PRELIMINARY STUDY OF VOLATILE ORGANIC COMPOUNDS IN THREE HOST PLANTS OF AUSTRALIAN CANE BEETLES

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INTRODUCTION

- Canegrubs are the major insect pests of sugarcane in Australia.
- The most common species is Greyback (*Dermolepida albohirtum*).
- Four stages make up the canegrub's lifecycle: the egg, the larva, the pupa, and the adult beetle (Fig. 1).

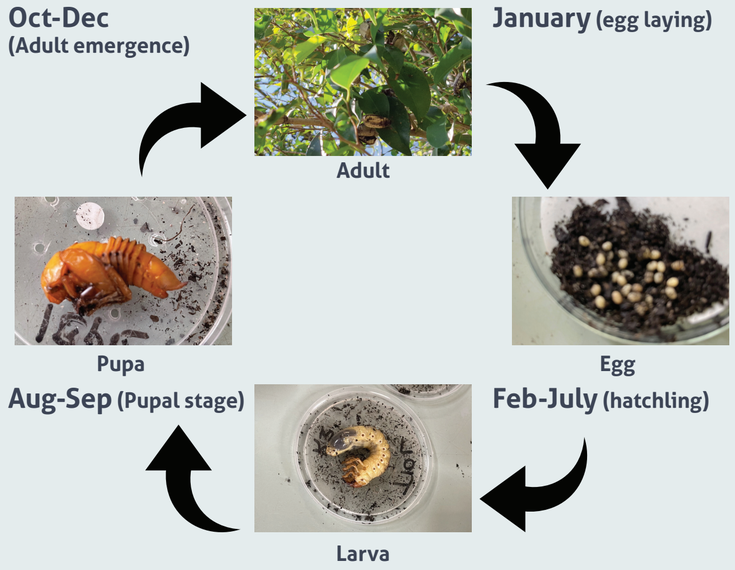

Figure 1. Life cycle of Greyback canegrub. Source: Samuel Bawa

- 20 canegrub species impact sugarcane in Australia (Fig.2).
- Larvae predominantly, which cause root damage (Fig.3) with an economic cost of over AU$50M/yr, is the only stage that is currently controlled by the use of insecticides.
- However, these chemicals have adverse effects on the environment, human health, and the potential build-up of resistant canegrub populations.
- Adults which occasionally feed on sugarcane leaves haven't been targeted for control, and one potential option is the use of volatile organic compounds (VOCs) from host plants (including sugarcane and figs).
- VOCs are naturally occurring organic compounds produced and released from different parts of plants.
- VOCs play a critical role in insect-plant interactions as they can serve as attractants or repellents and can influence insect behaviour such as feeding and oviposition.
- The use of VOCs released by cane beetle host plants could lead to a new control method.

AIM

In a one-year research project, the aim was to identify and analyse the VOCs produced by three host plants of cane beetles.

METHOD

- VOCs were collected in the Burdekin and Cairns regions.
- VOCs were collected using solid-phase micro extraction (SPME) and adsorption onto a commercial adsorbent Tenax TA, 80-100 mesh (Fig. 4 (D-F).
- The collected VOCs were analysed using gas chromatography-mass spectrometry (GC-MS) machine (Fig. 5).
- Compounds were identified using chromatograms (Figs. 6 & 7).

RESULT

- Three groups of VOCs were identified: Green-leaf volatiles (GLV), Aromatic compounds and Terpenoids (Tables 1-3).
- Sandpaper fig released 10 GLV compared to sugarcane and strangle fig with 7 each (Table 1).
- Strangle fig released a more diverse groups of sesquiterpenes compared to sandpaper fig (Table 3).

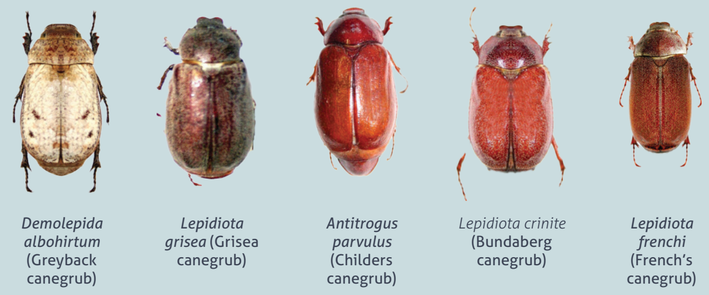

Figure 2. Some canegrub species in Australia. Source: SRA fact sheet

Figure 3. Canegrub damage symptoms (A-C).Where A = Early sign of damage, B = canegrub-infested field, C = Advanced sign of root damage. Source: SRA fact sheet

Figure 4. Volatile collection process (D-F). Where D = In situ collection sandpaper fig, E = In situ collection on strangle fig, F = In situ collection on sugarcane, G = Defoliated Sandpaper fig, H = a cluster of beetles on strangle fig, I = a cluster of Greyback beetles on sugarcane.

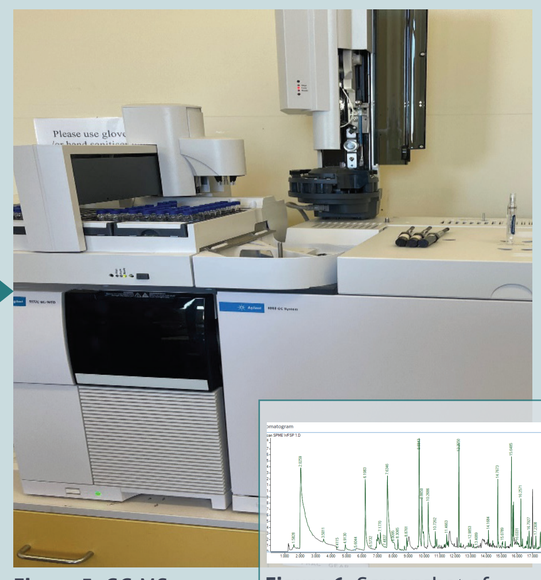

Figure 5. GC-MS machine for analysing VOCs from host plants.

Figure 6. Screenshot of chromatogram showing VOCs.

Table 1. Green leaf volatiles collected in situ from leaf-bearing branches of three host plants for Greyback cane beetles.

Compound name	Class	Plant Species		
		Sugarcane	Sandpaper fig	Strangle fig
Ethanol	F	++	++	-
Acetone	F	-	++	-
p-Menthan-3-ol	F	-	++	++
Nonanal	F	++	++	++
1-Butanol	C_6F	++	++	-
2-Hexanone	C_6F	++	++	++
3-Hexanol	C_6F	++	++	++
3-Hexanone	C_6F	-	++	++
Hexanal	C_6F	++	++	-
3-Hexen-1-ol, (Z)-	C_6F	-	-	++
Ethanol, 2-butoxy-	C_6F	++	++	++

Classification is based on Knudsen et al., (1993) and Del Socorro et al., (2010). F-floral volatiles, C6F-C6 fatty acid derivatives in leaves (green leaf volatiles). ++ = emitted, - = not emitted. Note: Collection was done in the morning.

Table 2. Aromatic compounds and Terpenoid-Monoterpenes collected in situ from leaf-bearing branches of three host plants for Greyback cane beetles.

Compound name	Class	Plant Species		
		Sugarcane	Sandpaper fig	Strangle fig
Ethylbenzene	A	++	++	++
Benzaldehyde	A	++	++	-
Phenol, 2-methoxy-	A	-	-	++
Isoprene	M	-	++	-
Cumene	M	++	++	++
α -pinene	M	++	++	-
Isovanillin	M	++	++	++
β-pinene	M	-	++	-
p-Menthone	M	++	++	++

Classification is based on Knudsen et al., (1993) and Del Socorro et al., (2010). A-aromatic compounds, M-monoterpenes. ++ = emitted, - = not emitted. Note: Collection was done in the morning.

Table 3. Terpenoids-Sesquiterpenes collected in situ from leaf-bearing branches of three host plants for Greyback cane beetles.

Compound name	Class	Plant Species		
		Sugarcane	Sandpaper fig	Strangle fig
α.-cubebene	S	-	-	++
Copaene	S	-	++	++
gamma-amorphene	S	-	-	++
α-cedrene	S	-	-	++
(-)-β-bourbonene	S	-	-	++
(E)-β-caryophyllene	S	-	-	++
β.-Copaene	S	-	-	++
β-guaiene	S	-	-	++
(+)-gamma-cadinene	S	-	-	++
Alloaromadendrene	S	-	-	++
β.-Guaiene	S	-	-	++

Classification is based on Knudsen et al., (1993) and Del Socorro et al., (2010). S-sesquiterpenes . ++ = emitted, - = not emitted. Note: Collection was done in the morning.

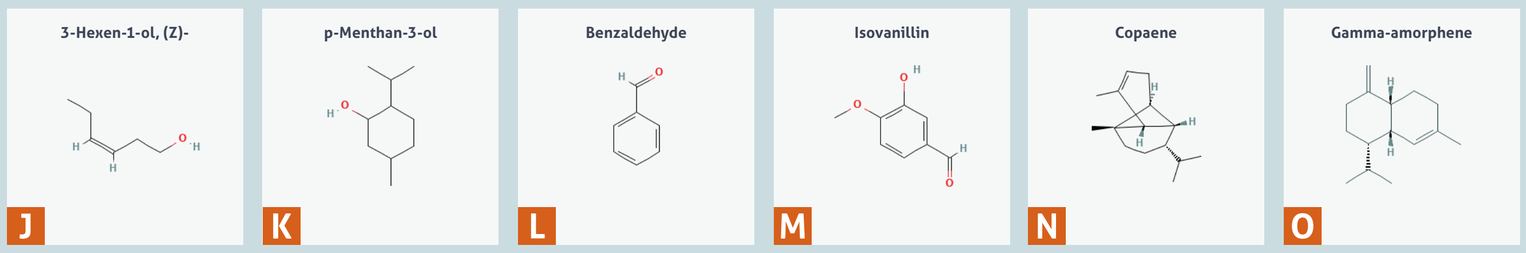

Figure 7. Chemical structure of some identified volatile organic compounds. J and K=GLV, L= Aromatic compound, M=Monoterpene, N and O= Sesquiterpenes. Source : https://pubchem.ncbi.nlm.nih.gov/. Note: Monoterpene and sesquiterpenes are terpenoids

CONCLUSIONS

- All the three groups of volatile organic compounds were released by Strangle fig and Sandpaper fig.
- Sesquiterpenes are known insect attractants.
- Strangle fig released more diverse sesquiterpene compounds compared to Sandpaper fig.
- Sugarcane is not a common feeding and breeding site for Greyback beetles, and it did not emit any sesquiterpenes.

FUTURE DIRECTIONS

- To investigate the potential use of VOCs as a management tool for adult cane beetles.
- Further research on VOCs from a wider variety of beetle host plants including other cane beetle species.
- Future control of cane beetles will be more effective if it targets two life stages (larvae and adults).

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