

**ALLELOPATHIC POTENTIAL OF ESSENTIAL
OILS ISOLATED FROM LOCAL PLANTS ON
COMMON WEEDS FOUND IN MALAYSIAN
CROPLANDS**

AHMED ABDULWAHID ALI ALMARIE

UNIVERSITI MALAYSIA PERLIS

2017

UNIVERSITI MALAYSIA PERLIS

DECLARATION OF THESIS

Author's Full Name : AHMAD ABDULWAHID ALI ALMARIE
Title : ALLELOPATHIC POTENTIAL OF ESSENTIAL OILS
ISOLATED FROM LOCAL PLANTS ON COMMON WEEDS
FOUND IN MALAYSIAN CROPLANDS
Date of Birth : 03/01/1981
Academic Session : 2016/2017

I hereby declare that this thesis becomes the property of Universiti Malaysia Perlis (UniMAP) and to be placed at the library of UniMAP. This thesis is classified as:

- CONFIDENTIAL** (Contains confidential information under the Official Secret Act 1972)*
- RESTRICTED** (Contains restricted information as specified by the organization where research was done)*
- OPEN ACCESS** I agree that my thesis to be published as online open access (Full Text)

I, the author, give permission to reproduce this thesis in whole or in part for the purpose of research or academic exchange only (except during the period of _4_ years, if so requested above)

Certified by:

SIGNATURE

A49497572

Date: _____

SIGNATURE OF SUPERVISOR

Ibni Hajar Hj. Rukunudin (PhD, PE)

Date: _____

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

وَاصْبِرْ لَهُمْ مِثْلَ الْحَيَاةِ الدُّنْيَا

كَمَا أَرْسَلْنَا مِنْ السَّمَاءِ فَاخْتَلَطَ بِهِ

نَبَاتُ الْأَرْضِ فَأَصْبَحَ هَشِيمًا تَذْرُوهُ

الرِّيَّاحُ وَكَانَ اللَّهُ عَلَى كُلِّ شَيْءٍ

مُقْتَدِرًا

Surah al kahf; verse (45)

To the scent of paradise and my life's light

My father and my mother

To my soul, who ever gave me encouragement to get higher ideas of my life

My wife MUNA

To the smiling face of my life

My beloved kids

ABDULLAH & ALI

©This item is protected by original copyright

ACKNOWLEDGMENT

First and foremost, I bow my head in reverence to the **Almighty Allah**, the most omnipotent, omnipresent, benevolent and merciful for having blessed with the strength and courage to accomplish this work. Secondly, my humblest gratitude to the Holy Prophet **Muhammad** (blessings and peace of **Allah** be **upon him**) whose way of life has been a continuous guidance for us.

I would like to express my deep and sincere gratitude to my supervisor **Ibni Hajar Hj. Rukunudin (PhD, PE)** for his kindness, admirable supervision, direct guidance and fruitful and interesting discussions throughout this work. Without whose constant help, deep interest and vigilant guidance, the completion of this thesis will not be possible. I am really indebted to him for his accommodating attitude, immense intellectual input, patience and sympathetic behavior.

Special thanks to my former supervisor **Prof Dr. Awang Soh Mamat** and my co-supervisor **Prof Dr. Zakaria Wahab** who all the time respected my ideas and gave me the opportunity to go abroad to pursue my PhD study program. They assisted in all matters, provided solutions to different problems and always gave input even at their personal times.

Deepest gratitude is due to the School of Bioprocess Engineering, especially **Assoc. Prof. Dr. Muhammad Syarhabil Ahmad, Prof. Dr. Mahmud Nor Jaafar, Assoc. Prof. Dr. Mohammad Che Husain and Vocational Training Officer (PLV) Miss Hafizah Mohd Johar**. They always helped me in the Lab and field. I thankful for their support and from beginning till the end of the study.

I am also very much grateful to **Dr. Ammar Zakaria**, Center of Excellence for Advanced Sensor Technology (CEAS Tech), School of Mechatronic Engineering, UniMAP to help me in the analysis of the samples by GC/MS and column chromatography.

I really acknowledge and offer my heartiest gratitude to all members of my family, especially my big brothers, **Mohammad** and **Mustafa** and my sweet sisters for their huge sacrifice, moral support, cooperation, encouragement, patience, tolerance and prayers for my health and success which enabled me to achieve this excellent goal.

Words cannot express how grateful I am to my father-in-law, **Mr. Mamoon Yousif**, my mother-in-law, my brothers-in-law **Dr. Nael, Omar and Mohammed**. Thank you for supporting me for everything.

Last but not least, I am also highly indebted to my best friends and fellow for their assistance, good company, marvelous behavior and friendly attitude.

To all of you, thank you very much...

Ahmed Abdulwahid Ali Almarie

TABLE OF CONTENTS

	PAGE
DECLARATION OF THESIS	i
ACKNOWLEDGMENT	iv
TABLE OF CONTENTS	vi
LIST OF TABLES	xiii
LIST OF FIGURES	xiv
LIST OF ABBREVIATIONS	xx
LIST OF SYMBOLS	xxi
ABSTRAK	xxii
ABSTRACT	xxiii
CHAPTER 1: INTRODUCTION	1
1.1 Problem statement	4
1.2 Objectives of the study	5
1.3 Scope of the study	5
CHAPTER 2: LITERATURE REVIEW	7
2.1 Weed plants	7
2.2 Weed control	9
2.2.1 Weed control method	9
2.3 Effect of synthetic herbicides on human health and ecosystem	11
2.3.1 Human health	11

2.3.2	Ecosystem	12
2.4	Development of weed resistance synthetic herbicides	13
2.5	Plant secondary metabolites	16
2.5.1	Phenolic compounds	17
2.5.2	Alkaloid compounds	19
2.5.3	Terpenoids	21
2.5.4	Primary metabolites biosynthesis pathways of secondary metabolites	24
2.6	Allelopathic activity in plant ecosystem	26
2.6.1	Allelochemical compounds	29
2.6.2	Criteria used for the phytotoxicity evaluation	31
2.7	Essential oils	32
2.8	Uses of essential oil as bioherbicides	35
2.9	Phytotoxic mechanisms of the essential oils as bioherbicides	40
2.9.1	Herbicidal activity of essential oil in combination	42
2.10	Allelochemical compounds in tropical botanicals	43
CHAPTER 3: METHODOLOGY		44
3.1	Research methodology flow chart	44
3.2	Selection of plants for isolation	44
3.3	Preparation plant materials for isolation	45
3.4	Collection and preparation of the four targeted weed seeds	48
3.5	Isolation of the essential oils.	49

3.6	Screening the phytotoxic effects of the essential oil on seed germination and seedling development	50
3.6.1	Preparation the solution of essential oils as bioherbicide solutions	51
3.6.2	Preparation of weed seeds under laboratory bioassay conditions for preemergence experiment	51
3.6.3	Preparation of weed seeds under Pot culture conditions for preemergence experiment	52
3.7	Identification the chemical composition of the isolated essential oils	52
3.7.1	Gas chromatography –flame ionization detector	52
3.7.2	Gas chromatography-mass spectrometry	53
3.8	Evaluation the postemergence phytotoxicity mechanisms of the selected essential oils	54
3.8.1	Preparation of bioherbicides solution from the selected essential oils as postemergence bioherbicides.	54
3.8.2	Preparation of weed seeds under Pot culture conditions for postemergence experiment	55
3.8.3	Analysis total chlorophyll content of the potted weed plants	56
3.8.4	Analysis of relative electrolyte leakage of the potted weed plants	56
3.8.5	Analysis of cellular respiration (%) of the potted weed plants	57
3.8.6	Light compound microscope of the potted weed plant leaves	57
3.9	Phytotoxic effects as postemergence bioherbicides of the selected essential oils on weeds under open field conditions	58
3.9.1	Visible injury of targeted weeds	59
3.9.2	Estimation the dry weight of targeted weeds	59
3.9.3	Weed control percentage	60

3.9.4	Weed growth inhabitation percentage	60
3.10	Statistical analysis	60
CHAPTER 4: RESULTS AND DISCUSSION		61
4.1	Screening the phytotoxic effects of isolated essential oils on seed germination and seedling development of different common weeds	62
4.1.1	Screening the phytotoxic effects of isolated essential oils on seed germination and seedling development of the grassy weeds; <i>Dactyloctenium australe</i> weed	62
4.1.1.1	Seed germination of <i>D. australe</i> weed	63
4.1.1.2	Seedling shoot length of <i>D. australe</i> weed	65
4.1.1.3	Seedling dry matter weight of <i>D. australe</i> weed	67
4.1.2	Screening the phytotoxic effects of isolated essential oils on seed germination and seedling development of the grassy weeds; <i>Panicum virgatum</i> weed	70
4.1.2.1	Seed germination of <i>P. virgatum</i> weed	70
4.1.2.2	Seedling shoot length of <i>P. virgatum</i> weed	73
4.1.2.3	Seedling dry matter weight of <i>P. virgatum</i> weed	76
4.1.3	Screening the phytotoxic effects of isolated essential oils on seed germination and seedling development of <i>Stachytarpheta indica</i>	78
4.1.3.1	Seed germination of <i>S. indica</i> weed	78
4.1.3.2	Seedling shoot length of <i>indica</i> weed	81
4.1.3.3	Seedling dry matter weight of <i>S. indica</i> weed	83
4.1.4	Screening the phytotoxic effects of isolated essential oils on seed germination and seedling development of <i>Amaranthus spinosus</i> weed	85
4.1.4.1	Seed germination of <i>A. spinosus</i> weed	85

4.1.4.2	Seeding shoot length of <i>A. spinosus</i> weed	88
4.1.4.3	Green amaranth weeds seeding dry matter of <i>A. spinosus</i> weed	90
4.1.5	Selection of the best effective essential oils	96
4.2	Chemical composition of isolated essential oils	101
4.2.1	Chemical composition of <i>C. macrocarpa</i> oil	101
4.2.2	Chemical composition of <i>Melaleuca bracteata</i> oil	105
4.2.3	Chemical composition of <i>Plectranthus amboinicus</i> oil	109
4.2.4	Chemical composition of <i>Cymbopogon nardus</i> oil	113
4.2.5	Chemical composition of <i>Pelargonium radula</i> oil	117
4.2.6	Chemical composition of <i>Baeckea frutescens</i> oil	122
4.2.7	Chemical composition of <i>Murraya koenigii</i> oil	125
4.2.8	Chemical composition of <i>Persicaria odorata</i> oil	128
4.3	Compositional groups of compounds in the eight essential oils	132
4.3.1	Percentage components of the monoterpenoids group of the eight isolated essential oils	132
4.3.2	Percentage components of the sesquiterpenoids group of the eight isolated essential oils	135
4.3.3	Percentage components of the phenylpropanoids group of the eight isolated essential oils	137
4.3.4	Percentage components of other compounds of the eight isolated essential oils	139
4.4	Injury symptoms in plant tissues of the four targeted weed	140
4.4.1	Phytotoxic effect of the three selected essential oils on total chlorophyll content of the four targeted weed tissues	140
4.4.2	Phytotoxic effect of the three selected essential oils on relative electrolyte leakage of the four targeted weed tissues	146

4.4.3	Phytotoxic effect of the three selected essential oils on cellular respiration of the four targeted weed tissues	151
4.4.4	Phytotoxic effect of the three selected essential oils on leaf tissue injury of the targeted weed species using light compound microscope	155
4.5	Postemergence bioherbicidal effects of the three effective essential oils under open field conditions	158
4.5.1	Visible injury of weed population	158
4.5.2	Postemergence bioherbicidal effects of the selected essential on dry matter weight of weed population	161
4.5.3	Weed control percentage of the three selected essential oils	162
4.5.4	Weed growth inhibition percentage of the three selected essential oils	162
4.6	Postemergence bioherbicidal effects of the three effective essential oils used in a combination under open field condition	166
4.6.1	Herbicidal effect of essential oil used in combination on dry matter of weed population	166
4.6.2	Herbicidal effect of essential oil used in combination on weed control percentage using the selected essential oils in combination	170
4.6.3	Herbicidal effect of essential oil used in combination on weed growth inhibition percentage using the selected essential oils in combination	170
CHAPTER 5: CONCLUSIONS AND RECOMMENDATION		172
5.1	Conclusion	172
5.2	Recommendations	174
REFERENCES		175
APPENDIXES		192
APPENDIX- A: Raw data of the experiments		192
APPENDIX- B: GC/MS experiment report		198

APPENDIX- C: GC/FID chromatograph of the eight isolated essential oils	201
APPENDIX- D: Weed species found in the field of study (INSAT)	209
APPENDIX- E: Field Soil Properties	214
LIST OF PUBLICATIONS	215

©This item is protected by original copyright

LIST O TABLES

NO.		PAGE
2.1	Classification of Terpene compounds based on the number of isoprene units	23
2.2	Criteria for the efficacy of herbicides (% inhibition)	32
2.3	Allelopathic effects of essential oils on seed germination and seedling development of different weed species	39
3.1	Selected plant species from which the essential oils were isolated	45
4.1	Chemical composition of <i>C. macrocarpa</i> oil	102
4.2	Chemical composition of <i>Melaleuca bracteata</i> oil	106
4.3	Chemical composition of <i>Plectranthus amboinicus</i> oil	110
4.4	Chemical composition of <i>Cymbopogon nardus</i> oil	114
4.5	Chemical composition of <i>Pelargonium radula</i> oil	118
4.6	Chemical composition of <i>Baeckea frutescens</i> oil	123
4.7	Chemical composition of <i>Murraya koenigii</i> oil	126
4.8	Chemical composition of <i>Persicaria odorata</i> oil	129
4.9	Postemergence bioherbicidal activity of essential oils in three concentrations in weed control percentage, Dry matter and weed growth inhibition% compared with conventional synthetic herbicide (H130) on of weed population under open field condition at 7 days after treatment	164

4.10	Postemergence bioherbicidal activity of essential oils and their combinations in weed control %, dry matter and weed growth inhibition% compared with conventional synthetic herbicide on of weed population under open field condition at 7 days after treatment	168
------	---	-----

LIST OF FIGURES

NO.		PAGE
2.1	Number of resistant plant species for several herbicides according to their modes of action	16
2.2	Basic chemical structure of phenolic compounds	18
2.3	Multifunctionality of phenolic compounds	19
2.4	Pyridine alkaloids and pyrine alkaloids	20
2.5	Structure of one unit of isoprene	21
2.6	Isoprene head to tail link	22
2.7	General schematic biosynthetic pathways to produce major secondary metabolites	24
2.8	Biosynthesis of Terpenes	25
2.9	Methods of allelochemical compounds released from the donor plant into the environment	28
2.10	Direct and indirect allelopathic mechanisms of target plants	30
2.11	Chemical structures of some of the common terpenoid group of essential oil components of essential oil components	34
2.12	Phydura [®] and Eco SMART [®] natural bioherbicides for annual weeds	38
2.13	Contact herbicides; mode of action	40
2.14	Stomatal system of plants	41

3.1	Research methodology flow chart	46
3.2	Photographs of selected plants used to isolate essential oils	47
3.3	Photographs of targeted weeds taken during the collection of their seeds	49
3.4	Isolation of essential oil by steam distillation process	50
3.5	Gas chromatography-mass spectrometry schematic	54
3.6	Demonstration of surfactant in decreasing the surface tension of the herbicides droplet	55
3.7	Schematic depiction of the field experiment of postemergence bioherbicidal effects of the selected essential oils (INSAT)	
4.1	Inhibitory effects of 3 different doses of the 8 isolated essential oils on the <i>D. australe</i> weed seed germination at 10 th days after sowing under the 2 growing conditions	64
4.2	Inhibitory effects of 3 different doses of the 8 isolated essential oils on the crowfoot grass weed shoot length at 10 th days after sowing under the 2 growing conditions	66
4.3	Inhibitory effects of 3 different doses of the 8 isolated essential oils on the crowfoot grass weed seedling dry matter at 10 th days after sowing under the 2 growing conditions	68
4.4	Inhibitory effects of 3 different doses of the 8 isolated essential oils on the <i>P. virgatum</i> weed seed germination at 10th days after sowing under the 2 growing conditions	72
4.5	Inhibitory effects of 3 different doses of the 8 isolated essential oils on the <i>P. virgatum</i> weed shoot length at 10th days after sowing under the 2 growing conditions	74
4.6	Inhibitory effects of 3 different doses of the 8 isolated essential oil on the <i>P. virgatum</i> weed seedling dry matter at 10th days after sowing under the 2 growing conditions	77
4.7	Inhibitory effects of 3 different doses of the 8 isolated essential oil on the <i>S. indica</i> weed seed germination at 10 th days after sowing under the 2 growing conditions	79

4.8	Inhibitory effects of 3 different doses of the 8 isolated essential oil on the <i>S. indica</i> weed shoot length at 10 th days after sowing in the under growing conditions	82
4.9	Inhibitory effects of 3 different doses of the 8 isolated essential oils on <i>S. indica</i> weed seedling dry matter at 10 th days after sowing under the 2 growing conditions	84
4.10	Inhibitory effects of 3 different doses of 8 isolated essential oils on the <i>A. spinosus</i> weed seed germination at 10 th days after sowing under the 2 growing conditions	86
4.11	Phytotoxic effects of Goldcrest essential oil on seed germination of <i>A. spinosus</i> weed used in three doses under laboratory bioassay growing condition	88
4.12	Inhibitory effects of 3 different doses of 8 isolated essential oils on the <i>A. spinosus</i> weed shoot length at 10 th days after sowing under the 2 growing conditions	89
4.13	Inhibitory effects of 3 different doses of 8 isolated essential oils on the <i>A. spinosus</i> weed seedling dry matter at 10 th days after sowing under the 2 growing conditions	91
4.14	Inhibitory percent over control of 8 isolated essential oils at the highest dose (5µl/ml) on germination and seedling development of <i>D. australe</i> grass weed	97
4.15	Inhibitory percent over control of 8 isolated essential oils at the highest dose (5µl/ml) on germination and seedling development of <i>P. virgatum</i> weed	98
4.16	Inhibitory percent over control of isolated 8 essential oils at the highest dose (5µl/ml) on germination and seedling development of <i>S. indica</i> weed	90
4.17	Inhibitory percent over control of 8 isolated essential oils at the highest dose (5µl/ml) on germination and seedling development of <i>A. spinosus</i> weed	100
4.18	Typical GC-MS chromatogram of <i>C. macrocarpa</i> essential oil showing the separation of chemical components	105

4.19	Typical GC-MS chromatogram of <i>M. bracteata</i> essential oil showing the separation of chemical components	109
4.20	Typical GC-MS chromatogram of <i>P. amboinicus</i> essential oil showing the separation of chemical components	112
4.21	Structure of Citral	116
4.22	Typical GC-MS chromatogram of <i>C.nardus</i> essential oil showing the separation of chemical components	117
4.23	Typical GC-MS chromatogram of <i>P.radula</i> essential oil showing the separation of chemical components	121
4.24	Typical GC-MS chromatogram of <i>B. frutescens</i> essential oil showing the separation of chemical components	125
4.25	Typical GC-MS chromatogram of <i>M. koenigii</i> essential oil showing the separation of chemical components	128
4.26	Typical GC-MS chromatogram of <i>P. odorata</i> essential oil showing the separation of chemical components	131
4.27	Total monoterpene components (%) of the isolated essential oils	134
4.28	Total sesquiterpene components (%) of the 8 isolated essential oils	137
4.29	Total of phenylpropanoids components (%) of the 8 isolated essential oils	138
4.30	Total other components (%) of the 8 isolated essential oils	139
4.31	Effect of 4 different concentrations of <i>C. macrocarpa</i> essential oil on the total chlorophyll content of the 4 targeted weedy species	142
4.32	Effect of 4 different concentrations of <i>C. nardus</i> essential oil on the total chlorophyll content of the 4 targeted weedy species	143

4.33	Effect of 4 different concentrations of <i>P. radula</i> essential oil on the total chlorophyll content of the 4 targeted weedy species	144
4.34	Simulation the bioherbicidal mode of broad leaf weed seedling action of essential oils	145
4.35	Relative electrolyte leakage of recipient test weeds affected by 4 concentrations of <i>C. macrocarpa</i> oil compared with the controls	147
4.36	Relative electrolyte leakage of recipient test weeds affected by the 4 concentrations of <i>C. nardus</i> oil compared with the controls.	148
4.37	Relative electrolyte leakage of recipient test weeds affected by 4 concentration of <i>P. radula</i> oil compared with the controls	149
4.38	Interaction of some secondary metabolites with biomembranes	150
4.39	Cellular respiration of 4 recipient test weeds affected by 4 different concentrations of <i>C. macrocarpa</i> oil compared with the controls	152
4.40	Cellular respiration of 4 recipient test weeds affected by 4 different concentrations of <i>C. nardus</i> oil compared with the controls	153
4.41	Cellular respiration of 4 recipient test weeds affected by 4 different concentrations of <i>P. radula</i> oil compared with the controls	154
4.42	Light compound microscope of the leaf lower surface of the <i>S. indica</i> weed effecting by essential oils as postemergence bioherbicides	156
4.43	Light compound microscope of lower leaf surface of the <i>A. spinosus</i> weed effecting by essential oils as postemergence bioherbicides	157
4.44	Injury symptoms of the <i>D. australe</i> weed plant affecting by 10% of <i>C. nardus</i> essential oil days after treatment (DAT)	157

- 4.45 Visible injury symptom scale of weed population affected by 3 different concentrations of the 3 essential oils of *C. macrocarpa*, *C. nardus* and *P. radula* as compared with the synthetic herbicide (H130). 160
- 4.46 Postemergence activity of the 3 essential oils used at three concentrations of the dry matter weight of weed population, weed control % and weed growth inhibition% compared with conventional synthetic herbicide (H130) under open field condition at 7th day after treatment. 165
- 4.47 Postemergence activity of essential oils and its combination of the dry matter weight of weed population, control % and Inhibition% compared with conventional synthetic herbicide (H130) under open field condition at 7th day after treatment. T1 H130, T2 *C. macrocarpa* 10%, T3 *C. nardus* 10%, T4 *P. radula* 10%, T5 *C. macrocarpa* 5%+ *C. nardus* 5%, T6 *C. macrocarpa* 5%+ *P. radula* 5%, T7 *P. radula* 5% + *C. nardus* 5%. 169

©This item is protected by original copyright

LIST OF ABBREVIATIONS

ALS	Acetolactate synthase
ANOVA	Analysis of variance
CEAS Tech	Center of Excellence for Advanced Sensor Technology
CRD	Completely Randomized Design
DAS	Date after sowing
DAT	Days after treatment
DMSO	Dimethyl sulfoxide
DOXP	Deoxy-D-xylulose 5-phosphate pathway
ds. m ⁻¹	Decisiemens per meter
EC	Electrical conductivity
INSAT	Institute of Sustainable Agriculture Tech.
FAO	Food and Agriculture organization
FID	Flame Ionization Detector
GC	Gas Chromatography
H130	Haloxone 130
MS	Mass Spectrophotometer
MEP	Mevalonic acid pathway
OH ⁻	Hydroxyl
OM	Organic Matter
pH	Potential hydrogen
RCBD	Complete Block Design Organic matter
REL	Relative Electrolyte Leakage
SAS	Statistical Analysis System software
SDL	Sodium Dodecyl Sulphate
SEM	Scanning Electron Microscope
SPAD	Soil Plant Analysis Development
TTC	Triphenyl tetrazolium chloride
UniMAP	Universiti Malaysia Perlis

WHO World Health Organization

LIST OF SYMBOLS

cm	Centimeter
g	gram
ha	hectare =10000 m ²
id	Interior diameter
M ²	Square meter
ml	Milliliter
mm	Millimeter
μm	Micrometer
μl	Microliter
Nm	Nanometer
%	Percentage
v/v	Volume per volume

Potensi allelopatik minyak pati yang diasingkan dari tumbuh-tumbuhan yang biasa ditemui dalam kawasan tanaman di Malaysia

ABSTRAK

Penggunaan racun rumpai sintetik secara berterusan untuk mengawal rumpai dalam pengeluaran pertanian boleh memberi kesan buruk kepada alam sekitar dan ekosistem, seterusnya mewujudkan kebimbangan keselamatan dan kesihatan kepada pengendali, pengguna dan komuniti. Walau bagaimanapun, pembangunan rintangan dalam sifat rumpai terhadap racun sintetik dan kesan nya telah memberi justifikasi kukuh ke atas keperluan menghasilkan racun rumpai alternatif mesra alam, semulajadi dan berisiko rendah tetapi berkesan. Kajian ini meneroka potensi allelopatik tumbuhan yang ditunjukkan dalam minyak patinya untuk digunakan sebagai racun alternatif berasaskan bio. Penyelidikan ini melibatkan pengasingan minyak pati daripada lapan spesies tumbuhan terpilih iaitu *Cupressus macrocarpa* Hartweg. (Goldcrest), *Melaleuca bracteata* F. Muell. (Tea tree), *Plectranthus amboinicus* (Lour.) Spreng (Bangun-bangun), *Cymbopogon nardus* L. (Lemongrass), *Pelargonium radula* Cav. (Jeremin), *Baekkea frutescens* L. (Cucur atap), *Murraya koenigii* L. (Pokok kari) dan *Persicaria odorata* (Lour.) Sojak (Pokok Kesum) melalui proses penyulingan wap. Minyak pati yang diasingkan disaring aktiviti herbisidanya sebagai pra kemunculan dengan menggunakan tiga kepekatan ke atas dua jenis rumpai utama (masing-masing 2 jenis rumpai berdaun dan rumpai daun lebar) yang di tanam secara biocerakin makmal dan dalam pot kultur. Sebatian minyak pati tersebut diciri menggunakan GC-MS. Kesan fitotoksik lapan minyak pati juga dinilai sebagai paska kemunculan ke atas empat rumpai dengan menganalisa jumlah kandungan klorofil, kebocoran elektrolit relatif, pernafasan sel dan mekanisme stomata dalam membran daun. Minyak pati yang paling berkesan kemudiannya dinilai sebagai paska kemunculan terhadap rumpai yang terdapat di lapangan dengan aplikasi secara tunggal dan kombinasi dua minyak pati dan dibandingkan dengan racun sintetik Halexone (H130), sebagai kawalan. Minyak pati yang terbaik dipilih berdasarkan keberkesanan lebih daripada 70% perencatan. Keputusan menunjukkan bahawa minyak pati yang diasingkan daripada *C. macrocarpa*, *C. nardus* dan *P. radula* adalah yang paling berkesan dalam menghalang percambahan benih dan pertumbuhan anak benih sepenuhnya dalam biocerakin makmal dan kerosakan yang teruk ke atas rumpai yang tanam dalam pot. Berdasarkan analisis GC-MS, monoterpena adalah komponen yang paling dominan dan berkesan dalam semua minyak pati, diikuti oleh sesquiterpena dan phenylpropanoid. Ujikaji fitotoksik menunjukkan bahawa jumlah kandungan klorofil, kebocoran elektrolit relatif dan pernafasan sel dipengaruhi secara ketara dengan penggunaan racun berasas bio. Kesan meningkat dengan meningkatnya kepekatan minyak pati. Minyak pati didapati menunjukkan pengaruh yang ketara ke atas membran tumbuhan yang mempengaruhi mekanisme stomata, memecahkan membran sel dan pelarutan kandungannya yang akhirnya membunuh rumpai. Penggunaan minyak pati sebagai racun sentuh berasaskan bio diaplikasikan dalam bentuk pasca kemunculan kepada rumpai yang ditanam di

lapangan menunjukkan kesan yang setanding dengan racun sintetik konvensional H130. Penggunaan minyak pati yang dirumus dalam kombinasi dapat meningkatkan kesan fitotoksik berbanding aplikasi mintak secara individu. Kombinasi *C. macrocarpa* dan *P. radula* masing-masing pada kepekatan 5% menunjukkan kesan fitotoksik terbaik dalam menindas populasi rumpai.

Allelopathic potential of essential oils isolated from local plants on common weeds found in Malaysian croplands

ABSTRACT

Continuous use of the synthetic herbicides to control weeds in agricultural production can have an adverse impact on the environment and the ecosystems creating safety and health concerns to the operators, consumers and the community. However, it is the resistance to the synthetic herbicides that developed in the targeted weeds and its consequent that provide strong justification for the need to develop an eco-friendly, natural and low risk but effective alternative bioherbicides. The study thus explores the benefits of using plant's allelopathic potential that manifested in its essential oil, as an alternative herbicide. The research involved the isolation of the essential oils from eight selected plant species of *Cupressus macrocarpa* Hartweg. (Goldcrest), *Melaleuca bracteata* F. Muell. (Tea tree), *Plectranthus amboinicus* (Lour.) Spreng (Spanish thyme), *Cymbopogon nardus* L. (Lemongrass), *Pelargonium radula* Cav. (Radula geranium), *Baekkea frutescens* L. (Cucur atap), *Murraya koenigii* L. (Curry tree) and *Persicaria odorata* (Lour.) Sojak (Kesum plant) by steam distillation. Isolated essential oils were screened for their herbicidal activity as preemergence applied at three concentrations on two major weed types (2 grassy and 2 broad leaves weed species) grown under bioassay laboratory and pot culture conditions. The compounds were characterized using GC-MS. The phytotoxic effects of the eight essential oils were also evaluated on the four weeds as postemergence by analyzing the total chlorophyll content, relative electrolyte leakage, cellular respiration and stomata mechanism in the leaf membrane. The most effective essential oils were then evaluated as postemergence by applying singly and in a combination of two essential oils on widely known weed grown in the open field and compared with the known synthetic herbicide, Halaxone (H130) as a control. The best essential oils were selected based on their efficacy of more than 70 % inhibition. The results showed that the oils isolated from *C. macrocarpa*, *C. nardus* and *P. radula* were the most effective in inhibiting seed germination and seedling growth completely in laboratory bioassay and caused the most severe effects on weeds grown under the pot culture. GC-MS analysis showed monoterpene was the most dominant and effective component of all essential oils followed by sesquiterpene and phenylpropanoids. The phytotoxic experiment showed total chlorophyll content, relative electrolyte leakage and cellular respiration were significantly affected by the application of the bioherbicides. The effects increased by increasing the oil

concentration. There was a significant influence of the essential oils on plant membranes affecting the stomata mechanism, rupturing cell membrane, dissolution of its contents which eventually kill the weeds. The application of essential oils as postemergence herbicides to weed grown in the open field showed desirable efficiency against the weeds as non-selected contact bioherbicides comparable with the performance of the conventional synthetic herbicides H130. Application of the essential oils formulated in combinations improved the phytotoxic effects as compared to using oils singly. The combination of *C. macrocarpa* and *P. radula* at 5% each proved to produce the best phytotoxic effects in suppressing weed population.

©This item is protected by original copyright