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Colonization Efficiency Of Mycorrhizae-Forming Fungi In Two Different Edaphoclimatic Conditions Of Colosoana Grasslands

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

[1] *Universidad de Sucre, Facultad de Ciencias Agropecuarias, Colombia*
**corresponding author: alexander.perez@unisucre.edu.co*
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

ABSTRACT

The present study was carried out in cattle farms in two localities of the department of Sucre, Colombia, established with colosoana grass (Bothriochloa pertusa (L) A. Camus) with the objective of determining the percentage of colonization of arbuscular mycorrhizal fungi (AMF) in roots of this grass species. Soil samples with roots were collected from cattle farms in the municipality of Sincelejo and San Marcos, from which the percentage of AMF colonization in roots was determined. The results of the analysis of variance for the percentage of colonization in roots of Colosuana grasses showed that there were statistically significant differences ($p<0.001$) in the samples analyzed, reporting values from 38 ± 44.17% in the municipality of San Marcos to 69 ± 71.17% in the municipality of Sincelejo. The results obtained show that mycorrhizal fungi colonize colosoana grass under different climatic conditions.

Keywords. Fungi, soil, roots, pasture, municipalities.

1. INTRODUCTION

Bothriochloa pertusa (L) A. Camus, rapidly colonizes different livestock lands, displacing other cultivated species (Piñeros et al., 2011). The main economic activity in the department of Sucre is dual-purpose livestock farming, in which 84.9 % of its territory is dedicated exclusively to cattle grazing, where the exclusive source of animal feed is native legumes and grasses. Colosoana grass (Bothriochloa pertusa (L) A. Camus) is one of the most predominant pasture species in the department (Aguilera, 2005).

The establishment of symbiosis will depend on the interactions between three components of the system: the fungus, the plant and the environmental conditions. Their presence implies that processes of recognition between the symbionts, compatibility and specificity occur, which condition their expression and lead to the morphological and functional integration of the associations. Three phases can be distinguished in the process of symbiosis formation: Pre-colonization, initial penetration of the fungus, intraradical colonization and development of the external

mycelium and reproductive structures (Sánchez et al., 2002).

The importance and applicability of arbuscular mycorrhizal (AMF) plant-fungi symbiosis is evident in the global context of agricultural sustainability, although there are some aspects of community structure and function in tropical agroecosystems that have not been studied. In Colombia, 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 determining the potential use of these microorganisms in conventional production systems or in clean production systems (Rey et al., 2005).

In studies on in situ colonization of mycorrhizae in pastures carried out on cattle farms in the department of Sucre, Pérez et al. (2010) determined by means of mathematical models that the percentages of nitrogen, calcium and potassium are the chemical parameters that most influence the phenomenon of colonization of mycorrhizae-forming fungi associated with the rhizosphere of Angletón grass. Likewise, the results for the percentage of colonization in roots of Colossean and Angleton grass found that the highest colonization percentages were for Colossean grass (36.9±79.09%) with respect to Angleton grass (33.3±72.72%) in the five locations analyzed (Pérez et al., 2016).

However, to date no comparative studies have been carried out on the effect of environmental conditions on the colonization of AMF associated with roots of colosoana grass species in two geographical locations in the department of Sucre. For this reason, this research will contribute to the knowledge of this type of associations, to create a starting point for future research at the biodiversity level on these microorganisms and their potential use as biofertilizers in crops of economic importance for livestock, proposing and developing strategies for the rational use and management of available soil resources, optimizing the productivity of the soil-plant-animal system.

Based on the above situation, the alternative proposed was to determine the percentage of colonization of arbuscular mycorrhizal fungi in roots of colosoana grass under two agroclimatic conditions of livestock farms in the department of Sucre, Colombia.

2.1 MATERIALS AND METHODS

- **Study site.** The present study was carried out on the soil of livestock farms belonging to the municipalities of Sincelejo (197 metres altitude; Latitude: 9.3. Longitude: -75.4. Latitude: 9° 18' 0" North Longitude: 75° 24' 0" West) and San Marcos (Latitude: 8.667; Longitude: -75.133; Latitude: 8° 40' 1" North; Longitude: 75° 7' 59" West) sown exclusively with colosoana grass.
- **Sampling.** One hundred cattle farms distributed in two municipalities (Sincelejo and San Marcos) with predominantly colosoana grass pasture were randomly selected. Random sampling was carried out in each cattle farm. Ten complete plants (including roots) of each pasture were collected at each site (Pérez et al., 2016). Samples were identified and stored for transport to the Microbiological Research Laboratory of the University of Sucre and processed within 24 hours after collection. Roots were separated from each plant to determine the percentage of AMF colonization.

- **Determination of the percentage of AMF colonization.** The percentage of

colonization was determined by taking roots of 1 cm in length and depositing them in previously sterilized bottles, the roots were washed several times with water, using the technique proposed by Pérez (2016) for staining. The technique consisted of adding 10% KOH solution for a period of 24 hours, after which the samples were washed three times with sterile water to eliminate excess reagent, 1% HCl was added for 30 minutes, the roots were washed with sterile water and finally trypan blue was added at 0.1% in Lactophenol. The roots colored by this technique were taken in groups of 10 roots, placed parallel to each other on the slides, covered with coverslips and observed under the microscope with a 40X objective, in order to count them in 100 fields in an orderly manner. The positive field determined the type of colonizing structure such as: arbuscules, vesicles, hyphae and spores; and the negative field indicated the absence of colonizing structures. The following equation (E1) was used to determine the percentage of colonization of each sample:

$$\%\ \textbf{of colonization}(\textbf{E1}) = \frac{\text{Number of infected fields x } 100}{\text{Total Number of observed fields } (+ \text{ or } -)}$$

3. RESULTAS AND DISSCUSION

Figure 1 shows the main colonization structures used by AMF in colosoana grass roots under 40 X light microscopy.

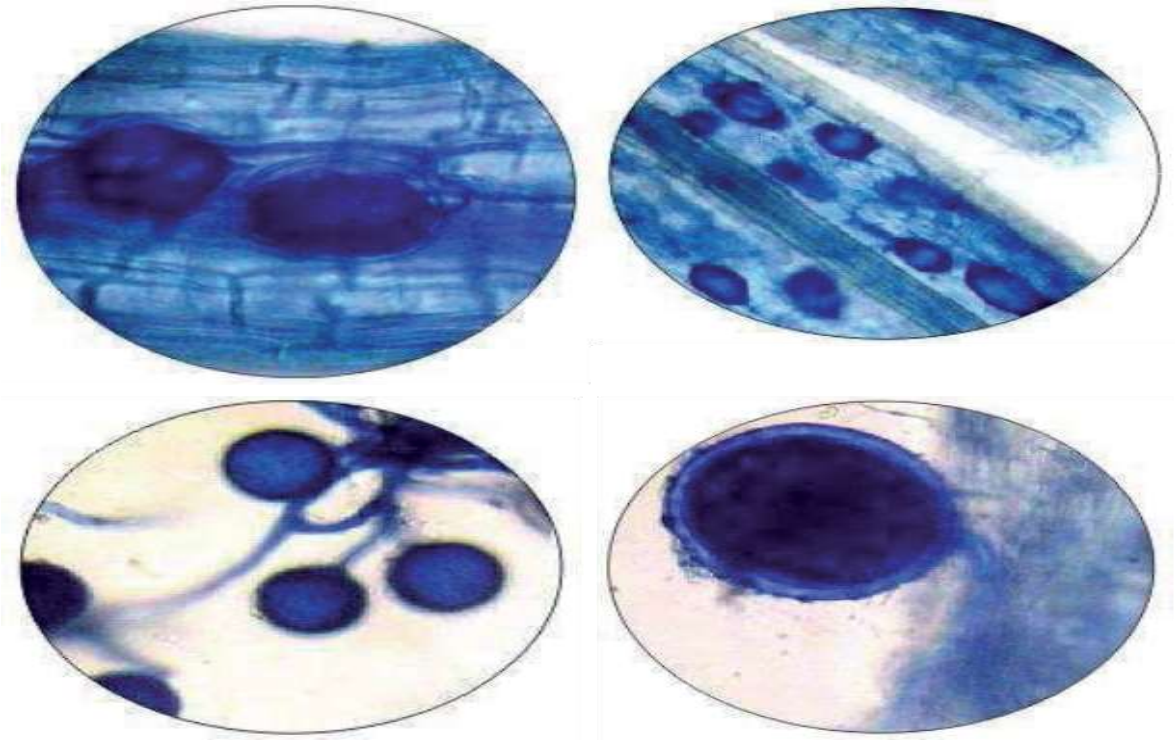

Figure 1. Colonizing structures of arbuscular mycorrhizal fungi on roots of Bothriochloa pertusa (L) A. Camus. Source: Pérez, 2021.

The results found for the percentage of colonization of colosoana grass roots by AMF show significant differences between the means of each municipality analyzed ($p<0.001$). The highest colonization percentages were reported in soils from cattle farms located in the municipality of Sincelejo compared to soils from cattle farms located in the municipality of San Marcos (figure 2). The level of AMF root colonization varied widely in the study, from 38 ± 44.17% municipality of San Marcos to 69 ± 71.17% municipality of Sincelejo. It is also observed that there is a difference between the percentages of colonization in the same colosoana grass according to the locality.

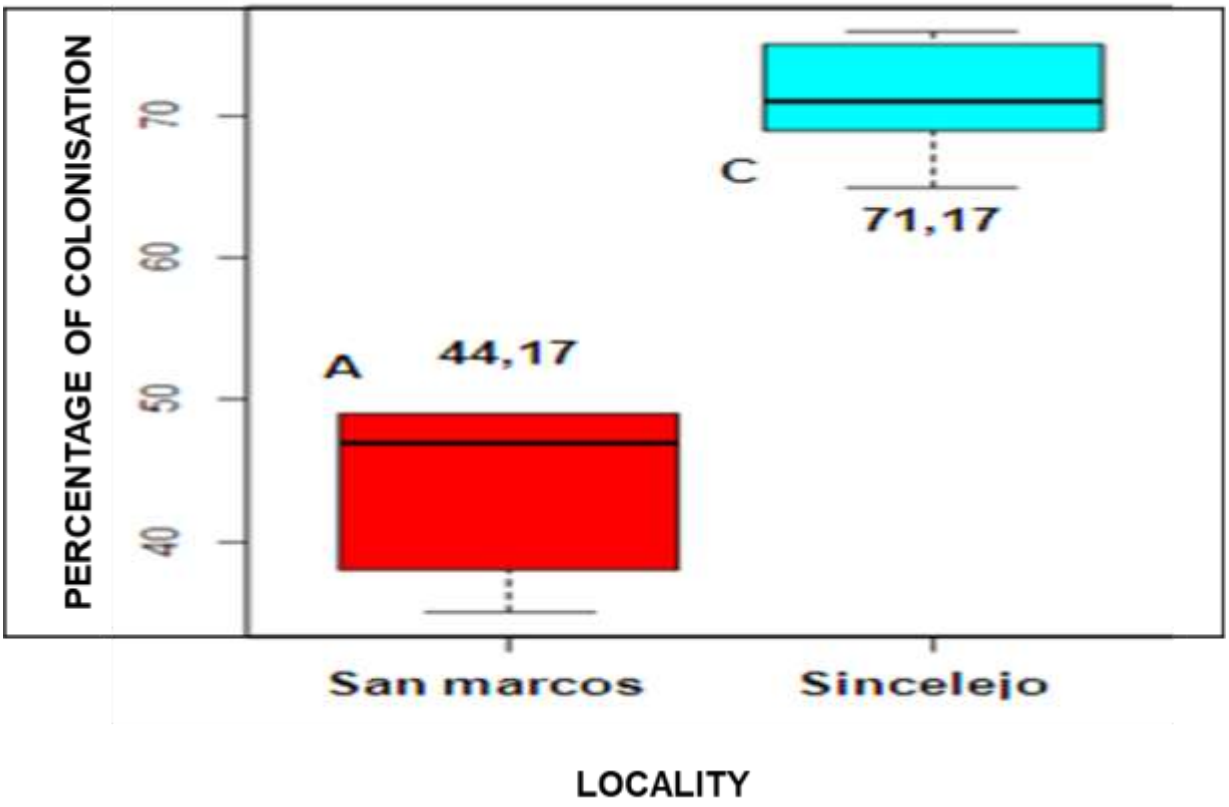

Figure 2. Percentage colonization of Bothriochloa pertusa (L) A. Camus roots by arbuscular mycorrhizal fungi.

The continuous grazing to which the sown cattle farms are subjected creates an unfavorable condition for the maintenance and conservation of the diversity of soil microorganisms. The results found in the percentage of colonization in colosoana grass roots for the municipality of Sincelejo (71.17%) and San Marcos (44.17%) are high in spite of the existence of soil compaction due to continuous grazing on the cattle farms under study. Jeffries and Barea (2003) agree that the physical factors that affect the percentage of mycorrhization or colonization in soils are intensive grazing by herbivorous animals, which increases compaction. Colonization by arbuscular mycorrhizal fungal structures is important in agriculture because colonizing structures such as extra-root mycelium form a link between the plant and the soil, since the plant-fungus association, mycorrhizal plants

have an advantage over non-mycorrhizal plants in terms of the uptake of low mobility nutrients (such as P), since in the former the external mycelium extends a greater distance into the soil than the root hairs of non-mycorrhizal plants (Blancof and Salas, 1997).

The effects of defoliation by continuous grazing on grassland induced changes in plant-fungus interactions and AMF diversity of cattle farm soils have been little studied (Ilmarinen et al., 2007; Ruotsalainen and Eskelinen, 2011; Yang et al., 2018). Studies on this situation to date are inconclusive; it has been observed that defoliation generally reduces the degree of root colonization by AMF (Van der Heyde et al., 2017; Faghihinia et al., 2020).

4 CONCLUSION

Arbuscular mycorrhizal fungi are part of the biological diversity of soils and should be included in both inventories and biodiversity analyses at ecosystem and agroecosystem level. Sustainable pasture production in the tropics is severely limited by the fragility of soils, which are prone to various forms of degradation. Making better use of biological resources in these soils can contribute to increased sustainability. Mycorrhizal fungi are an important biological resource in this respect. Their contribution to the biological chemistry and physical quality of the soil has been recognized, although there are still many questions on how to make optimal use of these beneficial fungi based on the evidence and results found on the presence and degree of colonization on colosoana grass roots in two locations with different climatic conditions on the analyzed cattle farms.

5. AUTHORSHIP CONTRIBUTIONS.

The authors declare that they participated equally in the collection of the data, the analysis of the results and the critical review of their content, as well as in the drafting and approval of the final report of the manuscript.

6. FUNDING. None.

7. CONFLICT OF INTEREST. The authors declare that they have no conflict of interest in relation to the publication of this manuscript.

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