

**EFFECTS OF ROOT RESTRICTION AND WATER STRESS ON GROWTH
PERFORMANCE, AND PHYSIOLOGICAL AND BIOCHEMICAL RESPONSES OF
MANGO (*Mangifera indica* cv. CHOKANAN)**

By

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

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*Specially Dedicated To:
Haji Sakimin Bin Sakidin
Hajjah Poriah Binti Haji Mokti
and
Ismail Ibrahım*

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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The effects of restricted root volume (10, 30 and 50-litre of soil) on growth, stomatal conductance and photosynthesis rate of mango (*Mangifera indica*) cv. Chokanan trees were investigated under a rain shelter condition. Root restriction (10-litre of soil) significantly ($P \leq 0.05$) reduced all growth parameters and leaf gas exchange of plants. However, stem and root dry weight, root:shoot ratio, number of branches and stem diameter were not significantly ($P > 0.05$) different between the 10 and 30-litre of soil. There were a linear relationships between root and total leaf dry weight; diameter of stem and plant height; and between photosynthesis rate and stomatal conductance.

Similarly, growth of mango plants was significantly affected by root restriction in a 24-litre volume of soil compared to control roots (unrestricted) under field condition. Root restriction reduced the number of fruits by 56.3% in the first season, but it increased the total number of fruits and total fruit weight in the second season

compared to the control. Average fruit weight per plant was not affected by the root restriction treatment in the second season.

Root restriction in combination with water stress was also studied. Root restriction inhibited the growth of mango trees as reflected in the reduction of leaf expansion with greater reduction under water stress conditions. Under well-watered condition, restricted root resulted in a considerable reduction in stomatal conductance and leaf water potential compared to the control root growth. Decreases in stomatal conductance and leaf water potential were rapid under restricted root and water stress condition compared to the control. On the other hand, leaf proline and abscisic acid (ABA) accumulation increased as a result of root restriction and water stress. Re-watering of mango trees increased stomatal conductance, leaf water potential and peroxidase accumulation in plants with both restricted and control root growth. However, proline and ABA accumulation decreased with re-watering. Anatomical studies of cross section of secondary branch of mango also showed that root restriction and water stress brought about various changes, such as smaller and compacted cell size (as estimated by epidermis thickness and area, as well as by cortex thickness), but increased the size of some of the cells (as measured by sclerenchyma, phloem and xylem thickness, sclerenchyma and pith area and pith diameter). These results suggest that reduction of soil volume and water stress could effectively control tree size by physiological and morphological changes and trigger reproductive development of fruit trees like mango.

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

**KESAN PEMBATASAN AKAR DAN KEKURANGAN AIR TERHADAP PRESTASI
PERTUMBUHAN, DAN TINDAKBALAS FISILOGI DAN BOKIMIA TANAMAN
MANGGA (*Mangifera indica* cv. CHOKANAN)**

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Kesan pembatasan akar (10, 30 dan 50-liter tanah) terhadap pertumbuhan, konduktiviti stomata dan kadar fotosintesis pokok mangga (*Mangifera indica*) kultivar Chokanan telah dikaji di bawah keadaan lindungan hujan. Pembatasan akar (10-liter tanah) secara bererti ($P \leq 0.05$) merendahkan kesemua parameter pertumbuhan dan pertukaran gas daun tanaman. Bagaimanapun, berat kering batang dan akar, nisbah akar ke pucuk, bilangan cabang dan garispusat batang tidak berbeza secara bererti ($P > 0.05$) antara 10 dan 30-liter tanah. Terdapat perkaitan secara linear di antara berat kering akar dan daun; garispusat batang dan tinggi pokok; dan antara kadar fotosintesis dan konduktiviti stomata.

Dalam keadaan yang sama, terdapat kesan secara bererti terhadap pertumbuhan pokok mangga dengan menggunakan pembatasan akar di dalam 24-liter isipadu tanah berbanding akar kawalan (tanpa pembatasan) di kawasan ladang. Pembatasan akar mengurangkan bilangan buah sebanyak 56.3% dalam musim

pertama, tetapi meningkatkan jumlah bilangan buah dan jumlah berat buah dalam musim ke dua berbanding kawalan. Purata berat buah sepokok tidak di pengaruhi oleh rawatan pembatasan akar

Pembatasan akar dengan kombinasi pengurangan air juga dikaji. Pembatasan akar mempengaruhi pertumbuhan pokok mangga sepertimana ditunjukkan dengan pengurangan pemanjangan daun dengan pengurangan yang jelas dalam keadaan kekurangan air. Dalam keadaan pengairan air yang baik, pembatasan akar menyebabkan penurunan yang banyak pada konduktiviti stomata dan potensi air daun berbanding pertumbuhan akar kawalan. Penurunan konduktiviti stomata dan potensi air daun di percepatkan dalam keadaan pembatasan akar dan kekurangan air berbanding kawalan. Pembatasan akar dan kekurangan air juga menyebabkan peningkatan pengumpulan proline dan asid absisik (ABA). Pengairan semula pokok mangga meningkatkan konduktiviti stomata, potensi air daun dan pengumpulan peroksidase pada kedua-dua pertumbuhan akar dengan pembatasan dan pertumbuhan akar kawalan. Bagaimanapun, pengumpulan proline dan ABA menurun dengan pengairan semula. Kajian anatomi terhadap keratan rentas cabang kedua mangga menunjukkan bahawa pembatasan akar dan pengurangan air membawa kepada pelbagai perubahan seperti pengecilan dan pepadatan saiz sel (yang dianggarkan dari ketebalan dan keluasan epidermis, dan juga ketebalan korteks), tetapi meningkatkan beberapa saiz sel (yang diukur dari ketebalan sklerenkima, floem dan xilem, keluasan sklerenkima dan empulur dan diameter empulur). Keputusan ini mencadangkan bahawa pengurangan isipadu tanah dan pengurangan air boleh secara efektif mengawal saiz pokok melalui perubahan

fisiologi dan morfologi dan merangsang pembentukan reproduktif pokok buahan seperti mangga.

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I certify that an Examination Committee has met on 29th March 2006 to conduct the final examination of Siti Zaharah Sakimin on her Master of Science thesis entitled “Effects of Root Restriction and Water Stress on Growth Performance, and Physiological and Biochemical Responses of Mango (*Mangifera indica* cv. Chokanan)” 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.

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TABLE OF CONTENTS

DEDICATION	ii
ABSTRACT	iii
ABSTRAK	v
ACKNOWLEDGEMENTS	vii
APPROVAL	ix
DECLARATION	xi
LIST OF TABLES	xv
LIST OF FIGURES	xvi
LIST OF PLATES	xii
LIST OF ABBREVIATIONS	xix

CHAPTER

1	INTRODUCTION	1
2	LITERATURE REVIEW	7
	2.1 Root Restriction and Plant Growth and Development	7
	2.1.1 Shoot and Root Growth	7
	2.1.2 Dry Matter Yield and Partitioning	9
	2.1.3 Reproductive Growth	12
	2.2 Physiological Responses to Root Restriction	14
	2.2.1 Leaf Gas Exchange	14
	2.2.2 Plant Water Relations	16
	2.2.3 Hormonal Regulation	17
	2.3 Plant Response to Water Stress	19
	2.3.1 Vegetative Growth	20
	2.3.2 Leaf Gas Exchange	25
	2.3.3 Biochemical Responses of Plants to Water Stress	29
	2.3.3.1 Peroxidase Activity	29
	2.3.3.2 Proline Synthesis	30
	2.3.3.3 Accumulation of Abscisic Acid	32
3	EFFECTS OF ROOT RESTRICTION ON GROWTH AND LEAF GAS EXCHANGE OF MANGO (<i>Mangifera indica</i> cv. CHOKANAN)	35
	3.1 Introduction	35

3.2	Materials and Methods	37
3.2.1	Plant Material	37
3.2.2	Experimental Site and Treatments	37
3.2.3	Vegetative Growth	38
3.2.4	Dry Matter Yield and Partitioning	38
3.2.5	Leaf Gas Exchange	39
3.2.5.1	Photosynthesis Rate, Evapotranspiration (ET) and Vapour Pressure Deficit (VPD)	39
3.2.5.2	Stomatal Conductance	39
3.2.6	Water Use Efficiency (WUE)	40
3.2.7	Experimental Design and Statistical Analysis	40
3.3	Results	41
3.3.1	Vegetative Growth	41
3.3.2	Dry Matter Yield and Partitioning	42
3.3.3	Stomatal Conductance and Photosynthesis Rate	45
3.3.4	Evapotranspiration (ET)	48
3.3.5	Vapour Pressure Deficit (VPD)	49
3.3.6	Water Use Efficiency (WUE)	50
3.4	Discussion	51
3.5	Conclusion	56
4	EFFECTS OF RESTRICTED ROOTING VOLUME ON THE GROWTH AND YIELD OF MANGO (<i>Mangifera indica</i> cv. CHOKANAN) IN THE FIELD	57
4.1	Introduction	57
4.2	Materials and Methods	59
4.2.1	Experimental Site and Treatments	59
4.2.2	Measurement of Vegetative Growth	62
4.2.3	Dry Matter Yield and Distribution	63
4.2.4	Reproductive Growth and Crop Yield	66
4.2.5	Experimental Design and Statistical Analysis	67
4.3	Results	68
4.3.1	Shoot Growth	68
4.3.2	Root Growth	71
4.3.3	Dry Matter Production and Partitioning	73
4.3.4	Yield and Yield Component	74
4.4	Discussion	78

4.5	Conclusion	82
5	GROWTH, LEAF GAS EXCHANGE, BIOCHEMICAL CHANGES AND BRANCH ANATOMY IN MANGO (<i>Mangifera indica</i> cv. CHOKANAN) IN RESPONSE TO ROOT RESTRICTION AND WATER STRESS	83
5.1	Introduction	83
5.2	Materials and Methods	86
5.2.1	Treatments and Experimental Design	86
5.2.2	Measurement of Leaf Elongation	87
5.2.3	Determination of Soil Moisture Content	87
5.2.4	Stomatal Conductance	87
5.2.5	Leaf Water Potential	88
5.2.6	Proline Assay	88
5.2.7	Peroxidase Activity	89
5.2.8	Measurements of Abscisic Acid (ABA)	90
5.2.9	Histological Study	91
5.2.10	Statistical Analysis	92
5.3	Results	93
5.3.1	Leaf Elongation	93
5.3.2	Soil Moisture Content	94
5.3.3	Stomatal Conductance	95
5.3.4	Leaf Water Potential (LWP)	97
5.3.5	Proline Accumulation	100
5.3.6	Peroxidase Activity	103
5.3.7	Abscisic Acid (ABA) Accumulation	105
5.3.8	Secondary Branch Anatomy	108
5.4	Discussion	114
5.5	Conclusion	123
6	GENERAL DISCUSSION AND CONCLUSION	124
	REFERENCES	152
	APPENDIX	
	BIODATA OF THE AUTHOR	175