Prevalence and Morpho-Anatomical Diversity of Arbuscular Mycorrhizal Fungi Spores, from Soybean (Glycine max L.) Rhizosphere in the Agro-Ecological Zone 1 of Cameroon

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Abstract: This work investigates on the morpho-anatomical diversity of arbuscular mycorrhiza fungus spores native to soybean rhizosphere in the agro-ecological zone 1 of Cameroon. Arbuscular mycorrhiza fungi spores have been trapped in pot on composite soils samples taken from three areas in each northern region. Soybean have been used as host plant. After 90 days of growth, the mycorrhizal fungus spores have been extracted and the host plant roots stained. Results analysis revealed that the mycorrhization frequency (F) and intensity (I) are higher at Maroua area (F = 4.6%, I = 3.95%) and lower at Guider zone (F = 1.33% and I = 1.22%). For the specific density, the values vary between 1.54% (Guider zone) and 5.2% (Yagoua zone). Regarding the specific richness, the obtained data fluctuate between 3% (Guider) and 8% (Mokolo). The morpho-anatomical characterization of the spores indicated the presence of 9 different specimens: Septoglomus constrictum, Glomus maculosum, Glomus manihotis, Acaulospora kentinensis, Acaulospora myriocarpa, Rhizophagus intraradices, Ambispora sp, Funnelliformis mossea, Diversispora epigae. Among these strains, Septoglomus constrictum is the most abundant specimen while Funnelliformis mossea, Ambispora sp and Acaulospora myriocarpa are the rarest. The agronomic performances of these strains can be evaluated for and ecological production of soybeans in the agro-ecological zone 1 of Cameroon.

Keywords: Agro-Ecological Zone 1, Specific Density, Specific Richness, Mycorrhization Frequency, Mycorrhization Intensity

Introduction
Arbuscular mycorrhizal symbiosis is the most common plant-microorganism symbiosis in plants kingdom (Strullu, 1991). The most appreciable advantage of this symbiosis is the uptake and transfer to plants, of some nutrients which are less available in the soil, mainly phosphorus (Lambers and al., 2008). This nutrients acquirement also concerns N, K, Mg, Na, S, B, Cl, (Caris and al., 1998). A mycorrhized plant shows a better resistance against environmental stresses, including drought (Subramanian and al., 1995), cold (Charest and al., 1993), high salinity (Davis and Young, 1985) and pollution (Leyval and al., 1995). In addition, mycorrhization reduces the incidence of root diseases and minimizes the harmful effect of some pathogenic microorganisms, (Dehne, 1982). This performance of mycorrhized plants in drawing soil nutrients and resisting to environmental stresses, grants to fungal symbionts a function of biofertilizer and crop protection agent (Dalpé, 2005). However, an appropriate knowledge of the arbuscular mycorrhiza communities structure and diversity, is crucial for the enhancement of their agronomic and environmental potentialities; particularly in tropical agroecosystems (including Cameroon), (Cardoso and Kuyper 2006; Lovera and Cuenca, 2007). In fact, Cameroon has a great climate diversity, due to its geographical position, and which allows it to be subdivided into 5 agro-ecological zones (FAO, 2008). The agro-ecological zone 1 on which our study is focused, covers the Far North region, the North and part of the North of the Adamawa region. This party of Cameroon is characterized by low rainfall, and the period of plant growth varies from 14 to 184 days (FAO, 2009). Among the several crops cultivated in this area, soybean is cited among the most widely cultivated legumes (FAO, 2009). Due to its exceptional nutritional qualities, the production and consumption of soybean deserve to be encouraged (Anonymous, 2016). Indeed, its grains have a very high fat content (20%) and very good nutritional protein (35%). The are particularly rich in lysine, which is an essential amino acid. Soybean can replace proteins from milk, meat, fish, eggs, (Anonymous, 2016). This work is an analysis of the
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prevalence and diversity of indogenous fungi associated with soybeans in agro-ecological zone 1 of Cameroon.

Material and Methods
an intensive degradation, where rainfall is reduced to 3 months and the dry season lasts at least 7 months. The precipitation varying between 500 and 1000 mm

Table 1: Geographical and climatological data of study site

| Regions   | Sampled zones | Sampled fields | Altitude (m) | Latitude | Longitude | Rainfalls (mm/year) | Temperatures °c |
|-----------|---------------|----------------|--------------|----------|-----------|---------------------|----------------|
| Adamawa   | Ngaoundéré    | Field 1        | 1211         | 07.27041 | 13.55515  | 225-285             | 12-30          |
|           |               | Field 2        | 1060         | 07.41049 | 13.54827  |                     |                |
|           |               | Field 3        | 1155         | 07.46221 | 13.59745  |                     |                |
| Far North | Mokolo        | Field 1        | 326          | 10.58731 | 14.00415  |                     |                |
|           |               | Field 2        | 317          | 10.7412  | 13.7986   |                     |                |
|           |               | Field 3        | 371          | 10.86547 | 13.89596  |                     |                |
|           | Marouna       | Field 1        | 408          | 10.61877 | 14.35906  |                     |                |
|           |               | Field 2        | 482          | 10.53025 | 14.13976  |                     |                |
|           |               | Field 3        | 357          | 10.53077 | 14.93538  |                     |                |
|           | Yagoua        | Field 1        | 357          | 10.25857 | 14.93538  |                     |                |
|           |               | Field 2        | 357          | 10.32601 | 15.24176  |                     |                |
|           |               | Field 3        | 331          | 10.49614 | 15.18793  |                     |                |
| North     | Guider        | Field 1        | 494          | 9.95649  | 13.62433  |                     |                |
|           |               | Field 2        | 384          | 9.92437  | 13.93035  |                     |                |
|           |               | Field 3        | 298          | 8.76711  | 13.35941  |                     |                |
|           | Garoua        | Field 1        | 247          | 9.30813  | 13.8870   |                     |                |
|           |               | Field 2        | 327          | 9.02162  | 13.49671  |                     |                |
|           |               | Field 3        | 295          | 9.31311  | 13.36625  |                     |                |
|           | Tcholiré      | Field 1        | 311          | 8.38526  | 14.17865  |                     |                |
|           |               | Field 2        | 493          | 8.41254  | 14.17865  |                     |                |
|           |               | Field 3        | 297          | 8.52431  | 14.10836  |                     |                |

1. Soils sampling
Soils samples have been collected in three zones, randomly chosen per region, considering the accessibility aspect; and in each zone, three fields have been also randomly chosen. The selected field per zone are at least 10 kilometers apart. During the soil collection exercise, approximately 10 kg of soil have been taken between 05-10 cm deep per field. The sampled soil have been mixed up in each zone to obtain a single composite soil.

2. Physico-chemical characteristics of soils samples
The physico-chemical properties of the soil samples have been evaluated using the Palintest Kit with a 5000 photometer. The evaluated parameters are: Sand content, silt content, clay content, pH, conductivity, organic carbon (CO), organic matter (OM), phosphorus (P), Magnesium (Mg2 +) and Calcium (Ca +). These analyzes have been carried out at the Soil-Water-Plants Analysis Laboratory (ITRAD) (Chadian Institute of Agronomic Research for Development).

3. Trapping of mycorrhiza fungus spores
The multiplication of the spores have been realised according to the method of Brundrette and al. (1996) adjusted as follows; Soybean seeds have been sown in pot (2 liters capacity). For each composite soil sample type, five pots have been used. The used seeds have been obtained from local farmers and three have been sown per pot. The pots have been placed out of ground contact, sheltered from the wind, and watered directly with rainwater for three months. At this moment, the above-ground biomass have been eliminated, while the roots and the soil substrate have been taken to the Laboratory for analyzes. The roots have been removed, stored in the fridge at 4 ° C while waiting to be analyzed.

4. Roots staining
Fine harvested soybean roots have been thinned according to the method of Hayman, (1970), to assess endomycorrhizal infestation structures. Youngest roots have been cut into 1-2 cm length, they were then successfully washed, inserted into a test tube containing 10% potassium hydroxide, and heated in a water bath at 90°C for 30 minutes to clear the roots. Potassium hydroxide was eliminated then, the solution was filtered through a sieve before neutralization by rinsing with acidified water. Neutralized roots were mixed into cotton blue under a water bath for 15 minutes, filtered again through a sieve and rinsed with distilled water. Some roots were mounted in water for direct observations, while other were mounted in glycerine for later
5. Estimation of mycorrhization

The mycorrhization estimation parameters were evaluated according to the method of Sghir and al. (2013).

a). The mycorrhization frequency

The frequency or percentage of mycorrhization is the number of root fragments that have been found mycorrhized among the total number of the observed fragments.

\[ F(%) = \frac{100 \times (N-N0)}{N} \]

where \( N \) is the number of fragments observed and \( N0 \) the number of non-mycorrhized fragments, Sghir and al., 2013.

b). The mycorrhization intensity

The mycorrhization intensity is the root cortex colonization density by arbuscular mycorhiza fungi. It is evaluated by attributing each root fragment a score class between 0 and 5 according to the estimation of root cortex colonization by arbuscular mycorhiza fungi:

- 0 = No infection,
- 1 = Trace of infection,
- 2 = less than 10%,
- 3 = 10 to 50%,
- 4 = 51 to 90%,
- 5 = More than 90%.

\[ I(%) = \frac{(95n5 + 70n4 + 30n3 + 5n2 + n1)}{N} \times 100 \]

where \( n5, n4, n3, n2, n1 \) are the numbers of the roots noted from 1 to 5, Sghir and al., 2013.

6. Extraction of arbuscular mycorrhizal fungi spores

The mycorrhizal spores have been extracted according to the wet sieving extraction method described by Gerdemenn and Nicolson, (1963) adjusted as follows: 1. Mix a 500g soil sample in 4 liters of distilled water; 2. Homogenize by mechanical stirring for 15 min (repeat this exercise 3 times); 3. Pass this solution through a series of sieves that have size corresponding to those of arbuscular fungi spores (25-50-100-200-300-400 microns); 4. After rinsing the sieves, recover and mix the residue from each sieve in a 60% sucrose solution, then create a density gradient by centrifugation at 3000 rpm; 5. Filter the supernatant through a 25 micron sieve and collect the spores in Petri dishes.

7. Morphological classification of spores

The extracted arbuscular fungal spores were collected in Petri dishes and placed under a binocular magnifying glass for observation. Using forceps, they were grouped by morphotypes under the criteria of size, color and shape.

8. Determination of spore size

The spores size have been determined according to the method of Walter, (2003) described as follows: a. The spore is mounted on a slide without being crushed; b. A graduated ruler is placed 25 cm from the slide and the lens of the magnifying glass; c. One eye, the spore is observed through the eyepiece of the magnifying glass, while the other eye is focused on the ruler; d. Carefully superimpose the image of the spore on the graduated ruler to obtain the size of the image in centimeters, the apparent size (Ta). e. Determine the magnification of the loupe (GO):

\[ GO = \frac{Objective \times Eyepiece}{50} \]

where GO = 5.0 and eyepiece 10, GO = 50. The real size of the object is:

\[ Tr = \frac{Ta}{GO} \times 100 \]

In our case, objective = 5.0 and eyepiece 10, GO = 50. The size of the spore is obtained in centimeters and the conversion table have been used to assess the size in micrometers.

9. Morpho-anatomical characterization of isolated spores

After the determination of the shape, color and size of spores, they were mounted between slide and coverslip; one part in PVGL (Polyvinyl-Lactic Acid-Glycerol), the other in PVGL-Melzer's Reagent (V:V1:1) (Koske and Tessier, 1983). Morphological genera determination have been made based on descriptions of Morton and Beny, (1990). The original descriptions of the species as well as the information provided on the website of the International Vesicular Mycorrhizal fungi collection (INVAM) (http://invam.caf.wv.edu/taxonomy/speciesID.htm) have been used for identification of spores. The morphological characters of the spores described were compared with those of the original specimens description and reference strains.

10. Estimation of arbuscular mycorrhiza fungal spores

a. Specific density

The specific density is an estimation of the spores number in 100g of soil sample.

\[ D(%) = \frac{N}{100} \times 100 \]

where \( N \) is the number of spores counted and 100, the amount of soil used for their isolation, Sghir and al., 2013.

b. Specific richness

Specific richness is the number of different genus of arbuscular mycorrhiza fungal in a given CMA collection.

\[ R(%) = \frac{100 \times (Different \ number \ of \ arbuscular \ fungus \ genus)}{Total \ number \ of \ spore \ counted} \]

11. Shanonne diversity index

This value permits to assess the diversity level within the identified arbuscular fungi community.

\[ H = -\sum_{i} P_i \log_2 P_i \]

where \( P_i \) is the portion of the species \( i \) in the total number of species \( S \) in the study medium. \( P_i \) is calculated as follows: \( P_i = \frac{ni}{N} \)

where \( ni \) is the number of individuals for species \( i \) and \( N \) is the total population (Shanonne and Weaver, 1949).
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11. Statistical analysis
The data have been statistically analyzed using the "statgraphics 5.0" program which performs analysis of variance (ANOVA). The results averages from the different localities were separated using the least significant difference (LSD) at the threshold of the probabilities indicated. Pearson's correlation was used to analyze the correlations between the studied different parameters. The links between the different parameters were determined by the Pearson correlation coefficient.

Results
1. Soils physico-chemical properties
Table 1 shows that all soil samples from the different zones of the three regions have an acidic pH (4.32-5.30). The degree of acidity is higher in the Yagoua zone (4.97) and less important in the Guider zone (5.30) (P <0.001). For the phosphorus content, its value is higher at Ngaoundéré (94ppm) and lower at Garoua (30 ppm) (P <0.001). The granulometric parameters are also variable according to the study zones: It is the Mokolo zone which is the most sandy one (73.20%), while it is that of Ngaoundéré which is the most clayey (56.91%) (P <0.001). Regarding the organic matter, significant difference was observed between the values, lower at Ngaoundéré (0.095%) and Maroua (0.0105%), and similar and higher in the other zones (112-114%), (P <0.001).

| Tableau 1 : Physico-chemical properties of sampled soils |
|---------------------------------------------------------|
| pH | Sand | Limon | Clay | Cond | O (% ) | MO | P (ppm) | K (ppm) | Mg2+ |
| Ngaoundéré | 5.00 cd | 20.28b | 23.52d | 56.19g | 212c | 0.055a | 0.095a | 94 f | 330a | 156e |
| Mokolo | 5.13d | 73.20g | 14.84b | 11.91a | 150.4a | 0.067bc | 0.116c | 43b | 405b | 60a |
| Maroua | 5.02 bcd | 12.86a | 42.62g | 44.55e | 166.4a | 0.061b | 0.0105b | 72d | 560d | 410f |
| Yagoua | 4.97a | 27.78c | 25.69c | -46.32f | 268e | 0.066bc | 0.114c | 43b | 365a | 115c |
| Tcholiré | 5.02 bcd | 71.52f | 15.68c | 12.79b | 232d | 0.085bc | 0.112c | 58c | 450c | 95b |
| Garoua | 4.98 a | 71.10e | 14.00a | 14.89c | 250f | 0.065bc | 0.113c | 30a | 450c | 180e |
| Guider | 5.30e | 57.45d | 15.60e | 26.83d | 175.2b | 0.066bc | 0.114c | 86e | 430c | 135d |

P-value: <0.001; Organic carbon; M.O: Organic matter; Cond: Conductivity, Ndéré: Ngaoundéré.

2. Demonstration of endomycorrhizal symbiosis
Thinning and staining of the soybean plants roots revealed the presence of some specific structures which characterized the endomycorrhizal symbiosis. Figure 1 shows the structures observed (vesicles: A; hyphae: B; endomycorrhiza spores: C). The spores are the structures that have been most observed.
3. The estimation of the mycorrhization
a. Mycorrhization frequency
Figure 2 indicates that the mycorrhization frequency is variable between the different study areas. The highest mycorrhization frequency was observed in the Maroua zone in the Far North (43.66%), followed by those in the Ngaoundéré zone (26.33%) in Adamawa and Tcholiré (25.33%) in the North; conversely, the values recorded in the areas of Guider (1.33%) and Garoua (3%) in the North are similar and are lower (p < 0.0001). Nadjilom and al. (2019) have also obtained similar results on the morphological and structural diversity of the arbuscular mycorrhiza fungi community in rice rhizosphere, grown in the sahelian zone of Chad: Mycorrhization frequency variable between 4 and 7.33%. These observations are lower than those of Gnamkoulamba and al. (2018) who recorded mycorrhization frequency values between 57-88% in a study on the diversity of arbuscular fungi in Togo. The variation of the mycorrhization frequency according to the sites can be justified by the history of particular land use of each site which negatively influences their mycorrhigenic potential; soils which have been cultivated for a very long time may see their mycorrhigenic potential greatly reduced, Głodowska and Wozniak, (2019).

b. Mycorrhization intensity
The variation of the mycorrhization intensity between the different study areas is illustrated in Figure 3. It have been noted that there is no significant difference

Figure 1: Mycorrhization structures (A: vesicules, B: Hypha, C: spores)

Figure 2: Mycorrhization frequency

The mycorrhization frequency values are the average of three replications. Bars with the same letter are not significantly different at the indicated probability threshold.
between the mycorrhization intensities of the Guider areas (1.22%), Garoua (3%) in the North and Yagoua (3.34%) in the Far North, and are lower compared to the values noted in the other zones. In addition, the intensities of the Tcholiré (24.26%) and Ngaoundéré (26.32%) zones are also similar and significantly lower than the value reported in the Maroua zone (39.55%), (P <0, 0001). Tobolbaï and al. (2018) recorded similar mycorrhization frequency values, ranging from 1 to 20% during a study on the diversity of arbuscular mycorrhiza fungi spores associated with maize in North Cameroon. On the contrary, these data are inferior to those of Ouallal and al. (2018) in Morocco who obtained an intensity of mycorrhization that fluctuates between 13 and 21% during a study on mycorrhizal fungi of the argan tree.

![Graph](image)

**Figure 3**: Soybean mycorrhization intensity

Mycorrhization intensity values are the means of three replicates. Bars with the same letter are not significantly different at the indicated probability threshold.

5. **Specific density**

Figure 4 shows that the specific density is variable depending of the study areas. Thus, the sporulation of arbuscular mycorrhiza fungi is greater in the Yagoua area (5.20%) compared to the other study areas (P = 0.0001). The lowest spore densities were observed in the areas of Guider (1.54%), Tcholiré (2.61%) and Mokolo (2.04%) which are not significantly different. The data reported in the areas of Ngaoundéré (3.65%), Garoua (3.87%) and Maroua (3.52%) are similar and are intermediate to the others. Similar specific densities have been reported by Zougari-Elwedi and al. (2012) in Tunisia where they recorded specific densities varying from 1 to 3% in the rhizosphere of date palm in the region of Djérid. Our results are lower than those of Ngonkeu and al. (2013) who reported a specific density that fluctuates between 15 and 115 during a study on the diversity of arbuscular fungi in Cameroon.
Figure 4: Specific density

Specific density values are the average of three replications. Bars with the same letter are not significantly different at the indicated probability threshold.

6. Specific richness

Analysis of the variation in specific diversity (figure 5) reveals that the highest specific richness is that of the Mokolo zone (8%) in the Far North, (p <0.001), followed by those of Yagoua (5%) and Garoua (5%), different of the data obtained in the areas of Guider (3%) and Tcholiré (3%) which are less. The diversities recorded in Ngaoundéré (4%) and Maroua (4%) are similar and intermediate to the others. These results are lower than those reported by Maurer and al. (2014) who obtained a richness that varies between 10 and 21% in Switzerland during a study on the effect of cultivation practices on the arbuscular mycorrhiza fungi community. The low diversity in our case can be attributed to the type of agricultural practices and the nature of the soils. In fact, a low specific richness can be attributed to a complex selection pressure by agricultural practices on the communities of CMAs among which, mineral fertilization, tillage, use of pesticides and monoculture, (Helgason and al. (1998).

Figure 5: Specific richness
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Specific richness values are the means of three replicates. Bars with the same letter are not significantly different at the indicated probability threshold.

7. Correlation between the mycorrhization parameters and the soils physico-chemical properties

It appears that the intensity and frequency of mycorrhization are positively related and the correlation is highly significant (P < 0.0001, r = 0.9968). At contrary, there is a negative and significant correlation between the pH and the specific density (r = -0.8089, P = 0.02). That means that a lower pH affects negatively soil CMA communities. A negative and significant correlation is also registered between the mycorrhizal frequency and the organic matter (r = -0.8061, P=0.027). Thus, when the soils is with high fertility, the role of mycorrhization symbiosis can be less required and even totally suppress, Tacon and al. (1999). All the others correlations are not significant.

Table 3: Correlation between density and specific richness and the soils physico-chemical properties

|        | F (%) | I (%) | D (%) | R (%) |
|--------|-------|-------|-------|-------|
| F (%)  |       | 0.9968| 0.0399| -0.2540|
| I (%)  | 0.000 | 0.9328| 0.5826|       |
| D (%)  | 0.000 |       | 0.9431| 0.5123|
| R (%)  | 0.0399| 0.0335| 0.0304|       |
| pH     |       |       | -0.8089|       |
| P      | 0.0423| 0.4507| -0.2198| 0.8749|
| K      | 0.4605| 0.4223| 0.1857| -0.2024|
| Cond   | 0.6264| 0.6503| 0.2352| 0.3148|
| Clay   | 0.3676| 0.3670| 0.5772| 0.2795|
| Sand   | -0.5286| -0.5136| -0.5763| 0.5438|
| Mg2+   | -0.1453| 0.2386| 0.1757| 0.5698|
| MO     | 0.0286**| 0.441| 0.7158| 0.6666|
| C.O    | -0.6264| 0.6503| 0.2352| 0.3140|
|        | 0.1323| 0.1168| 0.6116| 0.4929|

*** = Very highly significant; ** = highly significant; ns = Not significant; D (%) = specific density; R (%) = Specific richness; P (mm): Available phosphorus; C.O = Organic carbon, M.O : Organic matters ; Cond : Conductivity
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8. Morpho-anatomical characterization of endomycorrhiza spores

Figure 6: Freshly extracted spores

a. Septoglomus constrictum (Trappe, 1977)

It is a species easiest to recognize thanks to the distinctive color of its spores, notably brown-orange to black-brown (Trappe, 1977).

b. Acaulospora kentinensis (Kaonangbua and al., 2010)

c. Glomus maculosum (Mill and Walker, 1986)

d. Glomus manihotis (Schenk and al., 1984)

e. Rhizophagus intraradices (Schenk, 1982)

f. Diversispora epigae (Walker and Schubler, 1979)
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9. **Endomycorrhizal spores distribution**

Table 4 shows the distribution of arbuscular endomycorrhizal fungal spores in the soybean rhizosphere within the study area. It shows that *Septoglomus constrictum* is the most abundant and representative specimen under soybean in the three regions. It is therefore the ubiquitous specimen of the rhizosphere of the plant under investigation in the agro-ecological zone 1 of Cameroon. *Funnelliformis mossea*, *Ambispora sp*, *Acaulospora myriocarpa* are the least abundant.

The Shannon diversity index is high in the Mokolo zone ($H' = 0.99$), compared to the other zones showing that its diversity is the highest, while this index is lower in the Bénoué ($H' = 0.023$) meaning that its diversity is the lowest. Similar results were found by Maurer and al. (2014) in Switzerland who noted that *Septoglomus constrictum* is the most abundant specimen in cultivated plots. Nadjilom and al. (2019) reported similar results, where they indicated that *Septoglomus constrictum* is the most abundant specimen of the rhizophere of rice in the Sahelian zone in Chad.
Table 4: Distribution of spores in the rhizosphere of soybeans in the different departments

| Species                | Mokolo | Maroua | Yagoua | Garoua | Tcholéré | Guider | Ndéré |
|------------------------|--------|--------|--------|--------|----------|--------|-------|
| G. constrictum         | 1381   | 761    | 928    | 979    | 766      | 638    | 966   |
| G. maculatum           | 42     | 0      | 1      | 3      | 0        | 0      | 1     |
| G. manihortis          | 4      | 5      | 0      | 0      | 0        | 0      | 0     |
| A. kentensis           | 7      | 0      | 0      | 0      | 0        | 0      | 0     |
| R. intraradices        | 23     | 92     | 22     | 14     | 15       | 3      | 0     |
| Ambispora sp           | 4      | 0      | 0      | 0      | 0        | 0      | 0     |
| A. myricarpa           | 1      | 0      | 0      | 0      | 0        | 0      | 0     |
| F. mossea              | 0      | 2      | 0      | 0      | 0        | 0      | 0     |
| D. epigae              | 20     | 10     | 25     | 2      | 5        | 8      | 46    |
| **H'**                 | **0.99** | **0.39** | **0.27** | **0.023** | **0.12** | **0.035** | **0.55** |

**Conclusion**

This work aimed to study the diversity of arbuscular mycorrhiza fungus spores native to the soybean rhizosphere in agro-ecological zone I of Cameroon. The morpho-anatomical characterization of the spores indicated the presence of nine different specimens: Septoglamus constrictum, Glomus maculatum, Glomus manihortis, Acaulospora kentensis, Acaulospora myricarpa, Rhizophagus intraradices, Ambispora sp, Funneliformis mossea, Diversispora epigae. Among these strains, Septoglamus constrictum is the most abundant specimen while Funneliformis mossea, Ambispora sp, and Acaulospora myricarpa are the rarest. The agronomic performances of these strains can be evaluated for their use in the cultivation of soybeans in the agro-ecological zone I of Cameroon.

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