
4.10	Distribution of plant height throughout growing season for N <sub>100</sub>	82
4.11	Distribution of plant height throughout growing season for N <sub>125</sub>	82
4.12	Distribution of plant height throughout growing season for N <sub>150</sub>	83
4.13	Distribution of tiller number throughout growing season for N <sub>75</sub>	84
4.14	Distribution of tiller number throughout growing season for N <sub>100</sub>	84
4.15	Distribution of tiller number throughout growing season for N <sub>125</sub>	85
4.16	Distribution of tiller number throughout growing season for N <sub>150</sub>	85
4.17	Root dry weight at final harvest exposed to different ozone concentrations	88



4.18	Stem dry weight at final harvest exposed to different ozone concentrations	88
4.19	Leaf dry weight at final harvest exposed to different ozone concentrations	89
4.20	Grain dry weight at final harvest exposed to different ozone concentrations	89
4.21	Seasonal change of total dry weights in nutrient treatments at AOT 0	91
4.22	Seasonal change of total dry weights in nutrient treatments at AOT 7810	91
4.23	Seasonal change of total dry weights in nutrient treatments at AOT 21358	92
4.24	Total dry weight as affected by 3 level of ozone concentration subjected to different nutrient regime	94
4.25	Grain weight function to ozone subjected to different nutrient regimes	97



## LIST OF ABBREVIATIONS

AOT 40	Accumulated O <sub>3</sub> concentration above a threshold of 40 ppb
AQMS	Air Quality Monitoring System
ASMA	Alam Sekitar Malaysia
ANOVA	Analysis of Variance
BMP	Best Management Practices
B	Boron
CH <sub>2</sub>	Carbohydrates
CO <sub>2</sub>	Carbon dioxide
Ca	Calcium
CF	Charcoal filtered
Cu	Copper
DAP	Day After Planting
DRIS	Diagnosis and Recommendation Integrated System
DOE	Department of Environment
EPA	Environmental Protection Agency
Fe	Ferum
FAO	Food and Agriculture Organisation
H <sub>2</sub> O	Hydrogen dioxide
IRPA	Intensification of Research in Priority Area
K	Kalium
Mg	Magnesium
MR	Malaysian rice

MMS	Malaysia Meteorological Station
MT	Metric tonne
MADA	Muda Agricultural Development Authority
Nm	Nanometer
N	Nitrogen
NO <sub>x</sub>	Nitrogen oxides
NF	Non filtered
OTC	Open Top Chamber
O <sub>3</sub>	Ozone
ppm	Part per million
ppb	Part per billion
PPK	Pertubuhan Peladang Kawasan
PAR	Photosynthetically Active Radiation
PFD	Photon Flux Density
P <sub>max</sub>	Photosynthetic capacity
$\alpha$	Photosynthetic efficiency
P	Potassium
RH	Relative humidity
RGR	Relative growth rate
gs	Stomatal conductance
SO <sub>2</sub>	Sulfur dioxide
E	Transpiration rate
TDW	Total dry weight
USA	United States of America



VPD	Vapour pressure deficit
VOCs	Volatile organic compounds
Zn	Zink



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In this study, different nutrient regimes were employed to assess the impact of ozone on the growth and yield of variety of local rice (*Oryza sativa* L.) at Muda area in three different ambient ozone (O<sub>3</sub>) concentrations. A controlled experiment involving ambient ozone (non-filtered air) and filtered air treatment in



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# CHAPTER 1

## INTRODUCTION

### 1.1: Background information of research

There is an approved record of air pollution damaging crops in the world. In particular, ozone has historically been regarded as the principal urban and regional air quality problem in the United States and studies to determine the extent of its harmful effects on both human and environment have been ongoing for decades. However, ozone is not an emitted pollutant and is instead formed in the atmosphere from other pollutants. Therefore, its regulation has focused on controlling the emissions of its precursors that contribute to its synthesis. Major sources of ozone precursors are coal-fired utilities, many of which are located in the Midwestern United States. Recently, disputes between regions over emerging evidence of the long-distance transport of ozone across states has prompted the USEPA and state regulatory agencies to begin addressing the transport problem through cooperative efforts. Tropospheric O<sub>3</sub> is currently viewed as a widespread and growing problem that suppresses crop productivity on a large scale (USEPA, 1996; Mauzerall and Wang 2001; Fuhrer and Booker 2003). Ozone interferes with the ability of plants to produce and store food, making them more susceptible to disease, insects, other pollutants, and harsh weather. Exposure to ozone causes visible effects of ozone injury to plants such as bleached or light flecks or stipples (small clusters of dead cells) on the upper surface of leaves. Matured leaves are the most easily damaged (USEPA, 1998).

