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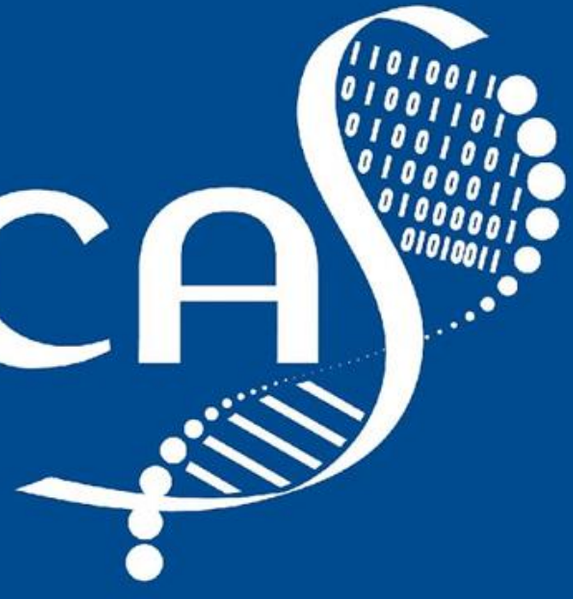

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Analysis of the fungal microbiome present in different types of cacao soils with cadmium

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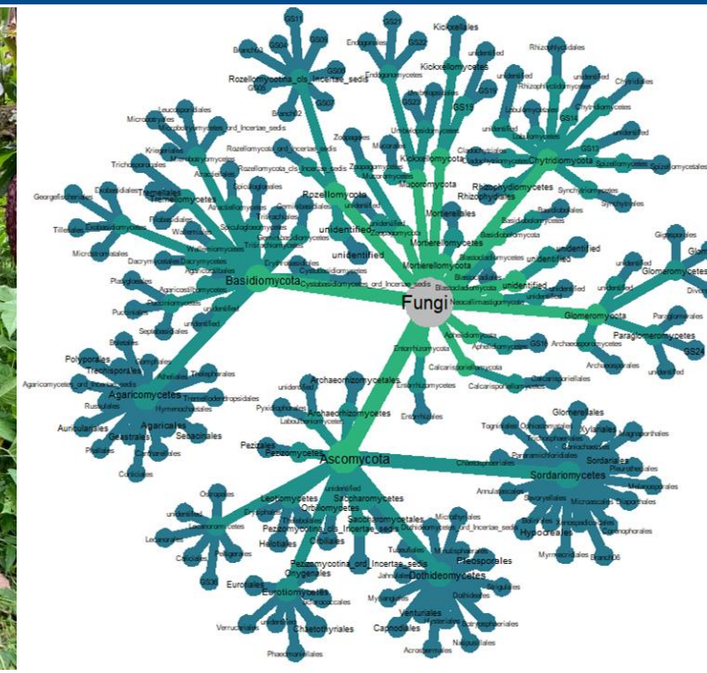
Agrobiodiversidad y Biotecnología

Grupo de investigación

Facultad de Ciencias Agrarias · Sede Bogotá



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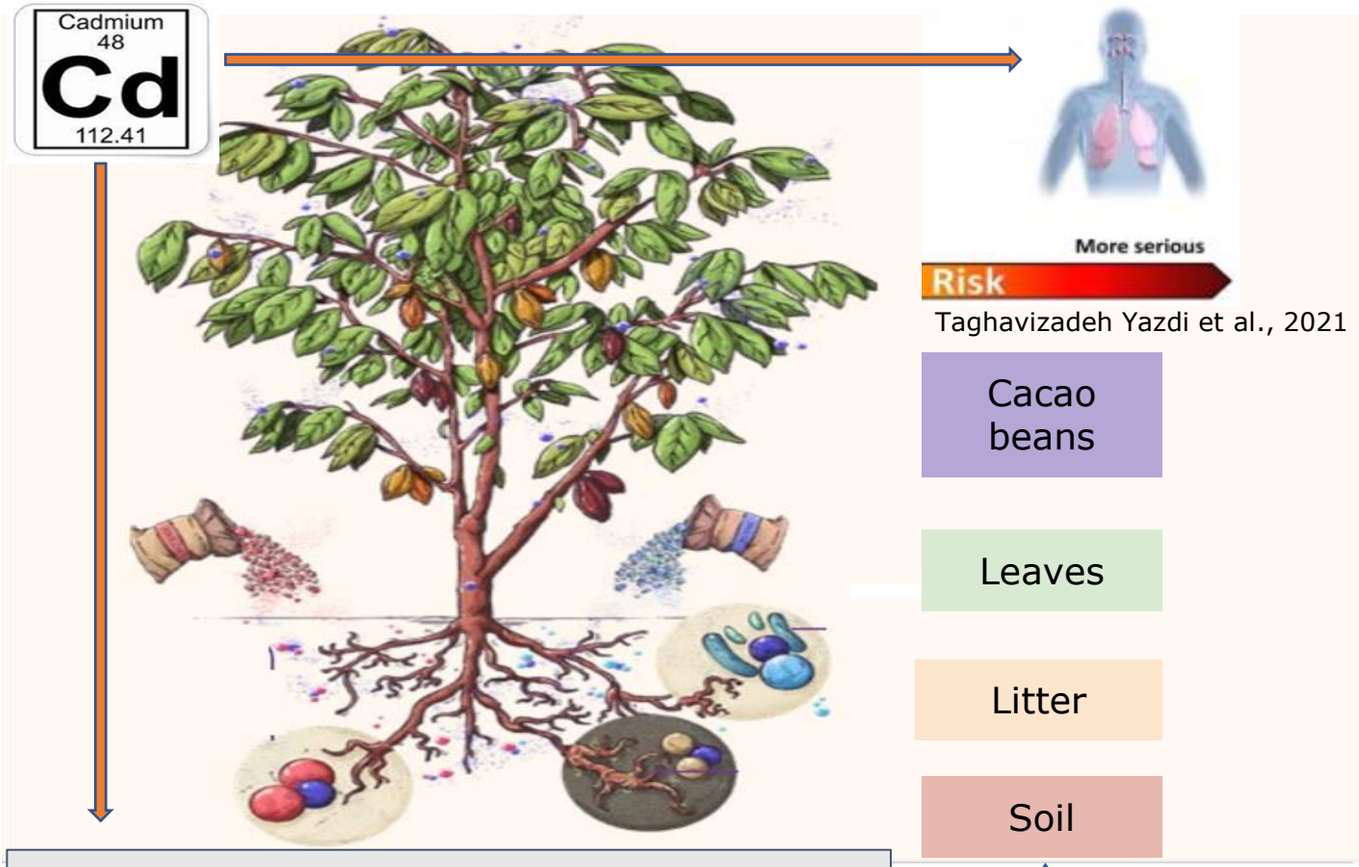
CONTENT

1. Introduction
2. Materials and methods
3. Results
4. Conclusions

INTRODUCTION



Cacao Cd contamination represents one of the greatest challenges for Colombia and other Latin American and the Caribbean countries.

Colombia Cd concentration in cacao beans **> 3 mg kg^{-1}** (maximum permissible level 0.5 – 1.1 mg kg^{-1}, E.U. regulation)

(Chávez *et al*, 2015; Vanderschueren et al., 2021)

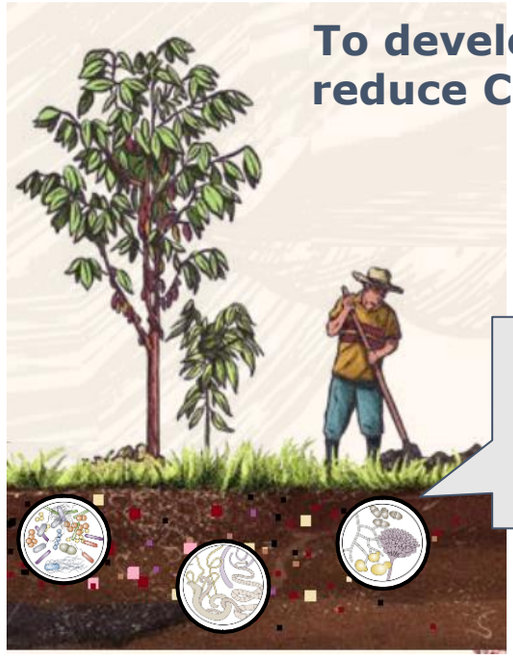
Cdt concentration in Colombian agricultural soils **> 10 mg kg^{-1}** have been reported.

(Bravo et al., 2021)

Cd limit values in soils by E.U.	
Total Cd (mg kg^{-1})	pH
0.5	< 6
1.0	< 7
1.5	> 7

(Ding et al., 2018)

INTRODUCTION

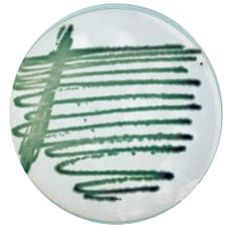


To develop strategies to reduce Cd uptake by the plant.

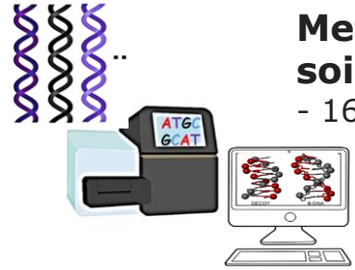
characterization of microbiomes associated with cacao soils

Soil microorganims play an important role in nutrient cycling, in bioremediation processes and in the rapid response to environmental changes

(Liu et al., 2020)



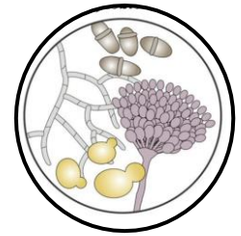
Cd-tolerant bacteria
- Bravo et al., 2018
- Cáceres et al., 2021
- Cordoba-Novoa et al., 2022



Metataxonomic cacao soils with Cd
- 16s: Cáceres et al., 2021

Cd-tolerant fungi
- Sandoval Pineda et al., 2020
- Guerra Sierra et al., 2022)

The Cd-tolerant fungi



- Mycelial networks
- Degradation lignocellulocic material
- Nutrient cycling (C, P)

- Fungi are resilient organisms and have a high capacity to develop tolerance mechanisms to abiotic stress conditions.

p.e. Heavy metal stress
- biosorption, bioprecipitation, and biotransformation

(Zeilinger et al., 2016)

INTRODUCTION

RESEARCH QUESTION

What is the composition of the fungal community present in cacao soils with different levels of total Cd?

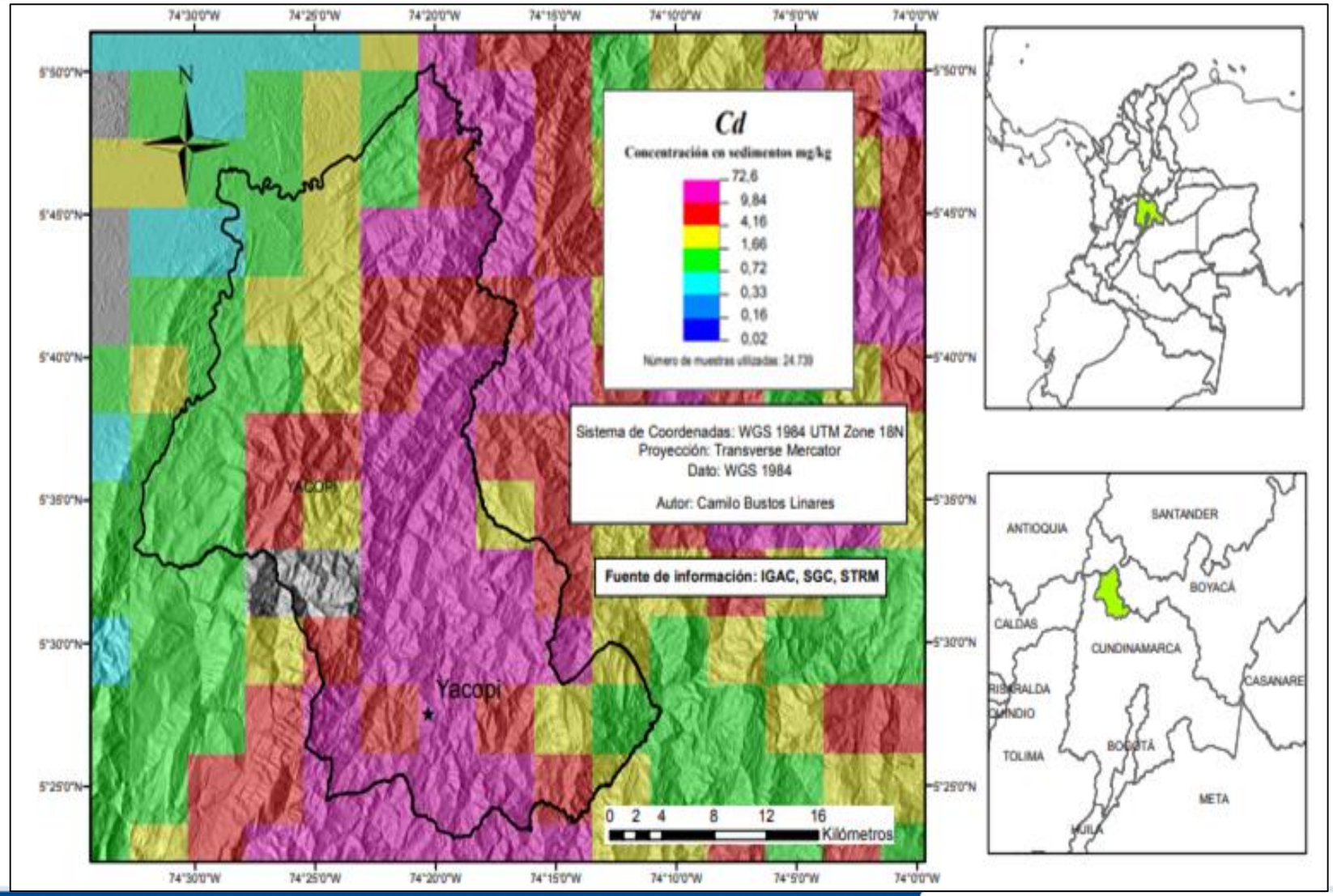
HYPOTHESIS

The presence of Cd and the physical and chemical properties of cacao soils affect fungal diversity and select Cd-tolerant fungi species.

AIM

To characterize the structural diversity of fungal communities present in cacao soils with different concentrations of natural Cd

MATERIALS AND METHODS



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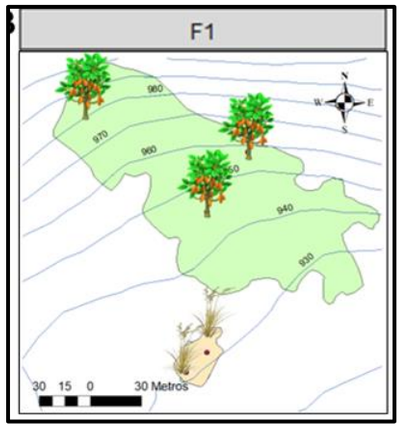
Rodríguez-Albarrcín et al. (2019)
High cadmium content in a cacao producing area of Central Colombia.

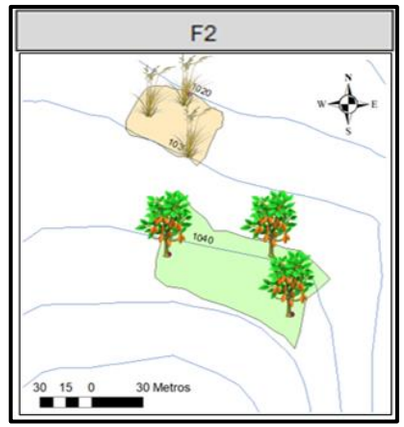
Sandoval Pineda et al. (2020)
High cadmium concentration resulted in low arbuscular mycorrhizal fungi community diversity associated to cocoa

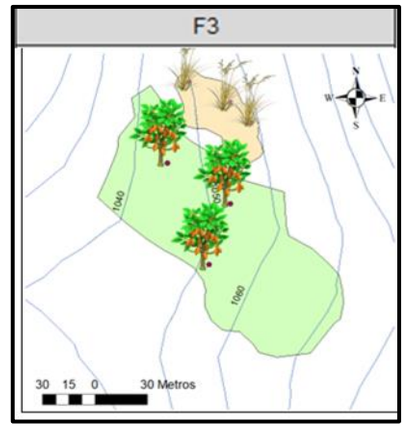
Cordoba-Novoa et al. (2022)
Cadmium-tolerant bacteria in cacao -Cultivated soils

Caceres & Torres. (2017)
Microorganismos cultivables asociados a cadmio (Cd) presentes en suelos cacaoteros

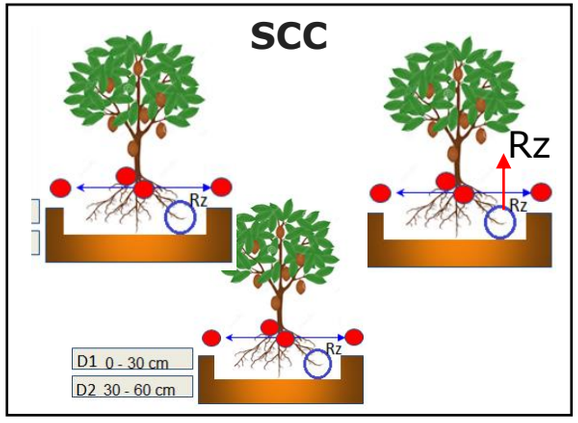
MATERIALS AND METHODS

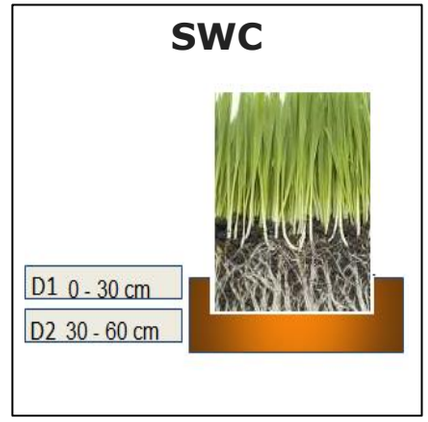






	SSC			SWC		TOTAL
	Rz	D1	D2	D1	D2	
F1	3	3	3	3	1	13
F2	3	3	3	3	1	13
F3		3	3	3	1	10
TOTAL	6	9	9	9	3	36





Soil Analysis

Texture, pH, ECEC, CO, Macro and microelements, Cd total and available

(Amacher, 2018; Rodríguez Albarrcín et al., 2019)

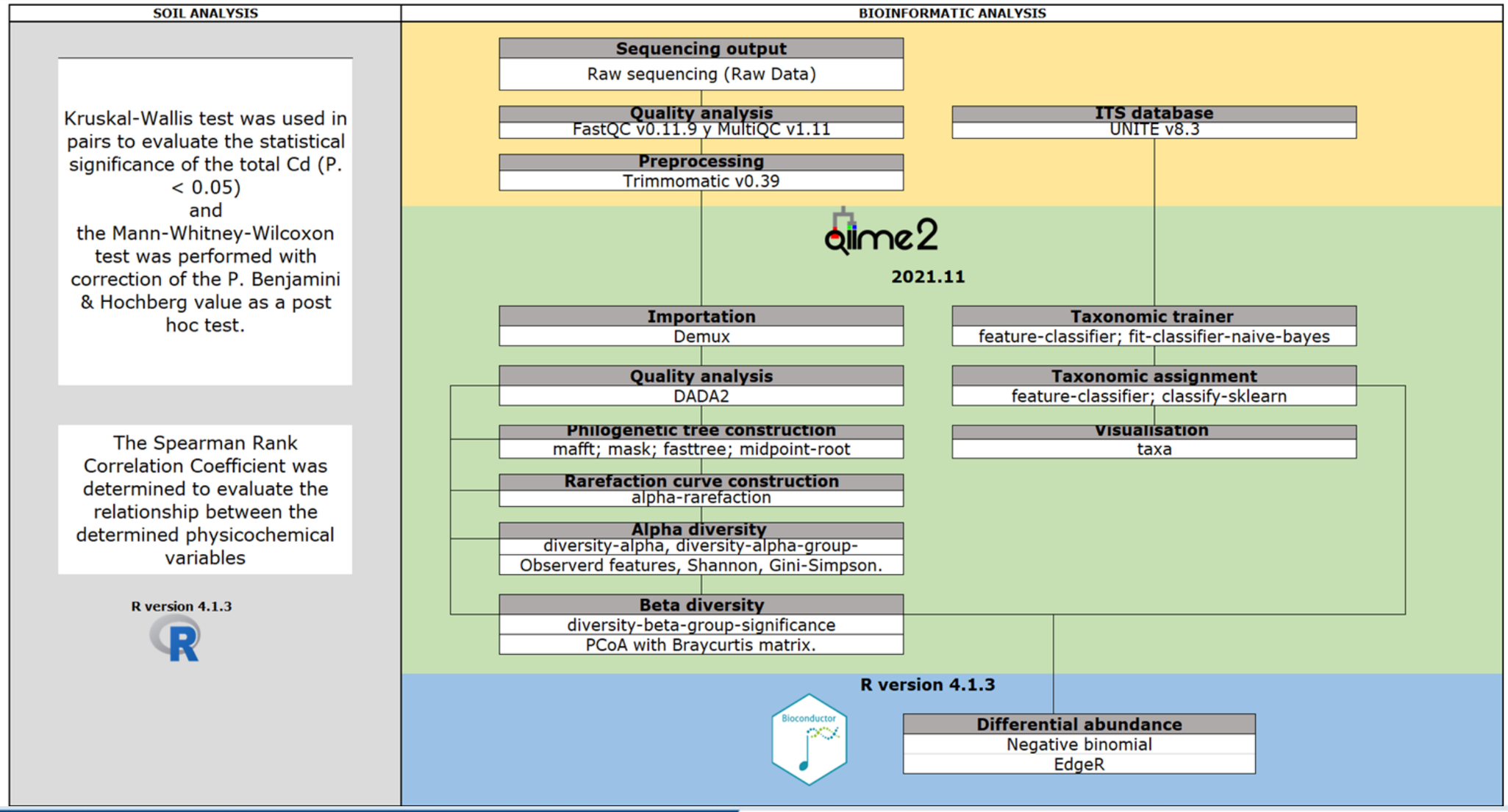
DNA extraction → **library** → **sequenciation**

DNeasy PowerSoil Pro Kit (Qiagen., Inc, Hilden, Germany)

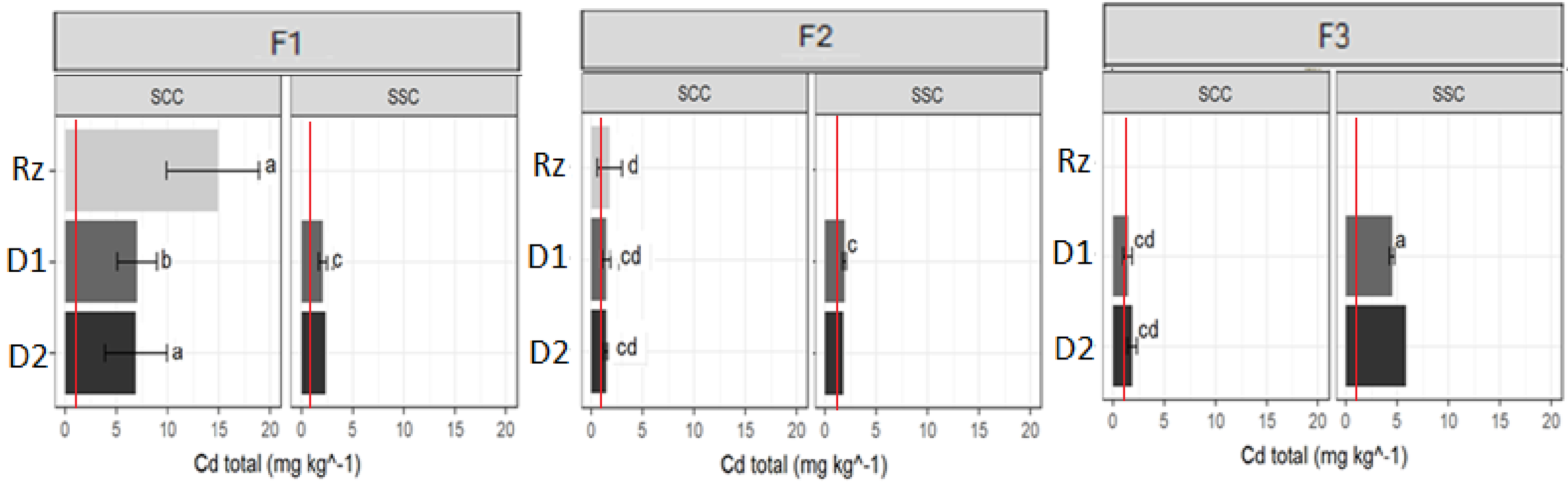
ITS3-KYO2 ITS4-KYO3 (Toju *et al.*, 2012)

MiSeq V3 x 600 cycles, 2 × 300 PE (Illumina, Inc., San Diego, CA, USA)

MATERIALS AND METHODS

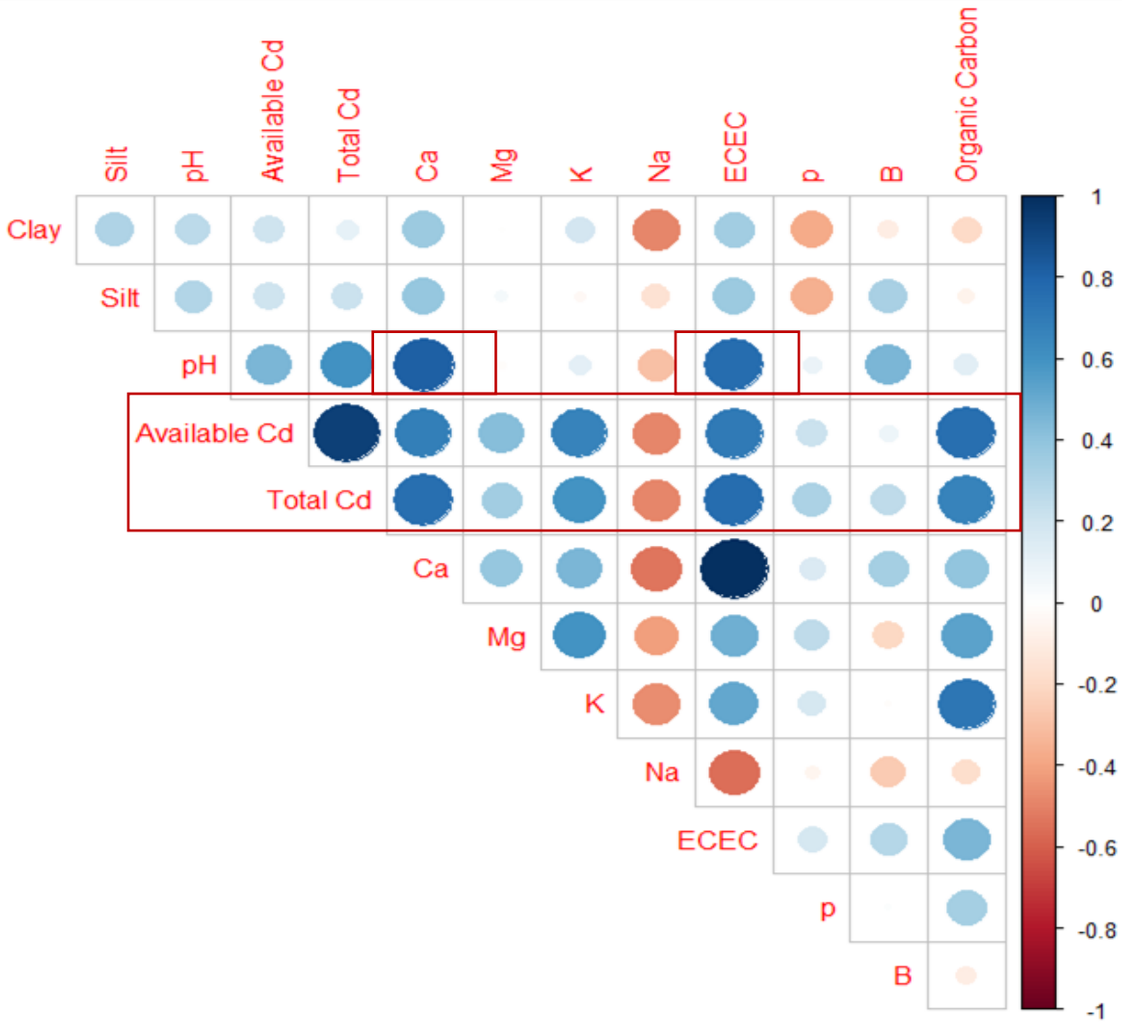


RESULTS: *Determination of Cd concentration and soil physicochemical analysis*



- The total Cd concentration in all the samples analyzed were higher than the maximum level allowed in agricultural soils reported by the European Union (0.5 - 1.5 mg kg^{-1}).
- The total Cd of F1 was statistically higher than F2 and F3.
- The rhizosphere of F1 was statistically different from D1 and D2.

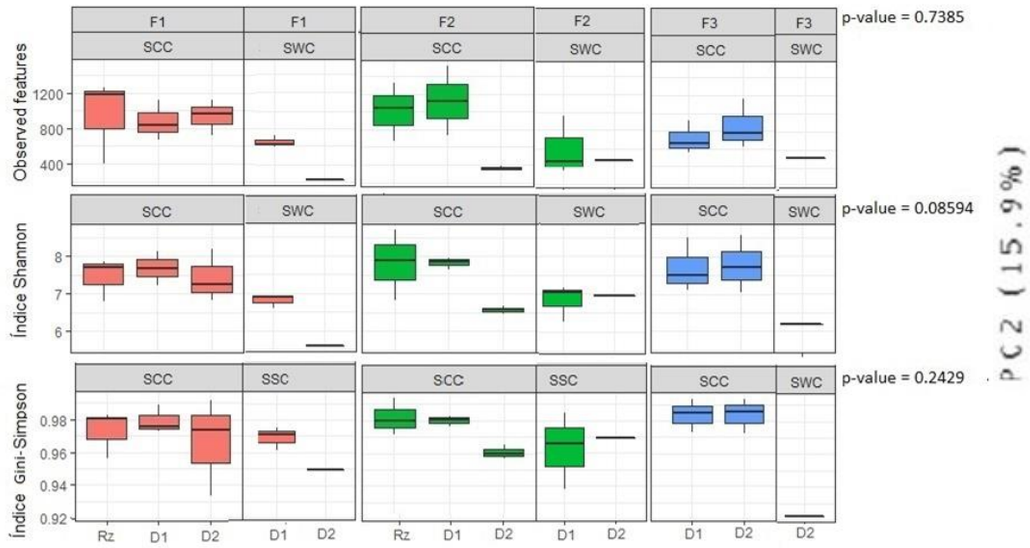
RESULTS: *Determination of Cd concentration and soil physicochemical analysis*



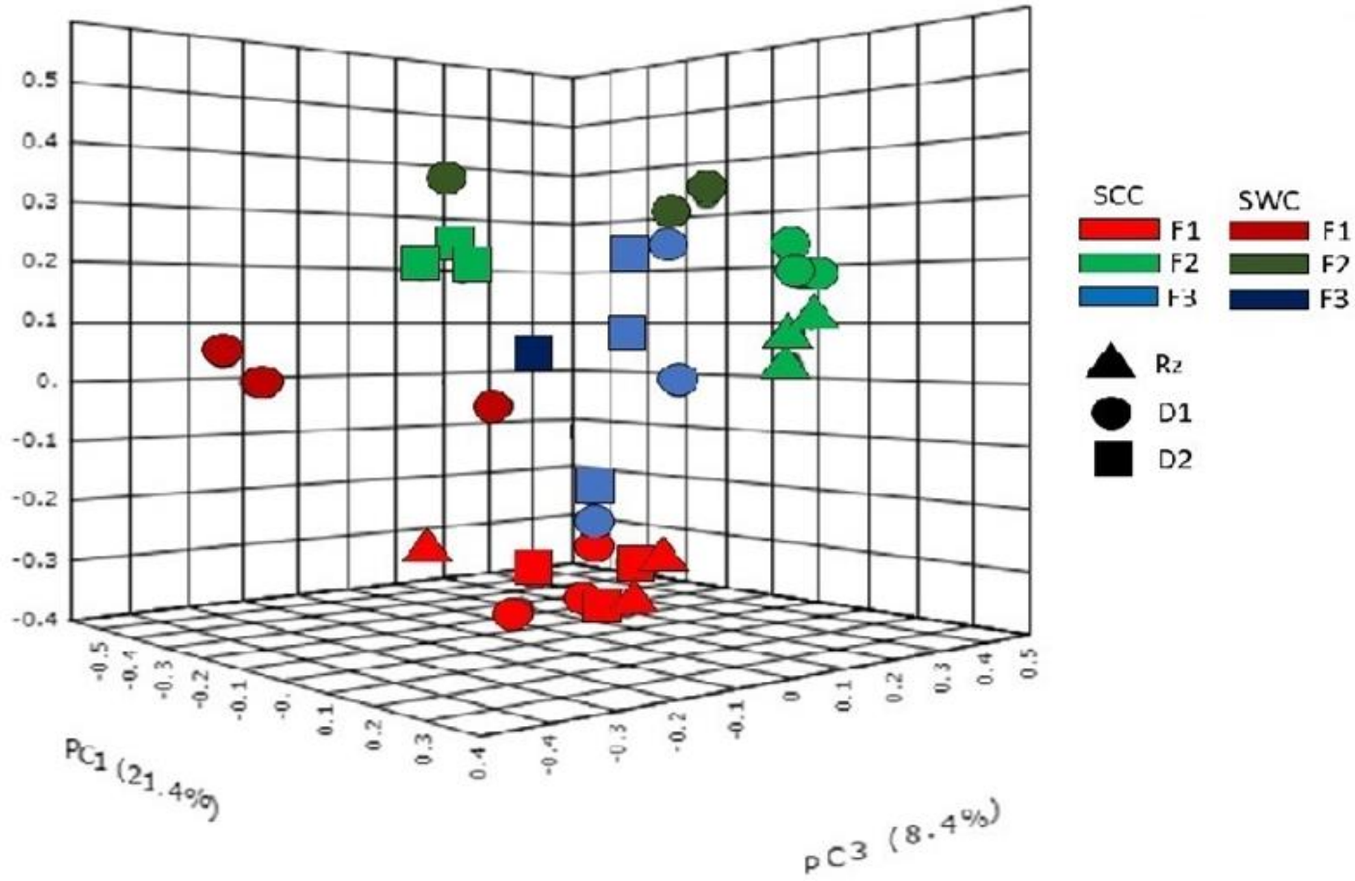
- The total Cd was positively correlated with available Cd, pH, ECEC, Ca and OC and Mg, K
- The pH also showed a correlation with Ca, ECEC and B
- Na was negatively correlated with the other variables

RESULTS: *Structural diversity of the fungal community present in cacao soils*

A

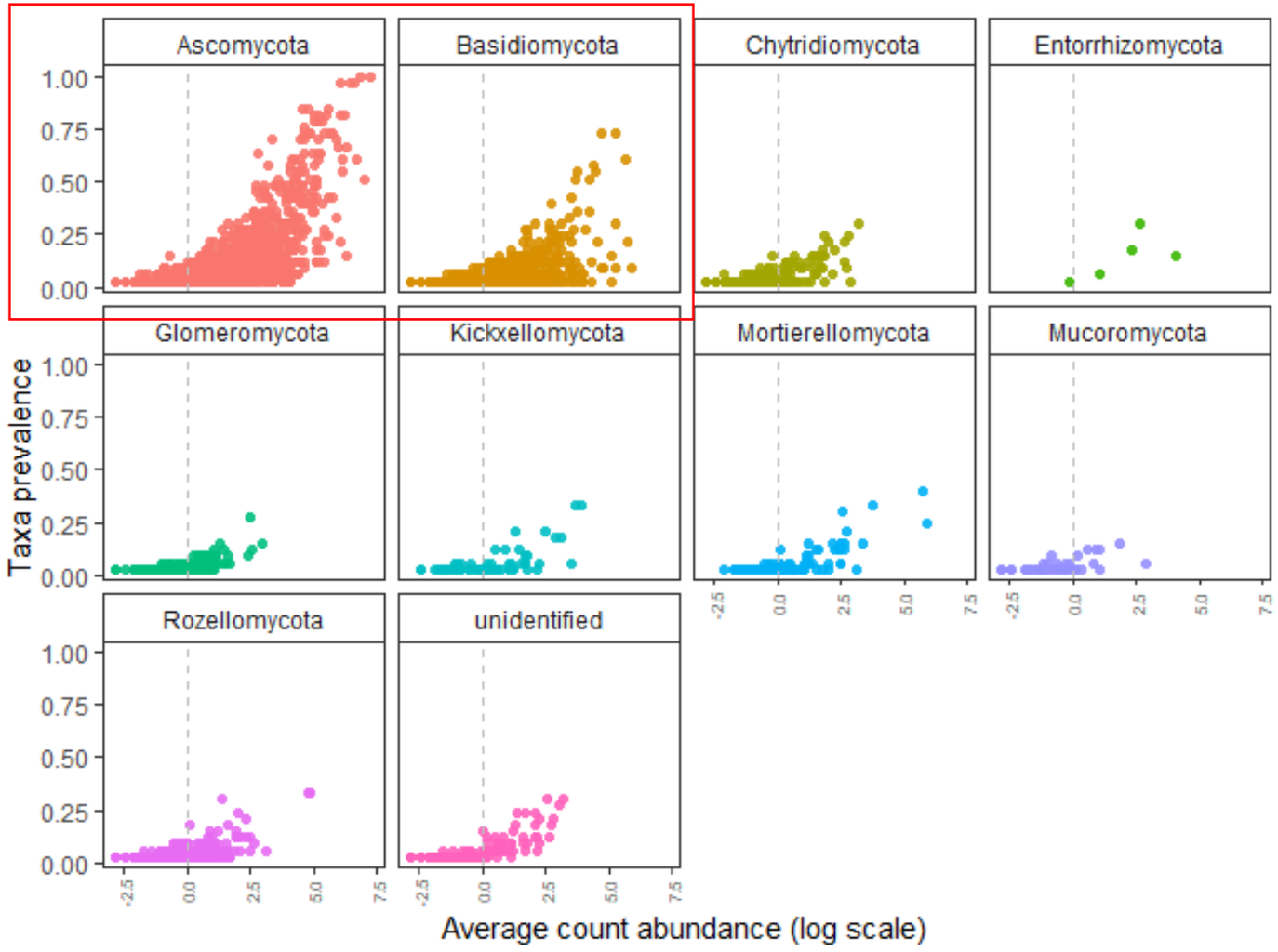


- Highly diverse and uniform soils.
- Higher diversity trend in SCC.



- The samples were grouped by farms, where Farm 2 and Farm 3 are more similar. Farm 1 was more distant.
- The SCC samples were separated from the SWC samples in F1.

RESULTS: *Structural diversity of the fungal community present in cacao soils*



16.013 ASVs were assigned

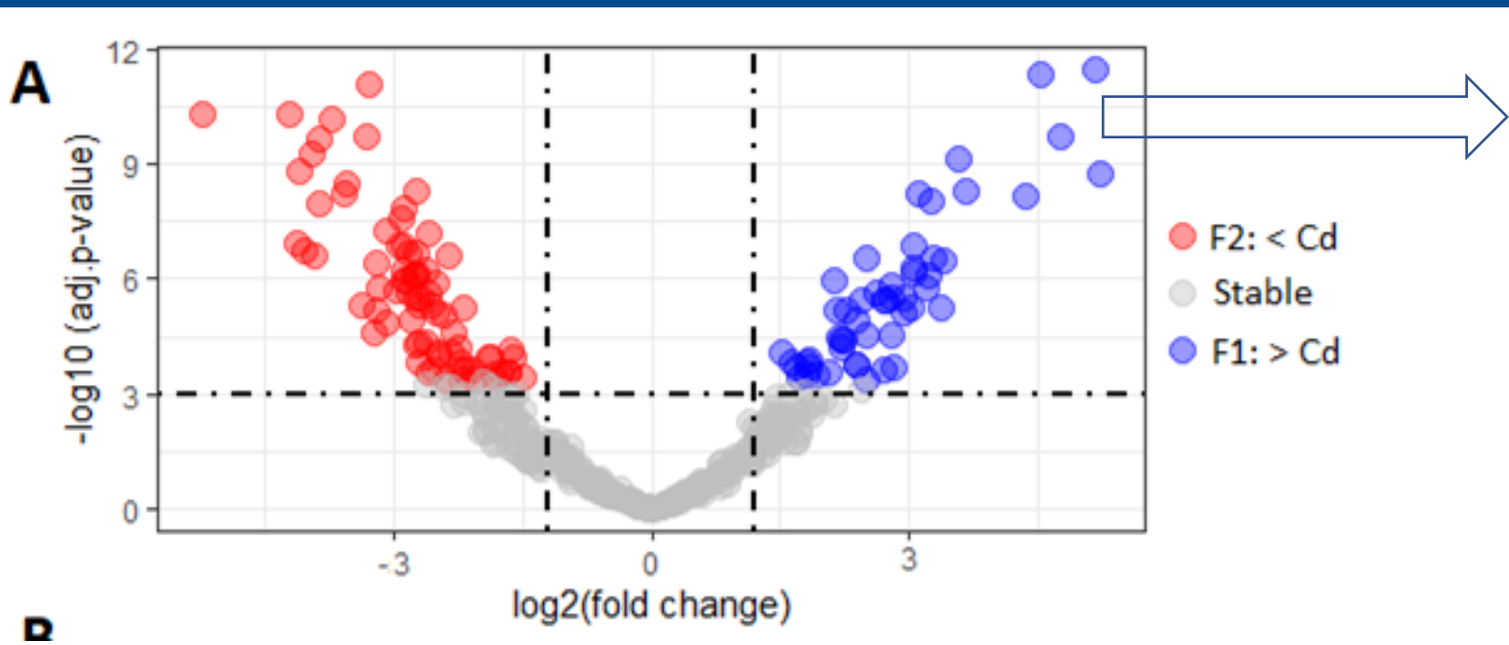
To carry out the taxonomic identification, the UNITE database version 8.3

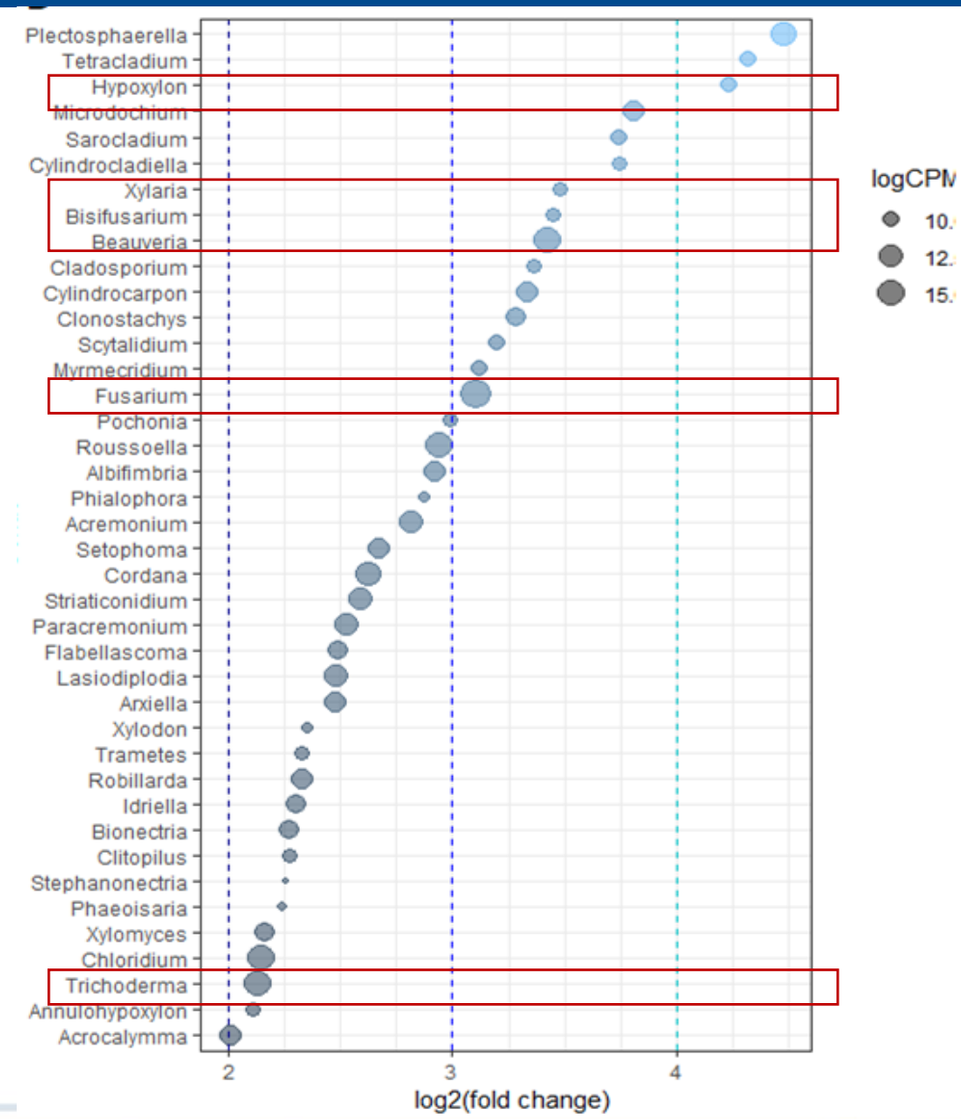
93% of the assigned ASVs corresponded to the phylum *Ascomycota* (68%) and *Basidiomycota* (25%).

- *Ascomycota* and *Basidiomycota* are the main soil decomposers.
- *Ascomycota* are saprophytic fungi that can decompose recalcitrant organic material,
- *Basidiomycota* that degrade lignin in plant residues.

(Sui et al., 2021)

RESULTS: *Structural diversity of the fungal community present in cacao soils*





- Fungi classified at the genus level presented a differential abundance between F1 (51) in relation to F2 (76).

- Total Cd could be affecting the structural diversity of the community.

CONCLUSIONS

- The distribution of Cd in the farms was heterogeneous, greater in the cacao crop, and independent of the depths analyzed.

- In the Rhizosphere of F1, higher total Cd content, more acid pH and higher OC content were found, but no differences in fungal diversity were found.

- Cd and soil physicochemical properties did not affect fungal community structure.

- Taxonomic assignment and differential abundance analysis showed more abundant genus in soils with higher total Cd concentration.

- 51 genera were identified as potential candidates for future bioremediation programs.

ACKNOWLEDGMENTS

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PURDUE UNIVERSITY

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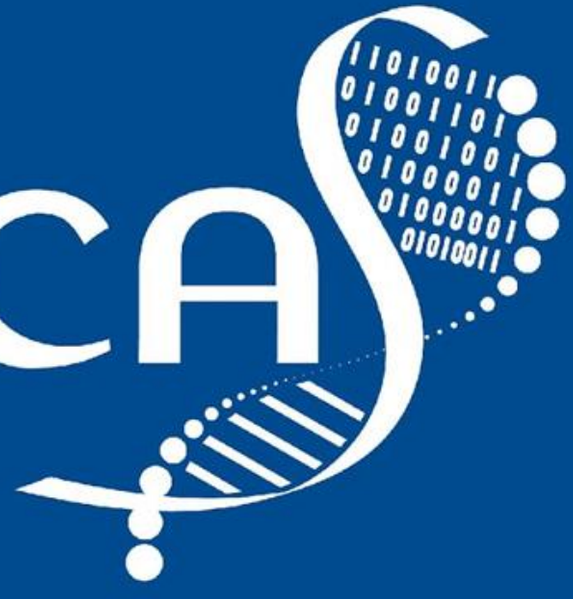

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