

AN INVESTIGATION OF THE RATE OF BIOGENIC VOLATILE ORGANIC CARBON EMISSIONS FROM COMMERCIAL CROP AND PLANTATION SPECIES IN THE MPUMALANGA PROVINCE



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of Science

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DECLARATION

I declare that this dissertation is entirely my own, unaided work. It is being submitted for the Degree of Master of Science in the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

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(Signature of candidate)

-----Day of-----2009

ABSTRACT

Volatile Organic Carbons (VOCs) are extremely reactive compounds and play an important role in the ozone chemistry of the atmosphere. Biogenic Volatile Organic Compounds (BVOCs) are estimated to contribute $\sim 10^{15}$ g C y⁻¹ per year to the atmosphere which constitutes ~ 80 % of the chemically reactive VOCs added to the atmosphere each year. In the last decade considerable scientific effort has focused on quantifying biogenic emission rates in South Africa, mainly from indigenous savanna species. The Mpumalanga province occupies 6.7 % of the land area of South Africa. There is a high species diversity and variable land use which includes forestry, cropping agriculture, grazing and nature conservation. The aim of this study was to measure the emission rates of isoprene, β -pinene, α -pinene, limonene and linalool from five selected plant species. These plant species were Mangoes, Avocados and Bananas (subtropical crops) and Pines and Eucalyptus (exotic forestry species). The experimental work, which was all conducted in the field, was designed to demonstrate the effect of environmental conditions on emission rates, especially temperature and water availability. A rapid screening technique was carried out in the initial phase of the study and a more detailed leaf level study was carried out over the 2007-2008 growing season. Plantation species, emitted higher levels of BVOCs than crop species. Isoprene emission rates were similar for two functional groups of plants, however, selected monoterpene (β -pinene, α -pinene, limonene and linalool) emission rates were higher in the plantation. Isoprene emissions represented 41.6 % of the total emissions measured followed by monoterpenes: β -pinene 31.5 % and limonene, α -pinene and linalool the remaining 26.8 % of total emissions. Emissions increased immediately after the onset of the spring rains and responded to the annual cycle with increasing values in the summer months and rapid decreases in winter. The measured emission rates were higher from the selected species than those published from temperate regions of the world. The data from this study can be used in the future to develop a regional emission budget.

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and **to my grandmother, Valentina Holnova**

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TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION.....	1
HYPOTHESIS AND KEY QUESTIONS	4
HYPOTHESES	4
KEY QUESTIONS	4
CHAPTER 2: LITERATURE REVIEW.....	5
2.1 THE ROLE OF BVOCs IN THE ATMOSPHERE	5
2.1.1 BVOCs and Ozone.....	5
2.1.2 BVOCs and the Greenhouse effect	6
2.2 BVOCs AND PLANT FUNCTION.....	7
2.2.1 Repellents and attractants.....	8
2.2.2 Disease	9
2.2.3 Membranes and heat stress	10
2.3 A DESCRIPTION AND SYNTHESIS OF ISOPRENE AND MONOTERPENES.....	10
2.3.1 Isoprene.....	11
<i>History</i>	<i>11</i>
<i>Structure.....</i>	<i>11</i>
<i>Isoprene emissions from selected plant families</i>	<i>12</i>
2.3.2 Monoterpene	12
<i>History</i>	<i>12</i>
<i>Structure.....</i>	<i>12</i>
<i>Monoterpene emissions from selected plant families.....</i>	<i>13</i>
2.4 BIOSYNTHESIS OF ISOPRENE AND MONOTERPENES	13
2.4.1 LOCATION OF SYNTHESIS AND SYNTHESIS PATHWAYS	13
2.4.2 Storage of BVOCs	15
2.5 FACTORS INFLUENCING BVOC EMISSIONS.....	18
2.5.1 Temperature	18
2.5.2 Light.....	19
2.5.3 Water stress and humidity of ambient air	21
2.5.4 Leaf nitrogen content	23
2.5.5 Stomatal conductance	24
CHAPTER 3: METHODS AND MATERIALS.....	26
3.1 SITE DESCRIPTION	26
3.2 SAMPLING TIME	27
3.3 STUDY SPECIES.....	27

3.4 EXPERIMENTAL DESIGN AND SAMPLING	30
3.4.1 First phase: screening.....	31
3.4.2 Second phase: seasonal field sampling	33
<i>Leaf sampling and emission measurements</i>	33
<i>Structure of the leaf cuvette</i>	34
<i>Detailed leaf cuvette analyses</i>	34
3.4.3 Detailed GC-FID analyses	36
<i>Calibration</i>	39
<i>Calculation of emission rates</i>	39
3.4.4 Other methods	41
<i>Soil moisture content</i>	42
<i>Soil pH</i>	41
<i>Soil texture</i>	42
<i>Leaf nitrogen content</i>	42
<i>Leaf area</i>	43
<i>Statistical analyses</i>	43
CHAPTER 4: RESULTS	44
4.1 SCREENING PHASE	44
4.2 SEASONAL LEAF CUVETTE STUDY	45
4.2.1 Ambient Air Temperature.....	45
4.2.2 Rainfall.....	46
4.2.3 Relative Humidity (%) of ambient air.....	48
4.2.4 Photosynthetic Active Radiation (PAR)	49
4.2.5 Soil properties	50
<i>Texture of soil</i>	50
<i>Soil water content</i>	51
<i>Soil pH</i>	52
4.2.6 Plant properties	52
<i>Leaf nitrogen content</i>	52
4.3 EMISSION RATES	55
4.4 ISOPRENE EMISSION RATES ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$)	57
4.5 MONOTERPENES EMISSION RATES ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) (β -pinene, limonene, α -pinene and linalool).....	60
4.5.1 β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$).....	60
4.5.2 limonene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$)	66
4.5.3 α -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$).....	68
4.5.4 linalool emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$).....	72
CHAPTER 5: DISCUSSION	75

5.1 IMPACTS OF BIOGENIC VOLATILE CARBONS ON ATMOSPHERIC CHEMISTRY	71
5.2 THE EMISSION RATES OF SELECTED COMPOUNDS FOR THE PLANTATION AND CROP SPECIES.....	76
5.3 THE EMISSION RATES FROM SAMPLED PLANTATION AND CROP SPECIES	78
5.4 FACTORS CONTROLLING THE SEASONAL EMISSIONS OF BVOCs IN MPUMALANGA	80
5.4.1 Ambient Air Temperature.....	81
5.4.2 Relative Humidity of ambient air (RH)	82
5.4.3 Photosynthetic Active Radiation (PAR) ($\mu\text{mol m}^{-2} \text{s}^{-1}$)	83
5.4.4 Soil water content, texture and ph of soils	85
5.4.5 Leaf nitrogen content	86
5.5 BVOC EMISSIONS AND LAND USE	87
CHAPTER 6: CONCLUSIONS AND FUTURE RESEARCH	89
CHAPTER 7: REFERENCES.....	91

LIST OF FIGURES

Figure 2.1 Plants respond to herbivory with the emission of chemical cues above and below ground, which can elicit responses in (1) carnivorous enemies of the herbivores, (2) herbivores and (3) neighbouring plants. The plant–plant interactions comprise interactions among conspecifics and heterospecifics. The red broken arrow represents herbivore attack on a plant; the blue arrows represent the emission of chemical cues that affect other organisms. The thickness of the blue arrows indicates the relative knowledge of the interactions (Dicke and Van Loon, 2000)	7
Figure 2.2 Structure of isoprene	11
Figure 2.3 Schematic compilation of the biosynthesis of the volatile and semi-volatile isoprenoids: isoprene, monoterpenes and sesquiterpenes in plants. Upper left part describes the classical acetate/mevalonate pathway, whereas the upper right part summarizes the recently described novel pathway via pyruvate by introducing 3-glyceraldehyde-3-phosphate (GAP), both leading to the key compound isopentenyl pyrophosphate (Rohmer <i>et al.</i> 1993)	14
Figure 2.4 BVOC emissions from woody plant species (Loreto <i>et al.</i> 1996a)	16
Figure 2.5 Isoprene emissions in White Oak leaves as a function of temperature (Lerdau <i>et al.</i> 1997)	18
Figure 2.6 Isoprene emissions in tropical deciduous forest leaves as a function of light intensity (Lerdau and Keller 1997)	20
Figure 3.1 Mpumalanga Province with arrows indicating study areas	26
Figure 3.2 Pine plantation site	28
Figure 3.3 Eucalyptus plantation site	28
Figure 3.4 Mango site	29
Figure 3.5 Avocado site	29

Figure 3.6 Banana site.....	30
Figure 3.7 Handheld Photoionization Detector 2020ppbPRO Photovac, Inc.....	31
Figure 3.8 Handheld Photoionization Detector model 2020ppbPRO flow diagram.....	32
Figure 3.9 A diagram of the leaf cuvette showing the leaf temperature sensor and the PAR sensor.....	34
Figure 3.10 Canister for sampling leaf air.....	35
Figure 3.11 Flame ionization detector.....	37
Figure 3.12 GC-FID equipment (Gas Chromatography with flame ionization detector) 1-Vacuum valve; 2-3 - valves; 4- the sample to the column; 5- sample injection port; 6-trap 1; 7- helium; 8- trap 2; 9- oven; 10- hydrogen.....	37
Figure 3.13 A soil textural triangle is used to determine soil textural class from the percentages of sand, silt, and clay in the soil.....	42
Figure 4.1a Isoprene concentrations (ppb) (crop species n=90, plantation species n=60, mean and standard error).....	44
Figure 4.1b Monoterpenes concentrations (ppb) (crop species n=90, plantation species n=60, mean and standard error).....	44
Figure 4.2a Total monthly rainfall (mm) for the period of sampling (2007) (Arrows in the Figure indicate the sampling month).....	47
Figure 4.2b Total monthly rainfall (mm) for the period of sampling (2008) (Arrows in the Figure indicate the sampling month).....	47
Figure 4.3 Leaf nitrogen content (%) for each of the sampled species at each sampling time (crop species n=15, plantation species n=10, mean and standard error).....	54
Figure 4.4 The emission rates of the sampled chemical species ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) from the crop and plantation species (crop species n=75, plantation species n=25, mean and standard error).....	55

Figure 4.5a The emission rates of isoprene ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) from the crop and plantation species (crop species n=75, plantation species n=25, mean and standard error).....	56
Figure 4.5b The emission rates of monoterpenes ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) from the crop and plantation species (crop species n=75, plantation species n=25, mean and standard error).....	56
Figure 4.6 Mean values (n=5 for each of the sampling period and standard error) of isoprene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the sampled species over the sampling time.....	57
Figure 4.7 The relationship of isoprene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and leaf nitrogen content (%) (Mangoes) ($R=-0.42$; $p=0.03$; $n=25$).....	59
Figure 4.8 Mean values (n=5 for each of the sampling period and standard error) of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the sampled species over the sampling time.....	61
Figure 4.9 The relationship of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and temperature of ambient air (T °C) (Mangoes) ($R=-0.42$; $p=0.04$; $n=25$).....	63
Figure 4.10 The relationship of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and temperature of ambient air (T °C) (Pines) ($R=0.51$; $p=0.009$; $n=25$).....	63
Figure 4.11 The relationship of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and PAR ($\mu\text{mol m}^{-2} \text{ s}^{-1}$) (Mangoes) ($R=-0.67$; $p=0.0003$; $n=25$).....	64
Figure 4.12 The relationship of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and PAR ($\mu\text{mol m}^{-2} \text{ s}^{-1}$) (Pines) ($R=0.43$; $p=0.03$; $n=25$).....	64
Figure 4.13 The relationship of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and RH (%) (Mangoes) ($R=0.48$; $p=0.01$; $n=25$).....	65
Figure 4.14 Mean values (n=5 for each of the sampling period and standard error) of limonene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the sampled species over the sampling time.....	66

Figure 4.15 The relationship of limonene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and temperature of ambient air ($T^{\circ}\text{C}$) (Pines) ($R=0.42$; $p=0.03$; $n=25$).....	68
Figure 4.16 Mean values ($n=5$ for each sampling period and standard error) of α -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the sampled species over the sampling time.....	69
Figure 4.17 The relationship of α -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and leaf nitrogen content (%) (Mangoes) ($R=-0.48$; $p=0.01$; $n=25$).....	71
Figure 4.18 Mean values ($n=5$ for each of the sampling period and standard error) of linalool emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the sampled species over the sampling time.....	72
Figure 4.19 The relationship of linalool emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) and leaf nitrogen content (%) (Pines) ($R=-0.45$; $p=0.02$; $n=25$).....	74

LIST OF TABLES

Table 3.1: Example of the data table for <i>Eucalyptus</i> for recording the concentration of BVOCs (ppb)	33
Table 3.2: Example of the data table for <i>Eucalyptus</i> for recording environmental conditions with hydrometer and simple thermometer.....	36
Table 4.1: Mean values and ($\pm$ Standard Error) of the isoprene and monoterpene concentrations (ppb) for the five study species (n=30).....	45
Table 4.2: Mean ($\pm$ Standard Error) values of the temperature ($^{\circ}$ C) of ambient air (10 am-3 pm) at the five study sites across the five study periods	46
Table 4.3: Mean ($\pm$ Standard Error) values of the temperature ($^{\circ}$ C) of ambient air at the five study sites	46
Table 4.4: Mean values of the rainfall (mm) for the period of sampling (2007-2008)	48
Table 4.5: Mean ($\pm$ Standard Error) values of relative humidity (%) at the five study sites across the five study periods (10 am-3 pm)	49
Table 4.6: Mean ($\pm$ Standard Error) values of relative humidity (%) at the five study sites.....	49
Table 4.7: Mean ($\pm$ Standard Error) values of PAR ($\mu\text{mol m}^{-2} \text{s}^{-1}$) at the five study sites over the five study periods (10 am-3 pm)	49
Table 4.8: Mean ($\pm$ Standard Error) values of PAR ($\mu\text{mol m}^{-2} \text{s}^{-1}$) at the five study sites.....	50
Table 4.9: Soil texture (%) from each of the study sites, 0-10 cm depth.....	50
Table 4.10: Mean ($\pm$ Standard Error) values of soil water content (%) at the five study sites across the five study periods.....	51
Table 4.11: Mean ($\pm$ Standard Error) values of soil water content (%) at the five study sites.....	51
Table 4.12: Soil pH values at each of the selected sites.....	52
Table 4.13: Mean ($\pm$ Standard Error) values of leaf nitrogen content (%) for the five study species (n=30) over the five study periods.....	53

Table 4.14: Mean ($\pm$ Standard Error) values of leaf nitrogen content (%) for the five study species (n=30)	53
Table 4.15: Mean ($\pm$ Standard Error) values of isoprene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for all species over the five study periods (n=25).....	58
Table 4.16: Mean ($\pm$ Standard Error) values of isoprene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the species for all of the five study periods (n=25).....	59
Table 4.17: Mean ($\pm$ Standard Error) values of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for all species over the five study periods (n=25).....	62
Table 4.18: Mean ($\pm$ Standard Error) values of β -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the species for all of the five study periods (n=25).....	62
Table 4.19: Mean ($\pm$ Standard Error) values of limonene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for all species over the five study periods (n=25).....	67
Table 4.20: Mean ($\pm$ Standard Error) values of limonene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the species for all of the five study periods (n=25)	67
Table 4.21: Mean ($\pm$ Standard Error) values of α -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for all species over the five study periods (n=25).....	70
Table 4.22: Mean ($\pm$ Standard Error) values of α -pinene emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the species for all of the five study periods (n=25).....	70
Table 4.23: Mean ($\pm$ Standard Error) values of linalool emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for all species over the five study periods (n=25).....	73
Table 4.24: Mean ($\pm$ Standard Error) values of linalool emission rates ($\mu\text{g C m}^{-2} \text{ hr}^{-1}$) for each of the species for all of the five study periods (n=25)	73

LIST OF ABBREVIATIONS

ABA	Absciscic acid
BHC	Biogenic hydrocarbons
BVOC	Biogenic Volatile Organic Carbon
GAP	Glyceraldehyde 3-phosphate
GC-FID	Gas Chromatography with Flame Ionization Detector
GDP	Geranyl Diphosphate
DMAPP	Dimethyl Allyl Diphosphate
DOXP	Deoxy-d-Xylulose Phosphate
IPP	Isopentenyl Diphosphate
KCl	Potassium chloride
LA	Leaf Area (cm ²)
Leaf N	Leaf Nitrogen content (%)
LNC	Leaf nitrogen concentration
MBO	Methyl-Butenol
MEP	Methyl-Erythritol
NMHC	Non Methane HydroCarbons
MVA	Mevalonic Acid Pathway
PAR	Photosynthetically Active Radiation (μmol m ⁻² s ⁻¹)
PEP	Phosphoenolpyruvate
PFD	Photon flux density
PID	Photolionization Detector
ppb	Mass solute/mass solution×10 ⁹ = concentration ppb (parts per billion) or (μg·m ⁻³)
RF	Response factor
RH	Relative humidity (%)
SLA	Specific leaf area
SWS	Soil water storage

T air	Temperature of ambient air (°C)
Tg	10 ¹² gram / yr (Teragram)
T leaf	Temperature of leaf (°C)
VOC	Volatile Organic Carbon
CH₄	Methane
CO	Carbon monoxide
H₂O₂	Hydrogen peroxide
NO_x	Nitrogen oxide
OH	Hydroxyl
O₂	Oxygen
O₃	Ozone