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Aboveground plant–insect interactions under belowground bacterial influence

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Plants emit natural enemy-attracting semiochemicals known as herbivore-induced plant volatiles (HIPVs) in response to herbivory. This study aimed to test the role of soil bacteria in HIPVs production and consequently on aboveground communities interactions. As a case study, a system based model with three trophic levels was designed with Nerium oleander as a host plant, Aphis nerii as a phytophagous and Chrysoperla carnea as a predator. Plants were grown during 3 months on soil amended with an organic biofertilizer (vermicomposted olive wastes) used as microbial inoculant, and then infected with A. nerii. Plants grown in soil amended with sterilized vermicompost were used as control. HIPVs produced were sampled using solid-phase micro-extraction (SPME) and measured by GC-MS. A Y-tube olfactometer was used to investigate the orientational response of C. carnea toward plant volatiles. To determine the abundance and activity of soil bacteria, we used quantitative PCR analysis of 16S DNA and RNA, respectively. A metagenomic approach was used to analyse the composition and diversity of the bacterial communities.

Volatiles measured before the phytophagous attack showed a similar pattern in plants grown in bacteria-inoculated soils and those of the control. However, HIPVs blend composition was different between them, mainly due to terpenoids as 2-decanone and 2-dodecanone. In correspondence, C. carnea females exhibited a significant preference for aphid-infested plants grown in bacteria-inoculated soils. As expected, bacterial biomass, activity and diversity were quite higher in soils inoculated with the no sterilized organic amendment. The possible relationships of soil bacterial community structure and HIPVs blend could help to establish some ecological implications of the plant–insect interactions under soil microbial influence.

Aboveground plant–insect interactions under belowground bacterial influence

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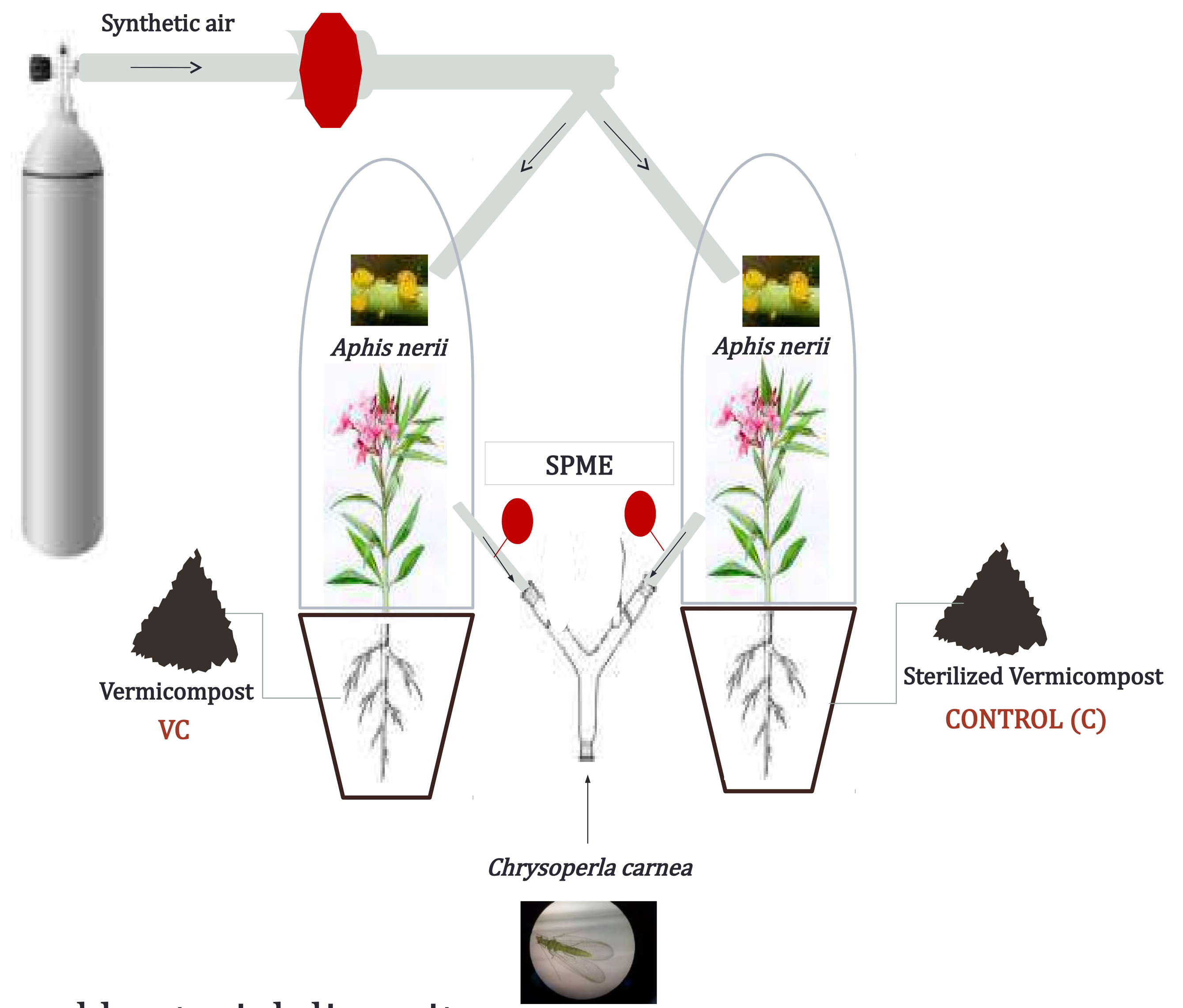
Plants emit natural enemy-attracting semiochemicals known as herbivore-induced plant volatiles (HIPVs) in response to herbivory.

AIM: To test the role of soil bacteria in HIPVs production and consequently on aboveground communities interactions

EXPERIMENTAL DESIGN

A system based model with three trophic levels was designed with *Nerium oleander* as a host plant, *Aphis nerii* as a phytophagous and *Chrysoperla carnea* as a predator

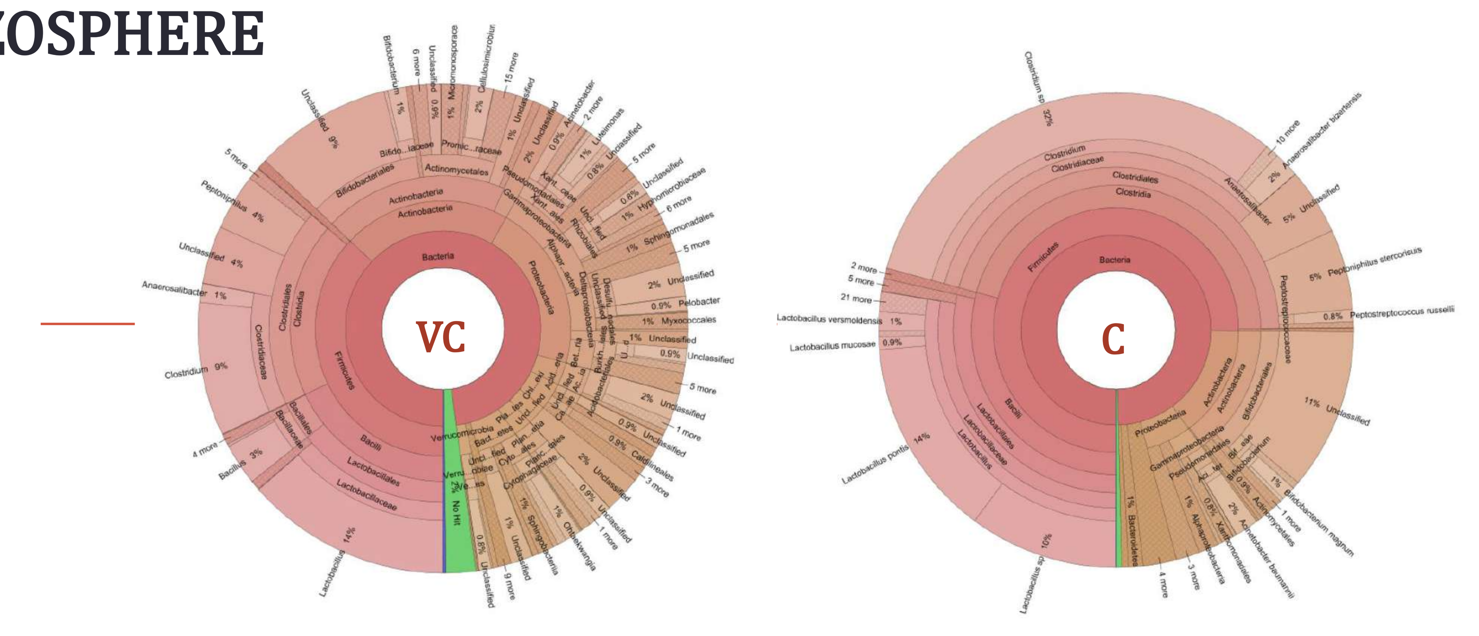
Soil amended with an organic biofertilizer (vermicomposted olive wastes) used as microbial inoculant.
Plant volatiles were measured by headspace-solid-phase microextraction (SPME)



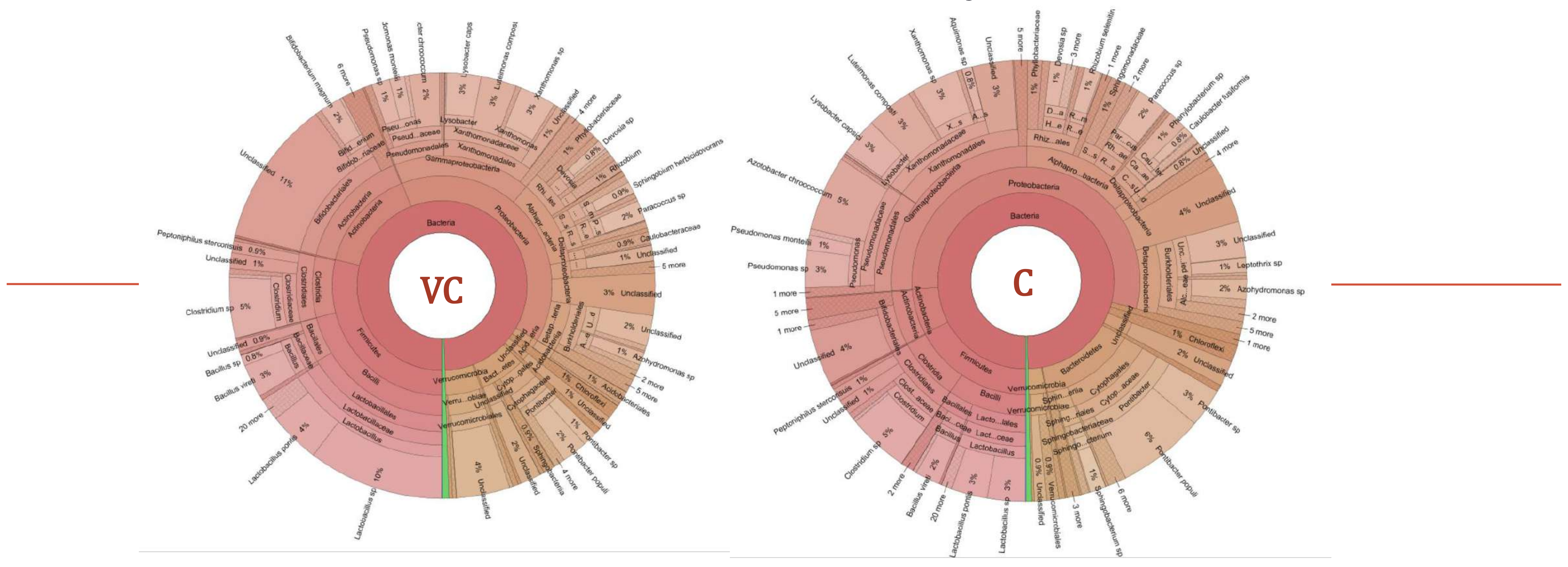
RESULTS

1. RIZOSPHERE

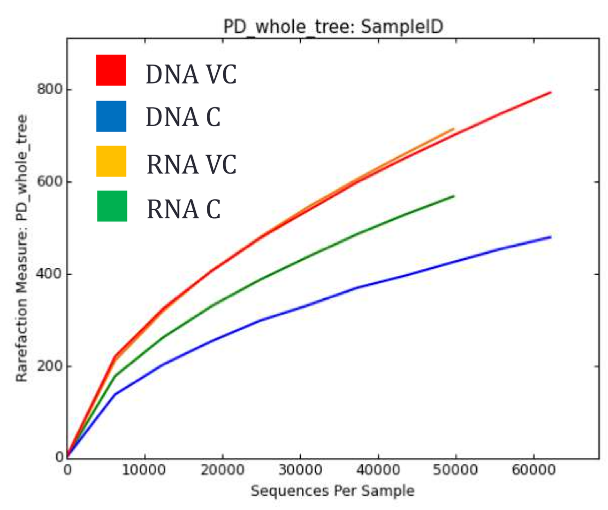
DNA-based bacterial diversity



RNA-based bacterial diversity



α-diversity



β-diversity

	DNA VC	DNA C	RNA VC
DNA C	0.793		
RNA VC	0.753	0.828	
RNA C	0.819	0.761	0.818

Higher total (DNA) and metabolycally active (RNA) bacterial diversity in vermicompost amended soils

2. PLANT VOLATILES

Before the phytophagous attack: similar pattern in plants grown in bacteria-inoculated soils and those of the control

After the phytophagous attack: different HIPVs blend composition between treatments

Volatile	Formula	VC	Control
PHENYLMETHANOL	C_7H_8O	++	+
ALKYLBENZENE	$C_6H_5CHR1R2$	+	+
BENZOTHIAZOLE	C_7H_5NS	+	+
4-METHOXY-BENZOALDEHYDE	$C_8H_8O_2$	+	+
DICHLOROBENZOIC ACID	$C_7H_4Cl_2O$	+	++
TRIMETHYLBENZENE	C_9H_{12}	++	+
2-DECANONE	$C_{10}H_{20}O$	+	-
2-UNDECANONE	$C_{11}H_{22}O$	+	++
2-DODECANONE	$C_{12}H_{24}O$	+	-
TETRADECANE	$C_{14}H_{30}$	++	+
BENZYL ALCOHOL	C_7H_8O	++	+

3. *Chrysoperla carnea* PREFERENCE

C. carnea females exhibited a significant preference for aphid-infested plants grown in VC treatment, i.e. bacteria-inoculated soils (*Akaike* information *criterion R)*

	M3	M4
a	1.0937	1.0873
b	0.6088	0.6088
ε^{b}_{e}	0.3072	0.1225
	-------	0.3037

CONCLUSIONS

Changes in soil bacterial community structure provoked changes in the volatiles blends emitted by *Nerium oleander* after the phytophagous *Aphis nerii* attack, consequently determining the behaviour of the natural enemy *Chrysoperla carnea*. The possible relationships between soil bacterial community structure and HIPVs blend could help to establish some ecological implications of the plant–insect interactions under soil microbial influence.

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