An investigation into the efficacy of pine oil on two natural area weeds

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The facts

- **Invasive species** are the **second most common** cause of **extinctions in the world**
- Annually **9 new herbicide resistant weeds discovered**

My weed control experience

- Work: **Natural Area Management** on the Sunshine Coast, Queensland
  - Weed control is main focus!
- Study: **Master of Environmental Management** at University of Queensland
- Combine work and university in a research thesis

- **Evaluation of alternative herbicides in NAM**
  - Effective?
  - Cost effective?
  - Safe for humans and the environment?

Pine oil (Bioweed® Organic Herbicide Concentrate)

- Early Bioweed™ batch – continuous Research and Development!
- Essential oil from ***Pinus radiata***
- **Contact herbicide**
- **Pre emergent (PRE) and Post emergent (POST)**
  - Very few herbicides, let alone organic herbicides can do this!
- In Queensland, mainly used in **agricultural situations**

- Few studies compare
  - Synthetic vs organic herbicides
    - field and greenhouse experiments
    - NAM context
  - PRE experiments in pot trials

The weeds of choice

- **Woody weed and grass species**

- *Ochna serrulata* (**Mickey mouse plant**)
  - Top 25 worst weeds in SEQ
  - Woody shrub 2-3m
  - Invades both **disturbed and undisturbed natural areas**
  - **Long tap root** that easily breaks and reshoots
  - Very attractive for birds – BUT **low in nutrition**!

- *Sporobolus africanus* (**Parramatta grass**)
  - **Weedy sporobolus grass** *(indicus* complex)
  - Related to Giant rat's tail grass (*S. pyramidalis)*
  - Grows in **reserve edges** and **access tracks**
  - Susceptible to **sooty mould** – can affect crops
  - One plant can produce up to **85,000 seeds/year**

Is pine oil effective on natural area weeds?

- **Three experiments (field and greenhouse):**
- **1. Field experiment – POST:** does pine oil affect the survival of (mature) *O. serrulata* and *S. africanus* plants?
- **2. Greenhouse experiment – PRE:** does pine oil affect the germination of *O. serrulata* and *S. africanus* seeds?
- **3. Greenhouse experiment – POST:** does pine oil affect the growth of (juvenile) *O. serrulata* and *S. africanus* plants?

1. Field experiment - POST

- **Does pine oil affect the survival of (mature) *O. serrulata* and *S. africanus* plants?**

- Two species (*O. serrulata* and *S. africanus*), five herbicide treatments
- Battery-powered knapsack (70 psi) with flat fan nozzle

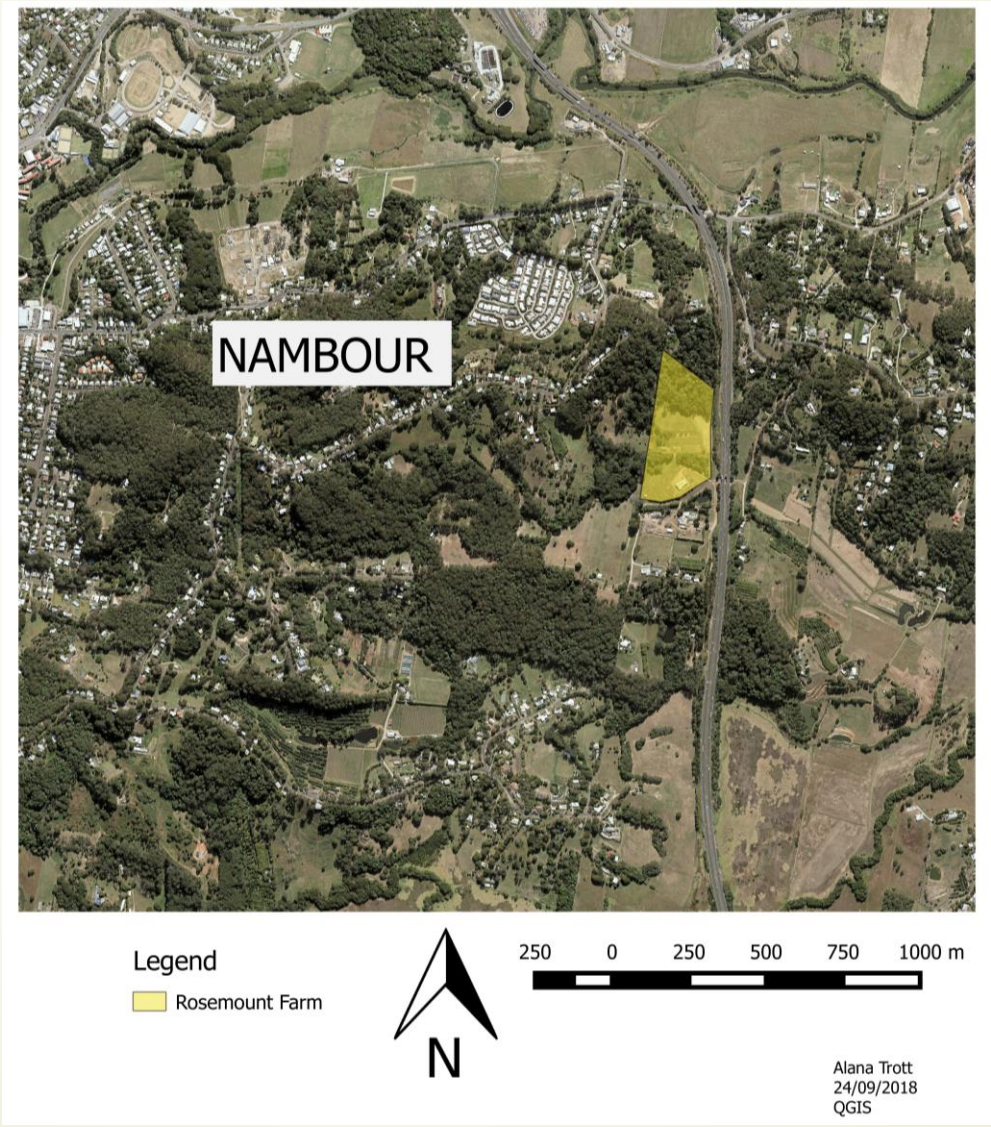
Herbicide Treatments

Synthetic herbicides = 70% coverage
Organic herbicides = 100% coverage

Species: *Sporobolus africanus*		
Herbicide Treatment	Average observed spray volume (L ha^{-1}) including herbicide and water	Recommended spray volume (L ha^{-1}) including herbicide and water
Control	NA	NA
Glyphosate 360g/L	1600	100
Pelargonic acid 525g/L	2700	100
Pine oil 680g/L	2700	600
Pine oil/glyphosate	1700	100

Species: *Ochna serrulata*		
Herbicide Treatment	Average observed spray volume (L ha^{-1}) including herbicide and water	Recommended spray volume (L ha^{-1}) including herbicide and water
Control	NA	NA
Glyphosate 360g/L	730	100
Pelargonic acid 525g/L	630	100
Pine oil 680g/L	1200	600
Pine oil/glyphosate	960	100

Field Experiment – Rosemount Farm



Before treatment – *Sporobolus africanus*

After treatment – Day 1

Pine oil

Pine oil/glyphosate

Glyphosate

Pelargonic acid

After treatment – Day 7

Pine oil

Pine oil/glyphosate

Glyphosate

Pelargonic acid

After treatment – Day 22

Pine oil | **Pine oil/Glyphosate** | **Control** | **Glyphosate** | **Pelargonic acid**





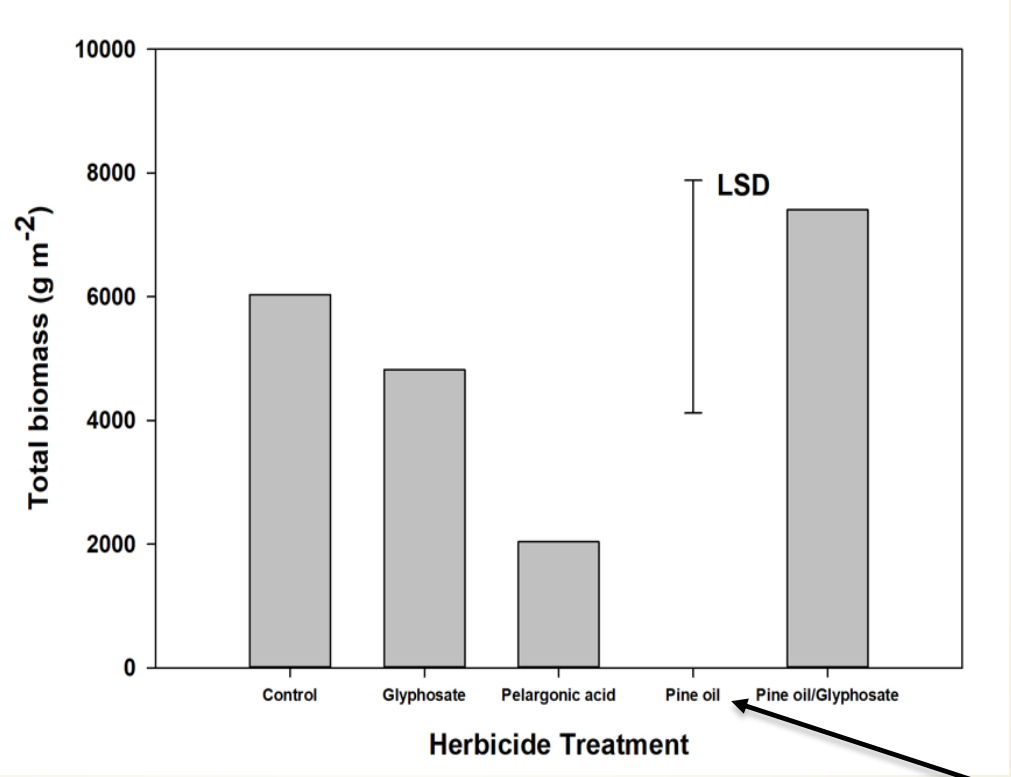





End experiment – Day 28

Results

The effect of different herbicide treatments on *Sporobolus africanus* average total biomass (g m^{-2}) at end of experiment 1.



100% mortality, biomass = 0

Before treatment – *Ochna serrulata*

After treatment – Day 1

Individual plant photos shown only.

Pine oil

Pine oil/Glyphosate

Glyphosate

Pelargonic acid

After treatment – Day 7

Pine oil

Pine oil/Glyphosate

Glyphosate

Pelargonic acid

After treatment – Day 14

Pine oil

Pine oil/Glyphosate

Glyphosate

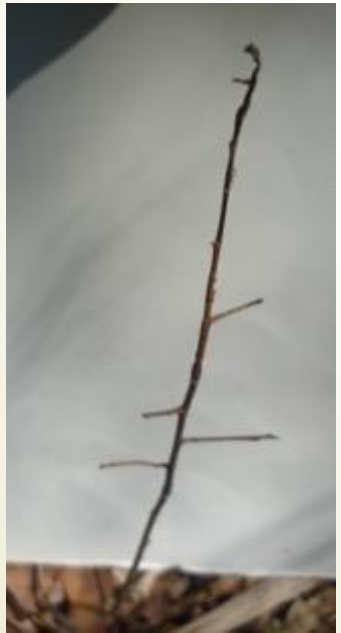
Pelargonic acid

End experiment – Day 28

20

Pine oil

Pine oil/Glyphosate

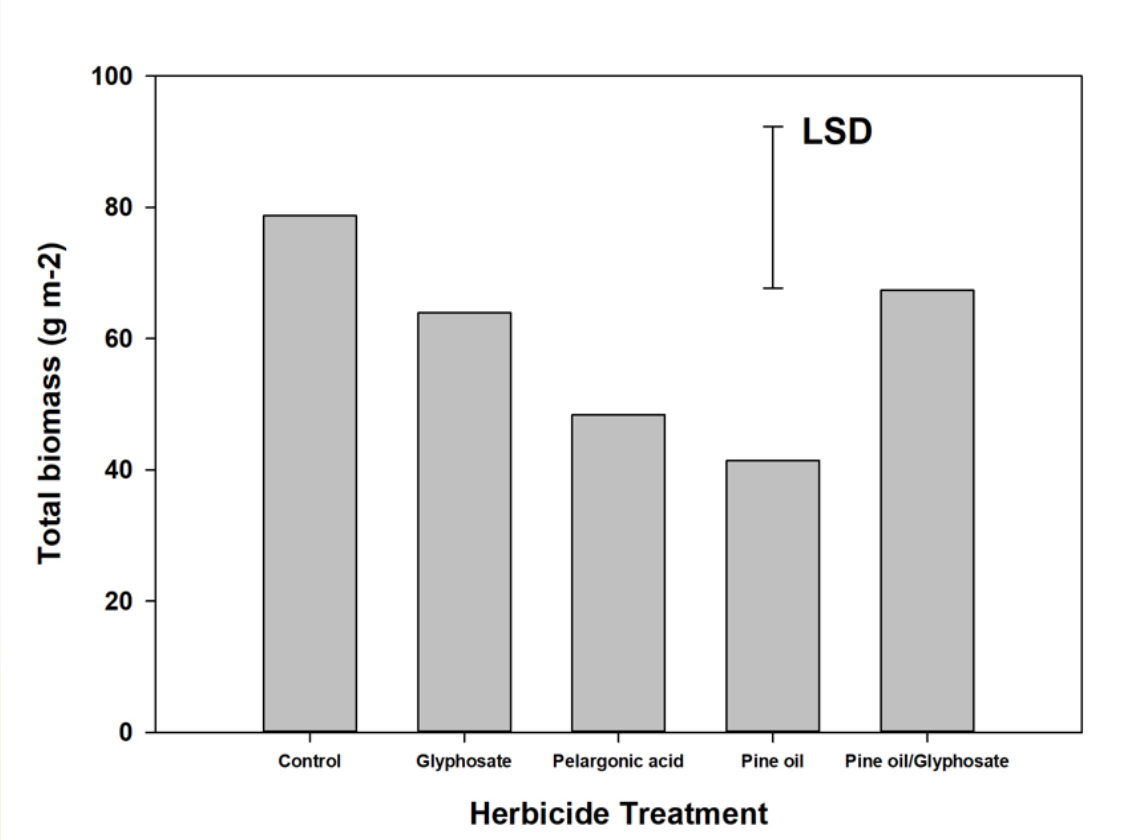


Glyphosate

Pelargonic acid

Results

The effect of different herbicide treatments on *Ochna serrulata* average total biomass (g m^{-2}) at end of experiment 1.

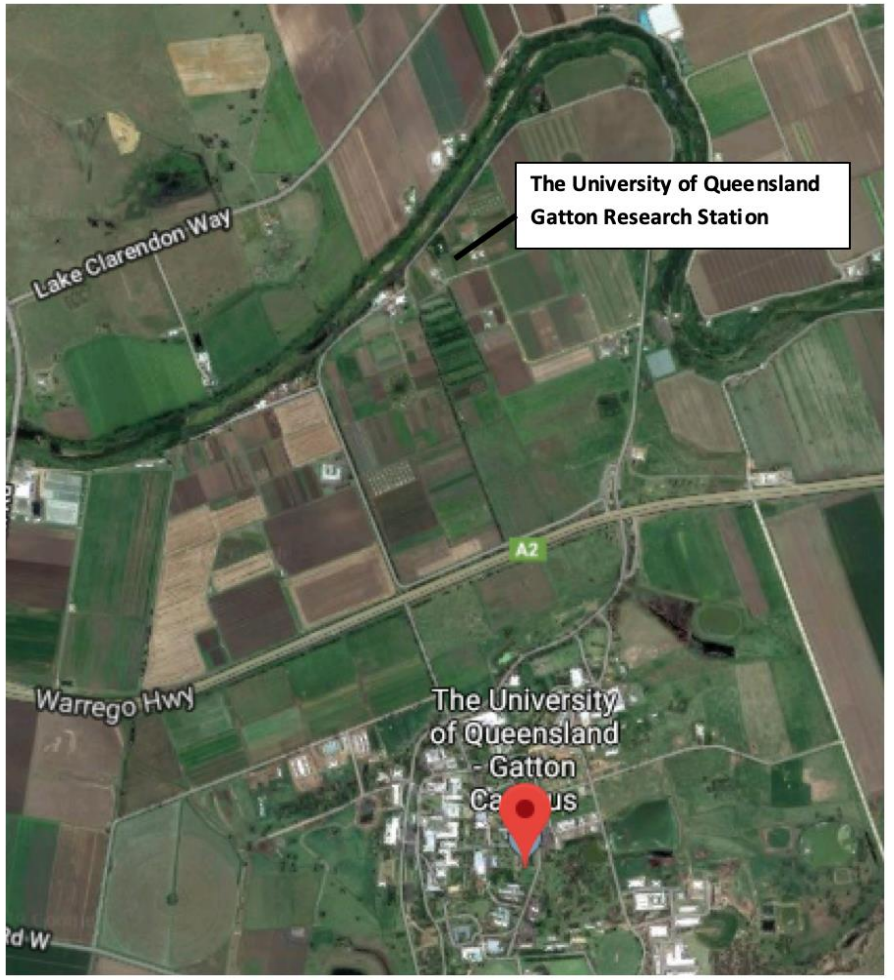


Why use contact herbicides on a woody weed?

2. Greenhouse Experiment - PRE

- **Does pine oil affect the germination of *O. serrulata* and *S. africanus* seeds?**
- **Pot trial** using **research track sprayer**
- Two factors: five herbicide treatments, two soil depths
- Only ***S. africanus* studied**!
  - **Seed dormancy of *O. serrulata***
  - Seed viability test = > 80% viability, but NO germination!

Greenhouse Experiment – University of Queensland (Gatton)

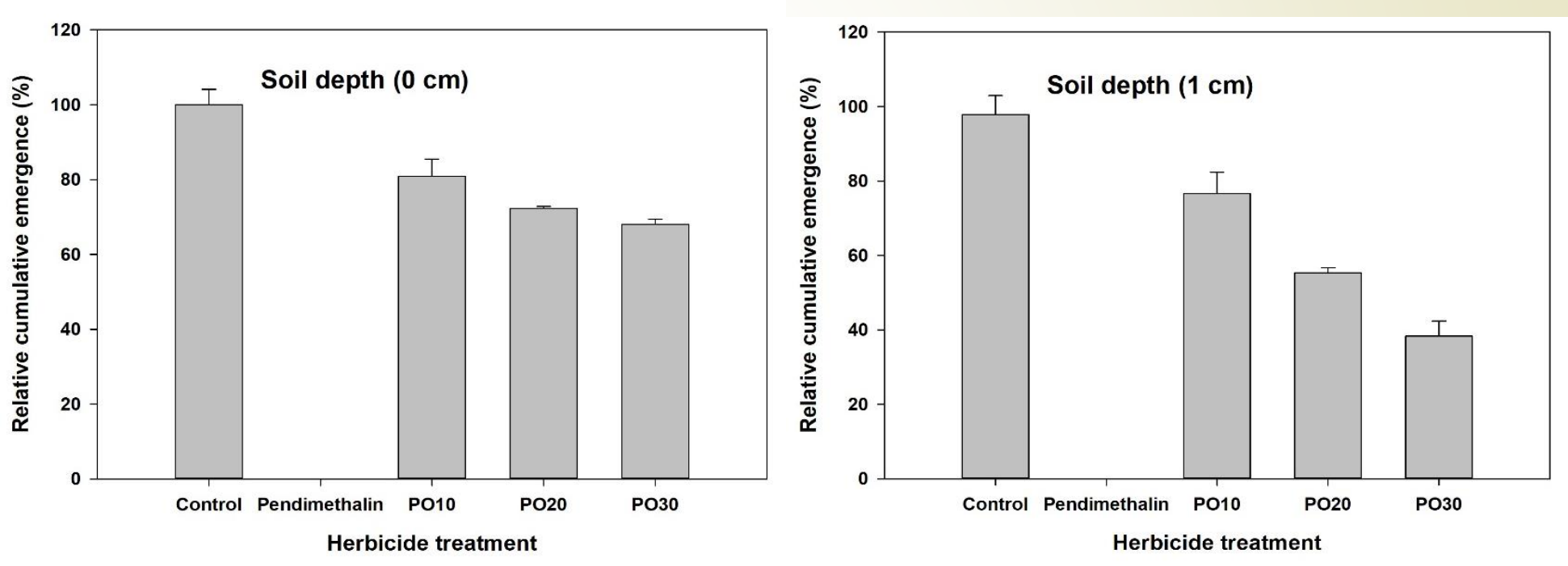


Herbicide and Soil Depth Treatments

Herbicide	Factor 1 Herbicide treatment	Factor 2 Soil depth
Control		Above soil
Pendimethalin 440g/L		1cm below soil
Pine oil 680 g/L	10% at 108 L/ha (PO10)	
	20% at 108 L/ha (PO20)	
	30% at 108 L/ha (PO30)	

Results

Relative average cumulative emergence (%) of *Sporobolus africanus* seeds according to soil depth, and herbicide treatment.

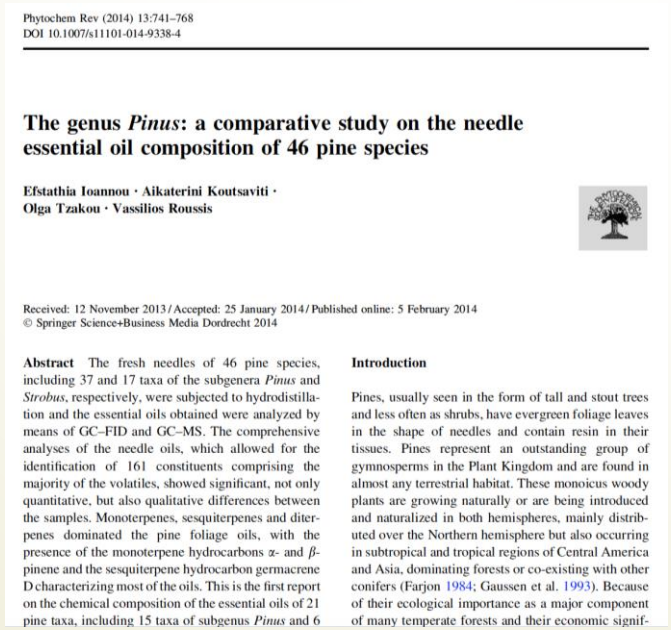


Overall Findings and Recommendations

- **Pine oil PRE and POST controls *S. africanus***
  - Similar to *S. pyramidalis* (GRT)
- **Pine oil PRE** is effective at **lower soil depths** with **saturated soil** (takes effect at **two weeks)**
- Pine oil PRE Pine oil **increases** in **efficacy with increasing concentration**
- Pine oil is suitable in:
  - **Integrated Weed Management**
  - **Herbicide resistance**
  - Other **environmental, health or community** outcomes are valued
  - Another tool in the tool belt!

Interesting finding

- Other Pinus species could be suitable for Bioweed™ synthesis
- **α- and ß-pinene active compounds** of pine oil
- ***Pinus radiata* (Bioweed®)** = **18.9% α-pinene** and **38.7% ß-pinene**
- ***Pinus ponderosa* (Ponderosa pine)** = **22.5% α-pinene** and **45% ß-pinene**
- ***Pinus sabineana* (Digger pine)** = **61.6% α-pinene**



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The genus *Pinus*: a comparative study on the needle essential oil composition of 46 pine species

Efstathia Ioannou · Aikaterini Koutsaviti · Olga Tzakou · Vassilios Roussis

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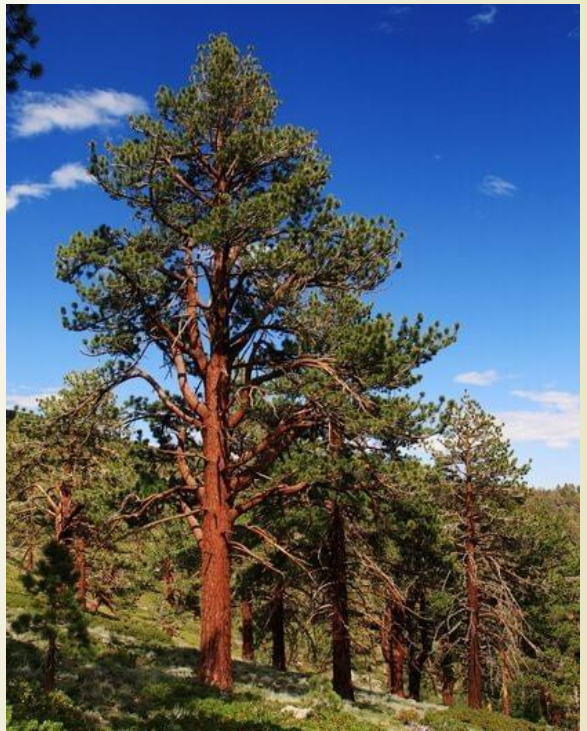
Abstract The fresh needles of 46 pine species, including 37 and 17 taxa of the subgenera *Pinus* and *Strobus*, respectively, were subjected to hydrodistillation and the essential oils obtained were analyzed by means of GC–FID and GC–MS. The comprehensive analyses of the needle oils, which allowed for the identification of 161 constituents comprising the majority of the volatiles, showed significant, not only quantitative, but also qualitative differences between the samples. Monoterpenes, sesquiterpenes and diterpenes dominated the pine foliage oils, with the presence of the monoterpene hydrocarbons α- and β-pinene and the sesquiterpene hydrocarbon germacrene D characterizing most of the oils. This is the first report on the chemical composition of the essential oils of 21 pine taxa, including 15 taxa of subgenus *Pinus* and 6

Introduction

Pines, usually seen in the form of tall and stout trees and less often as shrubs, have evergreen foliage leaves in the shape of needles and contain resin in their tissues. Pines represent an outstanding group of gymnosperms in the Plant Kingdom and are found in almost any terrestrial habitat. These monoicus woody plants are growing naturally or are being introduced and naturalized in both hemispheres, mainly distributed over the Northern hemisphere but also occurring in subtropical and tropical regions of Central America and Asia, dominating forests or co-existing with other conifers (Farjon 1984; Gaussen et al. 1993). Because of their ecological importance as a major component of many temperate forests and their economic signif-



Suggestions

- **Replication, replication, replication**!
  - APVMA minor use permit - $$$
- Comparative studies of **pine oil vs. metsulfuron or flupropanate**
- Break ***Ochna serrulata* seed dormancy**
- Impact of **organisms, water quality, and soil health (Griffith Uni and USC)**
- Investigate pine oil's effect on **plant physiology in real time**
  - **PhotosynQ: Physiological function, photosynthesis, chlorophyll content**

Suggestions 2.0

- **Limitations** of organic herbicides as **contact herbicides**
  - cut/paint, drill/inject treatment method relies on herbicide translocation
- **Growth hormone inhibitors** to organic herbicides
- Alternative application methods for pine oil: **wickwiping, foam or pastes**

Thank you!

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