Biodiversity of arbuscolar mycorrhizae and chemical properties in soils of the Colombian coffee zone

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INTRODUCTION

Given the characteristics of the cultivated soils in Colombia and that coffee does not present a notorious response to phosphoric fertilization in the production phase (Uribe and Mestre, 1976), the presence of the Arbuscular Mycorrhizal Forming Fungi (AMF) in the seedling development stage contribute to the increase of growth, dry weight and absorption of nutrients and water (Sánchez, 1999). In accordance with the above considerations, the purpose of the present investigation (Bolaños-Benavides, 1996) was to estimate the relationship between the diversity and colonization parameters of AMF isolated from Colombian coffee soils with their chemical properties.

METHODS

A cluster sampling design was employed with sample allocation proportional to the number of lots at 10 Cenicafé experimental substations located in eight departments of Colombia (**Fig. 1**). Sampling was done between 0 and 20 cm deep, at three radial distances from the trunk. Three subsamples were taken to form a composite sample; a representative sample (3000 g/soil and 600 g/roots).

ID	Substation	Department	Batch	Samples
1	El Rosario	Antioquia	1	30
2	Naranjal	Caldas	4	120
3	Rafael Escobar		4	120
4	Santa Bárbara	Cundinamarca	8	240
5	Jorge Villamil	Huila	2	60
6	Paraguaicito	Quindío	2	60
7	La Catalina	Risaralda	1	30
8	La Trinidad	Tolima	3	90
9	Albán	Valle del Cauca	2	60
10	La Sirena		1	30
Total			28	840

Figure 1. Substations and amount of soil samples collected (Map: Wikimedia Commons, 2009).

AMF taxonomic identification according to their morphology was carried out, increasing the native inoculum in trap crops of *Brachiaria decumbens* and *Pueraria phaseoloides*.

Evaluation of the colonization level (%) by root staining (Phillips and Hayman, 1970) and spore density AMF (g/soil) by wet sieving and sucrose gradient (Gerdemann and Nicolson, 1963), were carried out. Chemical characterization analyses were performed on the 28 soils samples. Response variables and soil chemical parameters were subjected to a multiple linear regression analysis, selecting the parameters with a p-value lower than 10%; processing the data through the free software R.

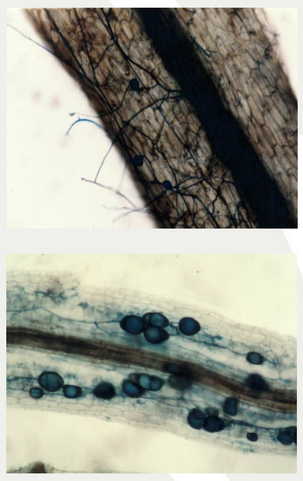

Fig. 2: AMF structures in roots: mycelium (left), vesicles and spores (right).

RESULTS

The soil presented pH ranges from 4.2 to 5.4; organic matter from 4% to 21%; real cation exchange capacity (CEC) from 8 to 38 cmol(+) kg^{-1}; nitrogen (N) from 0.2% to 0.9%; phosphorus (P) from 4 to 250 mg kg^{-1}; potassium (K) from 0.1 to 1.6 cmol(+) kg^{-1}; calcium (Ca) from 0,6 to 13,8 cmol(+) kg^{-1}; magnesium (Mg) from 0.1 to 2.7 cmol(+) kg^{-1}; iron (Fe) from 126 to 1.050 mg kg^{-1}; copper (Cu) from 0 to 39 mg kg^{-1}; manganese (Mn) from 5 to 222 mg kg^{-1}, and aluminium (Al) from 0.1 to 5.0 cmol(+) kg^{-1}. 20 species of AMF were identified in the Colombian coffee crops, belonging six genera; the colonization was between 14%-92% (Fig. 2 and Fig. 3).

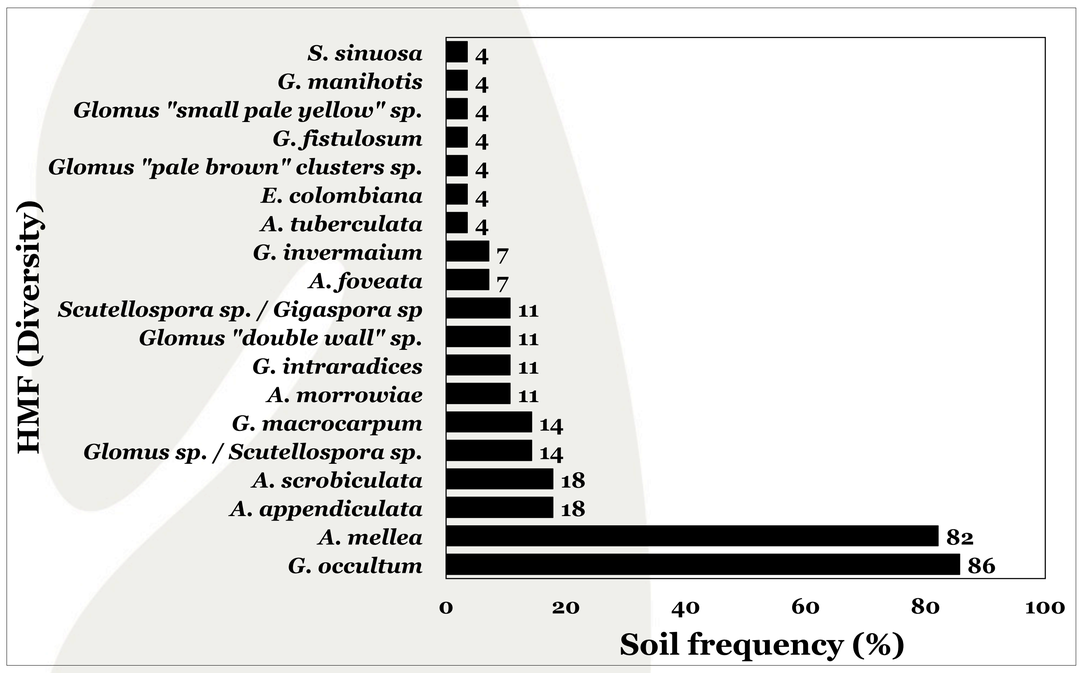

Fig. 3: HMF diversity in 28 soils cultivated with coffee in Colombia.

A positive effect of the pH, N and Fe; and negative of the organic matter (OM) and Mn on the total mycorrhizae diversity AMF) was observed; while the percentage of colonization (%AMF) was influenced by the content of P in the soil (negatively), and Fe and CEC (positively). The model related to spore density did not present significant parameters:

Species HFMA = -12,41 + 3,45pH + 12,46N – 0,55MO + 0,012Fe – 0,028Mn
(R^2 = 71%)

%AMF = -4,55 + 1,49CEC – 0,33P + 0,13Fe
(R^2=64%)

This study has verified the symbiosis between AMF and the rhizosphere of *C. arabica* and, therefore, showed that AMF should be considered as natural inhabitants of the coffee ecosystems by virtue of their presence and the variability of the chemical conditions of the soils evaluated. In order to guarantee the conservation of the soil resource as a natural living body, which serves as a support for plants, it is important the role played by different groups of organisms in processes of solubilization, mineralization, among others.

AGROSAVIA
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