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PRESENCE OF *GLOMUS AGGREGATUM* IN TWO PASTURE AGROECOSYSTEMS

Alexander Pérez Cordero[1*], Donicer E. Montes Vergara[2], Yelitza Aguas Mendoza[3]

[1*]Universidad de Sucre, Facultad de Ciencias Agropecuarias, Colombia, https://orcid.org/0000-0003-3989-1747
[2]Universidad de Sucre, Facultad de Ciencias Agropecuarias, Colombia, donicer.montes@unisucre.edu.co, https://orcid.org/0000-0002-2860-0505
[3]Universidad de Sucre, Facultad de Ingeniería, Colombia, yelitza.aguas@unisucre.edu.co https://orcid.org/0000-0003-4880-4510

***Corresponding Author:** Alexander Pérez Cordero
[*]Universidad de Sucre, Facultad de Ciencias Agropecuarias, Sincelejo, Sucre, Colombia, alexander.perez@unisucre.edu.co

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ABSTRACT
Although the importance of arbuscular mycorrhizal (AMF) plant-fungi symbiosis is recognized worldwide, there are some aspects of community structure and function in tropical pasture agroecosystems that have not been studied. In the Colombian Caribbean, most of the studies have been related to the benefits of symbiosis in different hosts, especially in aspects of productivity, plant nutrition and fertilizer substitution, which has allowed to determine the potential use of these microorganisms in conventional production systems or in clean production systems. The objective of this study was to isolate spores of arbuscular mycorrhizal fungi (AMF) associated with compacted and non-compacted rhizosphere of *Bothriochloa pertusa* (L) A. Camus from cattle farms in the municipalities of Sincelejo and Tolú and to establish the most predominant groups or species. The results show a higher abundance of AMF genera, corresponding to the genus Glomus in non-compacted soils of the two municipalities evaluated. The most adapted morphospecies found in both ecosystems was *Glomus aggregatum* Schenck & Smith, Koske, 1995, which is a morphospecies used as an inoculant for the improvement and productivity of tropical crops.

Keywords. Agroecosystem, kikuyo, arbuscular mycorrhizae, livestock soils**.**

INTRODUCTION
Arbuscular mycorrhizal fungi (AMF) establish symbiosis with plant roots, playing a key role in the recycling of ecosystem nutrients and plant protection against stress conditions, the elimination of pathogens and the decomposition of solid residues, which increases plant rooting, thanks to the production of phytohormones, enzymes and other phytoactive substances (Kaschuk et al., 2010); They also contribute to the improvement of soil structure and improvement of physico-chemical parameters to be taken into account when carrying out measurement, evaluation and sustainability studies, which makes them an optimal and sensitive indicator in soil quality monitoring (Schloter, 2003; Bending, 2004; Windinga, 2005; Sant'anna, 2009).

Most pasture soils in the Caribbean region of Colombia show deterioration due to indiscriminate logging, intoxication from the use of fertilizers and pesticides and overgrazing by livestock farming (Dane, 2010). In this region, cattle raising is the most representative economic activity in the department of Sucre, 84.9% of the land is dedicated exclusively to grazing, and its exclusive source of animal feed is native leguminous plants and grasses. Colosuana grass (*Bothrichloa pertusa* (L) A. Camus) is the predominant species in the region, where it reports an extensive sown area (approximately 274,005 ha); becoming the most economically important grass established in these soils as a feeding alternative (Chamorro, 1994; Sieverding, 1983).

Taking into account the above problems, it is necessary to isolate and evaluate the presence of spores and the most predominant morphospecies under two agro-ecological conditions (compacted and non-compacted soils) on livestock farms in the municipalities of Sincelejo and Tolú in the department of Sucre.

MATERIALS AND METHODS

- **Study site.** The present study is descriptive and was carried out in farms sown with kikuyo pasture dedicated to livestock and non-intervention forest areas located in the municipalities of Sincelejo and Tolú, in the Department of Sucre.
- **Sample selection.** The population will be made up of livestock farms planted with intensively grazed kikuyo grass and undisturbed native forest areas in the municipalities of Sincelejo and Tolú. The samples were collected in the first semester of the year 2021, during the rainy season, in two previously identified agroforestry zones (undisturbed native forest and degraded or compacted zone) established only with kikuyo grass (*Bothriochloa pertusa* (L) A. Camus). A representative sampling was carried out in the areas, taking 20 samples randomly at a depth of 0, 15 and 25 cm, collecting soil and roots at the same time. The samples were placed in plastic bags labelled with the name of the zone and date of collection. The samples taken from each agroforestry zone were divided into two equal portions for physicochemical and microbiological analysis.
- **Sample processing and spore isolation.** The soil samples were sieved to separate the coarse parts of the soil (stones, gravel) and roots. Once sieved, physical-chemical analysis and isolation of spores of arbuscular mycorrhizal fungi was carried out, using the technique proposed by Pérez et al., 2012. Spore counting was carried out by taking two millilitres of each sample, deposited in a nematode counting chamber (Nematodo de slide) (Menge, 1991) and three counts per sample were carried out to obtain an estimate of the total number of spores (Pérez et al., 2012; Epitia and Pérez 2016).
- **Taxonomic identity of AMF.** The isolated morphospecies were placed in Petri dishes, observed under a stereoscope to detail their characteristics in water, to verify and remove spores of other morphotypes and contaminating particles. Once the spores were cleaned and the morphospecies were verified, they were identified to genus level, using techniques proposed by Schenck and Pérez (1990), Morton (1996), Oehl et al. (2011); Pérez et al., (2012); Epitia and Pérez, (2016) and INVAM (2020).

RESULTS AND DISCUSSION

The results obtained for the quantity of spores per g of soil showed significant differences between the means of each municipality and type of soil analyzed. The highest quantities of spores were observed in the municipality of Sincelejo for compacted soils compared to Tolú. Likewise, according to Tukey's test, higher AMF density values were observed in non-compacted soils for the municipality of Sincelejo with respect to the other soils analyzed in Tolú.

Figure 1 shows the number of spores of arbuscular mycorrhizal fungi (AMF) isolated in compacted and non-compacted soils of cattle farms planted with *Bothriochloa pertus* (L) A. Camus grass in the municipalities of Sincelejo and Tolú. The amount of spores isolated in each agroecosystem indicates that under non-compaction conditions the presence of spores is higher for the cattle farms in the municipality and lower for those in the municipality of Tolú. Likewise, it is observed that under compaction conditions the quantity is reduced by approximately 35.94% in the soils of the cattle farms in the municipality of Sincelejo and 77.21% in the soils of the cattle farms in the municipality of Tolú.

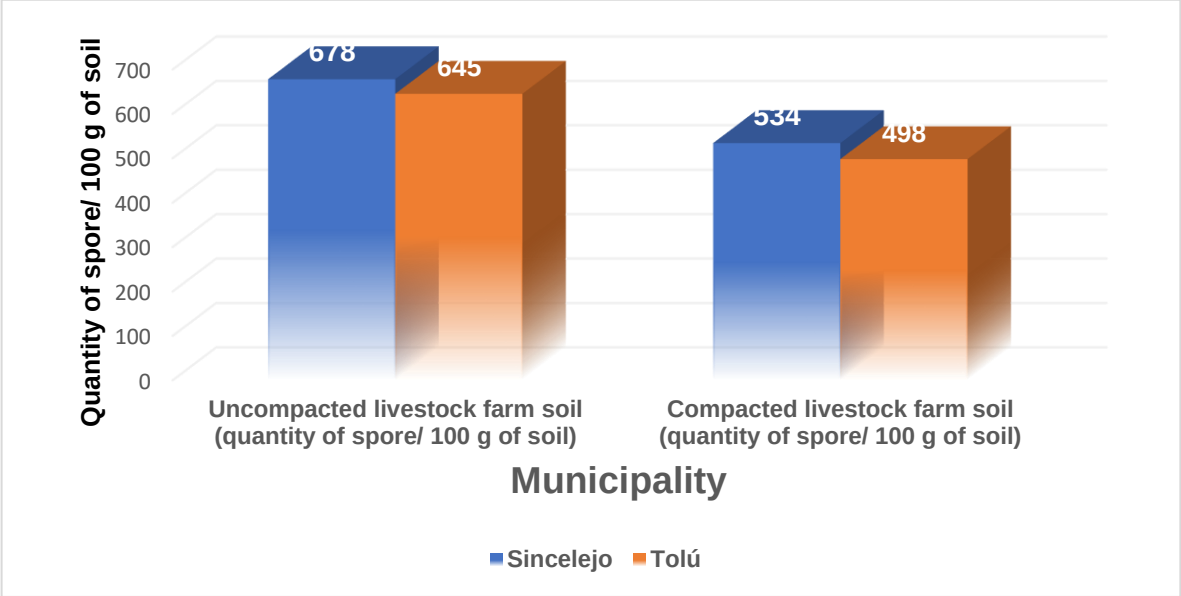


Figure 1. Number of spores of arbuscular mycorrhizal fungi in soils of livestock farms in compacted and non-compacted conditions in the municipalities of Sincelejo and Tolú, respectively.

The arbuscular mycorrhiza-forming fungi species known as *Glomus aggregatum* Schenck & Smith, Koske, 1995 (Figure 2 y 3) and other members of Glomeromycota may also help in soil detoxification processes and ecosystem-level metabolic pathways. For example, an experiment in 2010 showed that root-mycorrhizal interface was significantly more successful at detoxifying arsenic-laced soils than non-associated roots. The study showed that the presence of *G. aggregatum* methylated the arsenic in the soil, but that indigenous soil microorganisms were responsible for further detoxification of dimethylarsinic acid into trimethylarsine oxide (Ultra et al., 2007).
Figure 2 shows the characteristics of the morphospecies of arbuscular mycorrhizal fungi (Glomus aggregatum Schenck & Smith, Koske, 1995) isolated from the rhizosphere of compacted soil in the municipality of Tolú, department of Sucre, Colombia.

<table>
<tr><td colspan="2">Morphospecies: Glomus aggregatum</td><td>OBJ 40 X</td></tr>
<tr><td colspan="3">DESCRIPTION OF THE SPORE:</td></tr>
<tr><td colspan="2">Shape: Globose Diameter (µm): 115 Color: Aqua: Brown
L.V.P.: light brownish yellow
Cytoplasmic content:
Granular-filamentous Surface structure: Smooth
Composition and type of wall: Number of layers: 2 layers: Inner: light yellow with a lamellar appearance.
Outer: dark yellow with a smooth appearance
Wall width ((µm): 4</td><td>  </td></tr>
<tr><td>Hyphal junction width: Hyphal diameter (µm): 16.9
Pore diameter (µm): 6.8</td><td colspan="2">Taxonomic determination:
Genus: Glomus Clado Ab 2
morphospecies: Characteristics similar to Glomus aggregatum Schenck & Smith, 1985</td></tr>
<tr><td colspan="3">Additional Remarks: Two spores joined by hyphal connection.</td></tr>
</table>

Figure 2. Morphological characteristics of *Glomus aggregatum* Schenck & Smith, 1985, isolated in the municipality of Sincelejo, department of Sucre, Colombia.

Figure 3 shows the characteristics of the morphospecies of arbuscular mycorrhizal fungi (Glomus aggregatum Schenck & Smith, Koske, 1995), isolated from the rhizosphere of compacted soil in the municipality of Sincelejo, department of Sucre, Colombia.

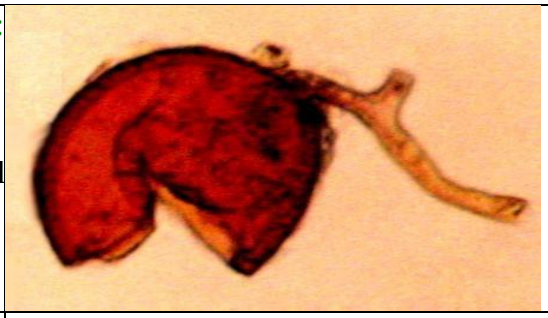
<table>
<tr><td colspan="2">Morphospecies: Glomus aggregatum</td><td>OBJ 40 X</td></tr>
<tr><td colspan="3">DESCRIPTION OF THE SPORE:</td></tr>
<tr><td colspan="2">Shape: Globosa Diameter (µm): 158.5 Color:
Water: Coffee
P.V.L: Semi-dark brown yellow
Cytoplasmic content: Granular
Surface structure: smooth Composition and wall type: Number of layers: 1 layers: only
Wall width (µm): 6.5</td><td>  </td></tr>
<tr><td>Width and type of hyphal junction: Hyphal diameter (µm): 32.5 Pore diameter (µm): 13</td><td colspan="2">Taxonomic determination:
Genus: Glomus Clado Ab 2
morphospecies: Characteristics similar to Glomus aggregatum Schenck & Smith, 1985</td></tr>
<tr><td colspan="3">Additional remarks: Hypha bifurcate. Spore fragmented</td></tr>
</table>

Figure 3. Morphological characteristics of Glomus aggregatum Schenck & Smith, 1985, isolated in the municipality of Tolú, department of Sucre, Colombia.

According to the isolation of spores of arbuscular mycorrhizal fungi associated with *Bothriochloa pertus* (L) Camus from the municipality of Sincelejo, 30 morphospecies were identified with microscopically similar characteristics (cf) to species according to taxonomic keys determined by Oehl et al. (2011), Oehl and Sieverding (2011), INVAM (2020), Peña (2006), which were taxonomically classified into 11 possible genera: Claroideoglomus, Viscospora, Glomus Ambispora, Gigaspora, Funneliformis, Intraspora, Tricispora, Acaulospora, Diversispora, Simiglomus, of which 48% corresponds to the genus Glomus, followed by the genera Claroideoglomus and Diversispora with 10%, Viscospora and Gigaspora with 7% and with a value of 3% morphotypes, corresponding to the genera Ambispora, Funneliformis, Intraspora, Tricispora, Acaulospora, Simiglomus.

The isolation of spores present in compacted and non-compacted soils associated with *Bothriochloa pertusa* (L) A. Camus grass in the municipality of Tolú, identified 12 morphospecies with microscopically similar characteristics (cf) to species according to taxonomic keys determined by Oehl et al. (2011), Oehl and Sieverding (2011), INVAM (2013), Peña (2006), classified in the following genera: Glomus Clado ab, Glomus Clado ab1, Glomus and Simiglomus, of which 70 % corresponds to the genus Glomus, followed by the genera Glomus clado ab.

The results obtained determined that the greatest presence of morphospecies in the compacted and non-compacted soils of the two municipalities studied corresponded to the genus Glomus, followed by other genera to a lesser extent. The soils in which the greatest quantity and/or richness of AMF in relation to genera was isolated were found in the municipality of Sincelejo, while those with the least richness corresponded to the municipality of Tolú. The richness composition of arbuscular mycorrhizal fungi in soils under different coverages is different, since vegetation, as an obligate host for arbuscular mycorrhizae, has a direct effect on the diversity of their populations (Schenck et al., 1989; Peña-Venegas et al., (2007).

CONCLUSION

The greatest number of spores of arbuscular mycorrhizal fungi (AMF) were isolated in the municipality of Sincelejo in non-compacted soils of cattle farms compared to the municipality of Tolú,

where the salinity of the soils could be an unfavorable abiotic condition for the growth and adaptability of the spores of these fungi. Likewise, a greater presence of AMF was observed in compacted soils in this municipality than in the municipality of Tolú. Glomus aggregatum is a morphospecies of arbuscular mycorrhizal fungus used as a soil inoculant in agriculture and fruit growing. Like other species of this phylum, it forms an obligate symbiosis with plant roots, where it obtains carbon from the host plant in exchange for nutrients and other benefits**.**

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AUTHOR CONTRIBUTION. Alexander Perez Cordero: experiment execution, data analysis. Donicer Montes V and Yelitza Aguas M, conceptualization, writing - revision and editing. All authors have read and approved the manuscript.

CONFLICT OF INTEREST. All the authors of the manuscript declare that they have no conflict of interest.

REFERENCES

1. Bending G, Turnera M, Raynsb F, Marxcand M, Wood M. 2004. Microbial and biochemical soil quality indicators and their potential for differentiating areas under contrasting agricultural management regimes. Soil Biology and Biochemistry. 36(11):1785-1792. https://www.sciencedirect.com/science/article/abs/pii/S0038071704001671**.**
2. Chamorro D. 1994. Informe final de investigaciones en forrajes tropicales. CORPOICA. Grupo Regional Pecuario. P 131.
3. DEPARTAMENTO ADMINISTRATIVO NACIONAL DE ESTADISTICA (DANE). Encuesta Nacional Agropecuaria, Resultados 1995, Costa Atlántica, 1996, p. 16. https://biblioteca.dane.gov.co/media/libros/LD_4039_1995_EJ_3.PDF
4. Espitia Doria F., Pérez Cordero A. 2016. Diversidad de hongos formadores de micorrizas arbusculares (HMA) en tres agroecosistemas con pasto colosoana (Bothriochloa pertusa (L) A. Camus) en el departamento de Sucre. Rev Colombiana Cienc Anim; 8(1):72-81.
5. INTERNATIONAL CULTURE COLLECTION OF VESICULAR ARBUSCULAR MYCORRHIZAL FUNGI-INVAM. 2020. General life cycle and the structures formed. Web http://invam.caf.wvu.edu/. Julio/13/2021.
6. Kaschuk G, Alberton O, Hungria M. 2010. Three decades of soil microbial biomass studies in Brazilian ecosystems: Lessons learned about soil quality and indications for improving sustainability. Soil Biology and Biochemistry. 42(1):1-13. https://www.sciencedirect.com/science/article/abs/pii/S0038071709003095
7. Morton, E. 1996. Classification and identification of mycorrhizal fungi- INVAM, Firs ICOM Workhosp. Wirginia, USA, p. 1-5.
8. Oehl F, Alves da Silva G, Tomio B, Sieverding E.2011 Glomeromycota: three new genera and glomoid species reorganized. Mycotaxon. 116:75-120. doi: 10.5248/116.75. https://www.ingentaconnect.com/contentone/mtax/mt/2011/00000116/00000001/art00011?crawler=true
9. Pérez C. Alexander., Botero Catalina, Cepero Maria. 2012. Diversidad de micorrizas arbusculares en pasto colosuana (Bothriochloa pertusa (L) A. Camus de fincas ganaderas del municipio de Corozal-Sucre. Rev.MVZ Córdoba 17(2):3024-3032. file:///C:/Users/Alexander%20P%C3%A9rez/Downloads/cindycs,+V17N2A10%20(1).pdf
10. Peña-Venegas C, Cardona G, Arguelles J, Arcos A.2007. Micorrizas arbusculares del sur de la amazonia colombiana y su relación con algunos factores fisicoquímicos y biológicos del suelo. Acta Amazónica. 2007. vol.37(3):327-336. DOI:10.1590/S0044-59672007000300003

11. Sant'anna S, Fernandes M, Ivo W, Costa J. 2009. Evaluation of Soil Quality Indicators in Sugarcane Management in Sandy Loam Soil. Pedosphere.
12. 19(3):312-322. https://doi.org/10.1016/S1002-0160(09)60122-3Get rights and content
13. Schloter M, Dilly O, Munch J.C. 2003. Indicators for evaluating soil quality. Institute of Soil Ecology, GSF-National Research Center for Environment and Health, Ingolstadter Landstr. 1, 85764, Neuherberg, Germany. Agriculture Ecosystems & Environment. 98(1-3):255-262.
14. Schenck, N.; Perez, Y. 1990. Manual for the identification of VA mycorrhizal fungi. Tercera Edición. USA: Synergistic Publications. USA.
15. Sieverding E. 1983. Manual de métodos para la investigación de las micorrizas arbusculares en el laboratorio. Centro Internacional de Agricultura Tropical, CIAT. p. 121.
16. Ultra, Venecio U. Y.; Tanaka, Sota; Sakurai, Katsutoshi; Iwasaki, Kōzō (August 2007). "Arbuscular mycorrhizal fungus (Glomus aggregatum) influences biotransformation of arsenic in the rhizosphere of sunflower (Helianthus annuusL.)". Soil Science and Plant Nutrition. 53 (4): 499–508. doi:10.1111/j.1747-0765.2007.00143x
17. Windinga A, Hund-Rinkeb K, Rutgers M. 2005. The use of microorganisms in ecological soil classification and assessment concepts. Ecotoxicology and Environmental Safety. 62(2):230-248. https://www.sciencedirect.com/science/article/abs/pii/S0147651305000746.