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**Research Article**

# DIVERSITY OF ENDOMYCORRHIZAL FUNGI (A.M.F.) IN THE RHIZOSPHERE OF SUGAR CANE (*SACCHARUM OFFICINARUM*) GROWN IN MOROCCO

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**ABSTRACT**

The identification of the arbuscular mycorrhizal fungi and the evaluation of the mycorrhization level in the roots were performed basing on the isolated spores from the soil and roots samples taken from the rhizosphere of four sugar cane parcels in the region of Dar Gueddari (North western of Morocco).

The analysis of the results has shown the presence of different characteristic structures of arbuscular endomycorrhizal in the roots of the sugar cane developed in the prospected sites. The mycorrhization frequency of the sugar cane roots varied from 60% to 100%. The highest intensities of mycorrhization were in the order of 70% in the level of site 2 and 61.53% in the level of site 1 and the lowest intensity was noted in the site 4 (13.3%). Otherwise, the observed arbuscular contents in the level of four sites were respectively 55.32; 66.12; 40.37; 54.03%. The vesicular contents varied from 1.43% (site 4) and 27.91% (site 2). The spore's density in the rhizosphere of the sugar cane varied between 53 spores/100g (site 3) and 88 (site 1).

The identification of the isolated spores allowed to note the presence of 49 species belonging to 8 genera (*Glomus*, *Gigaspora*, *Acaulospora*, *Entrophospora*, *Pacispora*, *Scutellospora*, *Ambispora*, *Rhizophagus*), 7 famillies (Glomaceae, Gigasporaceae, and Acaulosporaceae, Pacisporaceae, Scutellosporaceae, Entrophosporaceae, Ambisporaceae) and 4 orders (Glomerales, Gigasporales, Diversisporales, Archaeosporales**)**.



## INTRODUCTION

Morocco is one of the few countries producing sugar cane and beetroot (Anonymous, 2016). The crops are grown on the irrigated perimeters of Doukkala, Tadla, Gharb, Loukkos and Moulouya (Handaji and Allali, 1999; Doukkali *et al.*, 2009; Mrhari *et al.*, 2005). Currently, sugar cane (*Saccharum officinarum*) is grown on a total area of 13,400ha, in the 2010-11 season (Redani, 2015). According to these authors, sugarcane crops provide an annual equivalent of 9 million days of seasonal work in agriculture and 3,000 permanent jobs in agribusiness. The application of new biotechnologies in the nursery, a case of mycorrhizae, plays an important role in plant species, mainly in growth (Karagiannidis and Hadjisavva-Zinoviadi, 1998), Mineral nutrition, in particular phosphorus (Hernandez *et al.*, 2005; Lambers *et al*., 2008), macros (N, K, Mg, Na, S) and micros (B, Br, Cl, Cu, Cr, Cs, Co, Fe, Mo, Mn, Ni, Si, Zn) soil nutrients (Smith et Read, 1997), Water supply, plant resistance to drought stress and disease caused by micro-organisms (St-Arnaud and Vujanovic, 2007), Tolerance to trace elements of metal or to polycyclic aromatic hydrocarbons (Leyval *et al.*, 1998) and survival after transplantation (Joner and Johansen, 2000). Studies carried out in a greenhouse reveal that the inoculation from the beginning of cuttings of certain plant species, the olive tree, with an inoculum based on mycorrhizal arbuscular fungi (Semane *et al.*, 2016). According to these authors, it was the gradual establishment of mycorrhizal symbiosis at the level of the inoculated plants roots which led to a good development of the root mass and the vegetative mass of the plants. The mycorhization of cane seedlings is therefore an interesting way to explore in order to meet one of the main tasks of the Technical Centers of Sugar Cultivation (CTCS), which is the production of vigorous plants, able to establish and adapt to the different conditions of the culture regions.

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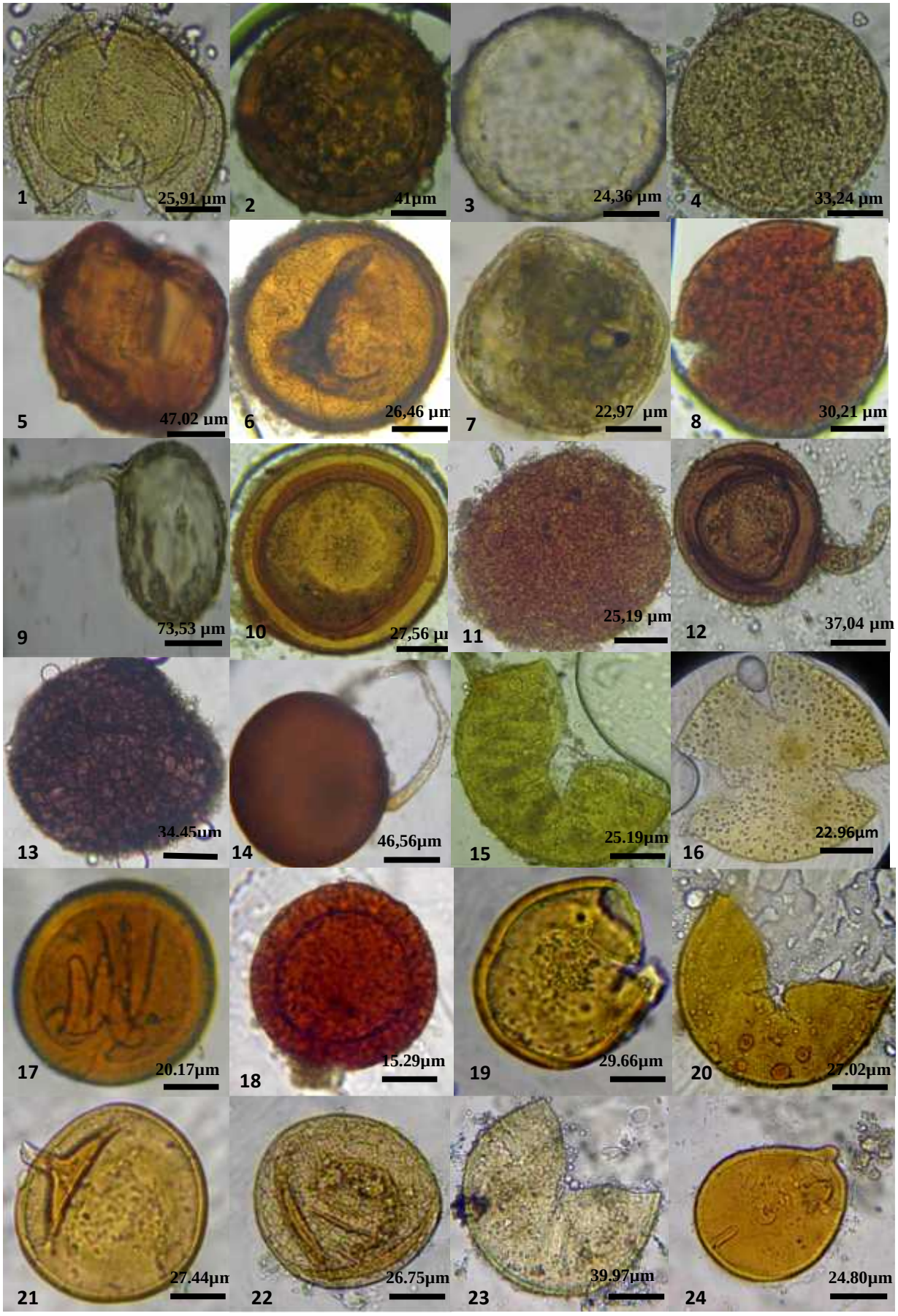
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27.02µm
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27.44µm
22
26.75µm
23
39.97µm
24
24.80µm


**Fig.1** Some spores of the endomycorrhizal species isolated from the rhizosphere of Sugar cane. **(1)** *A. morrowiae*; **(2):** *P. scintillans*; (**3**) and (**4):** *Gi.*sp*;* **(5):** *G.* sp; (**6**): *G. macrocarpum*; (**7**)**:** *Gi.* Sp*;* (**8**)**:** *A. spinosa*; **(9):** *Am. Appendicula;*(**10**)**:** *A. excavate;* **(11):** *A.* sp.1; (**12**)**:** *Gi.* sp; (**13**)**:** *E. infrequens*; (**14**): *G. versiforme;* (**15**)**:** *P. scintillans;* (**16**)**:** *P.* sp.1*;* **(17):** *G. globiferum;* **(18):** *S. heterogamma*, (**19**)**:** *G. fasciculatum;* **(20**): *A. dilatata*; (**21**)**:** *G. intraradices*; **(22):** *S. castanea;* (**23**): *A.* sp.2; **(24):** *G. macrocarpum*; (**25**)**:** *A.* sp.3; **(26):** *S. nigra;* (**27**)**:** *Gi.* sp. 2; **(28):** *G. lamellosum*; **(29):** *G. etunicatum;* **(30):** *A. cavemata*; (**31**)**:** *A.* sp. 4; **(32):** *P.* sp. 2*;* **(33):** *A.capsicula;* (**34**)**:** *G. clarum;* (**35**)**:** *G. monosporum*; (**36**)**:** *G. versiforme*; **(37):** *G. aggregatum*; **(38):** *G. glomerulatum;* **(39):** *A. laevis;* (**40**)**:** *A. scrobiculata* (**G×400**).
***A – Acaulospora; Am – Ambispora; Gi – Gigaspora; G – Glomus; P - Pacispora; S – Scutellospora***

In order to achieve this objective, it is necessary to give particular importance to the diversity of endomycorrhizal fungi in the rhizosphere of sugarcane growing in different areas. Indeed, to our knowledge, no study has been carried out in Morocco on the diversity of AMF associated with sugar cane.

## MATERIALS AND METHODS

***Prospecting and sampling.*** Soil sampling was carried out at the sugarcane rhizosphere (Gharb region in Douar Ouled Ghida, Dar Gueddari). Sampling was carried out at the foot of 5 plants per site at a rate of 1 kg of soil per plant at a depth of 0 to 20 cm and a composite soil sample was produced per site. Very fine roots, more likely to be mycorrhizal, are removed at the same time as the soil.

### *Mycorrhizal rates inside roots*

The roots observation was prepared according to the method of Koske and Gemma (1984).

They were first washed with water; the finest roots were then cut into a length of 1 cm then immersed in a solution of 10% KOH (potassium hydroxide) and placed in the water bath at 90 °C for one hour to eliminate cytoplasmic contents. At the end of this period, roots were rinsed and transferred in a solution of $H_2O_2$ (hydrogen peroxide) for 20 min at 90°C in the water bath until the roots became white. Roots were then rinsed, after this; they were dyed with cresyl blue, at 90°C for 15 min. After the final rinse, thirty pieces of dyed roots of 1 cm length were randomly selected and mounted, in groups of 10 to 15 segments, in glycerine between slide and coverslip. The remaining roots were kept in glycerol acid. The slides were examined under a microscope, each fragment being thoroughly checked over its entire length, at magnifications of x100 and x400 to observe and to note the mycorrhizal structures: arbuscules, hyphae, vesicles, external hyphae, intra and intercellular hyphae and even the endophytes structures. Vesicular and arbuscular frequencies and content of the

endomycorrhizal fungi inside the roots were measured assigning a mycorrhization index ranging from 0 to 5.

***Spores extraction***

The spores were extracted by the method of wet sieving described by Gerdemann and Nicolson (1963). In a beaker of 1L, 100g of each composite soil sample was submerged in 0.5 L of tap water and it was stirred with a spatula for 1 minute. After 10 to 30 seconds of settling, the supernatant was passed through four superimposed sieves with decreasing meshes (500, 200, 80 and 50 Mm). This operation was repeated two times. The selected content by the screen 200, 80 and 50 microns was divided into two tubes and centrifuged for 4 min at 9000 RPM. The supernatant was discarded and a viscosity gradient was created by adding 20 mL of a solution of 40% sucrose in each centrifuge tube. The mixture was quickly stirred and the tube was handed back into the centrifuge for 1 min at 9000 RPM. Unlike the first centrifugation process, the supernatant was poured into the sieve mesh of 50 microns; the substrate was rinsed with distilled water to remove the sucrose, and then disinfected with an antibiotic solution (streptomycin). The spores were then recovered with distilled water in an Erlenmeyer flask. Species richness and appearance frequency Species richness is the total number of the observed species per site collection and the occurrence frequency of species corresponds to the percentage of sites where each species is detected.

***Statistical analysis.*** The statistical treatment of results focused on the analysis of variance to a single criterion of classification (ANOVA).

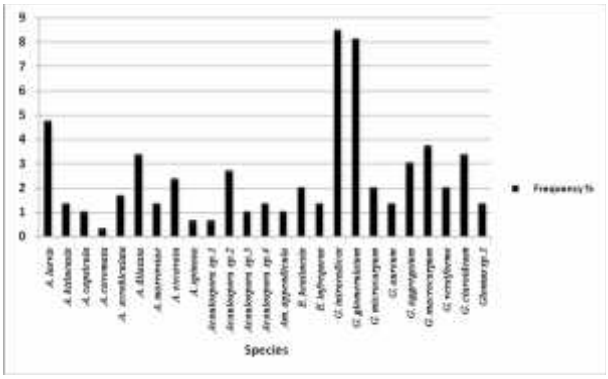


**Fig.2b**. Occurrence frequency of mycorrhizal species at each site.

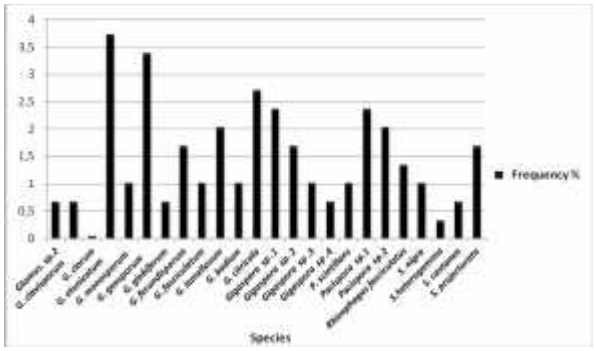


**Fig.2b** Occurrence frequency of mycorrhizal species at each site.

## RESULTS

All the roots of the sugarcane plants were revealed mycorrhizal in the four study sites. Diferrent characteristic structures of the arbuscular mycorrhizal were observed: Arbuscules, vesicles of hyphae intra and extra-cellular of endophytes (Fig. 4). The maximum value is 100% at site 1 and the minimum value is 60% at site level 4. Otherwise, the highest values of the mycorrhizal intensities (Fig. 5) were noted in the roots of the cane sugar of the sites 2 (70%) and 1 (61.53%) and the lowest in the 4 (13.3%) and 2 (52.73%). The arbuscular contents (Fig. 6) in the roots of site 2 were 66.12% and those of site 1 are in the order of 55.32%. By cons, those observed in the roots of site 3 were 40.37%. The vesicle contents (Figure 6) of the cane roots of site 2 (27.91%) and those at sites 1, 3 and 4 were respectively 4.15, 2.91 and 1.43%. Spore's densities in the rhizosphere of the sugar cane (Fig.7) varied between 88 spores/100g of soil in the level of site 1 and 53 spores/100g in the level of the site 3.

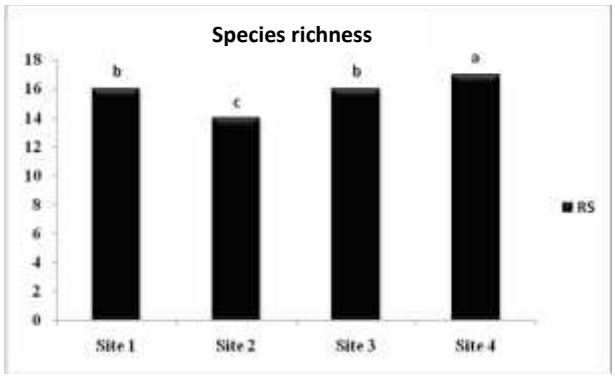


**Fig. 3** Species richness in the level of each site.

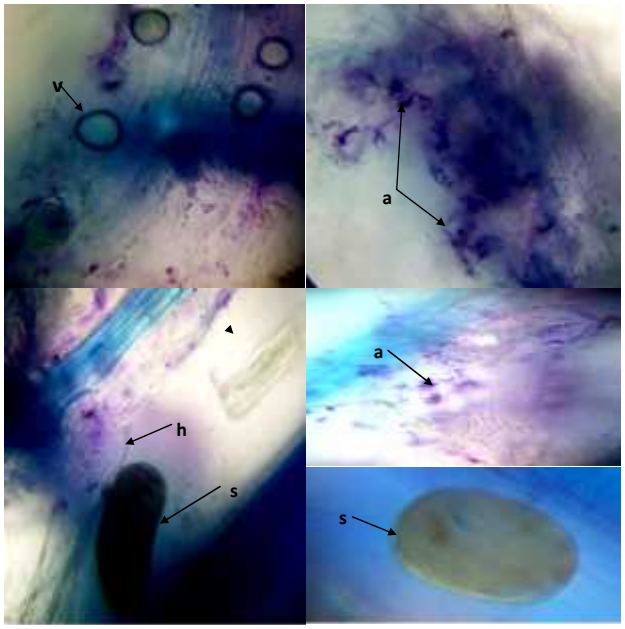


**Fig.4** Presence of different endomycorrhizal structure inside the roots of the sugar cane plant (a); external hyphae (h); spores (s); vesicules (v) (G. ×400).

It was noted that, generally, the variations are not so important between the sites of the same parcel. The number of spores, varied between 76 and 88 spores/100g of soil, was noted in the level of the sites 1, 2 and 4, have shown important mycorrhization frequencies (between 60 and 100%). However, the low number of spores (53 spores/100g of soil) was observed in the level of the site 3.

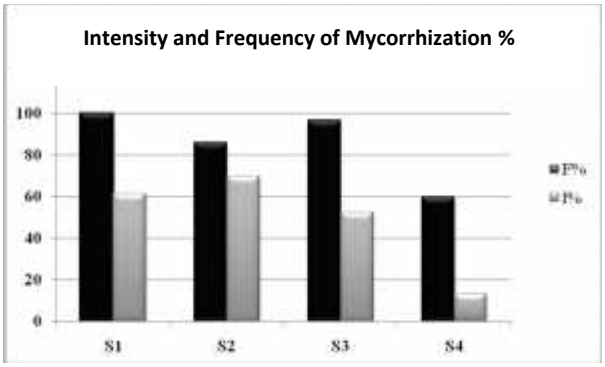


**Fig.5** Frequency and Intensity of mycorrhization of roots of the sugar cane in the study sites.

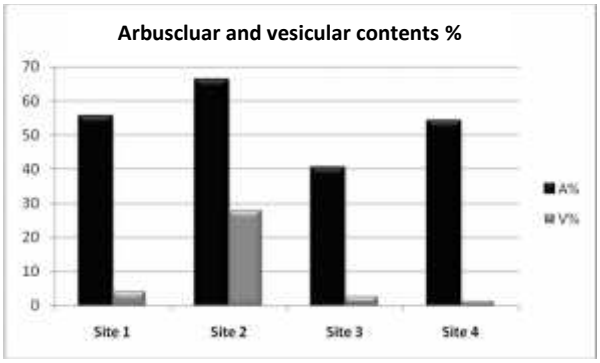


**Fig. 6** Vesicular and arbuscular contents in the roots of the sugar cane in the study sites

Preliminary identifications have made it possible to note that isolated spores (Figure 1) belong to 49 species (table 1): *Acaulospora laevis, Acaulospora kitinensis, Acaulospora capsicula, Acaulospora cavemata, Acaulospora scrobiculata, Acaulospora dilatata, Acaulospora morrowiae, Acaulospora excavate, Acaulospora spinosa, Acaulospora* sp.1, *Acaulospora* sp.2, *Acaulospora* sp.3, *Acaulospora* sp.4, *Ambispora appendicula, Entrophospora kentinesis, Entrophospora infrequens, Glomus intraradices, Glomus glomerulatum, Glomus microcarpum, Glomus aureum, Glomus aggregatum, G.macrocarpum, G. versiforme, G. claroideum, Glomus* sp.1, *Glomus* sp.2, *G. clavisporum, Glomus clarum, Glomus etunicatum ; Glomus monosporum ;Glomus geosporum; Glomus globiferum ; Glomus fecundisporum ; Glomus fasciculatum ; Glomus lamellosum ; Glomus badium ; Glomus citricola, Gigaspora* sp .1, *Gigaspora* sp. 2, *Gigaspora* sp .3, *Gigaspora* sp .4, *Pacispora scintillans, Pacispora* sp.1, *Pacispora* sp.2, *Rhizophagus fasciculatus, Scutellospora nigra, Scutellospora heterogamma, Scutellospora castanea* and *Scutellospora projecturata.*

Similarly, according to the classification of Oehl and Sieverding (2011), the encountered species are distributed in 8 genera (*Glomus, Gigaspora, Acaulospora, Entrophospora, Pacispora, Scutellospora, Ambispora, Rhizophagus*), 7 famillies (Glomaceae, Gigasporaceae, Acaulosporaceae, Pacisporaceae, Scutellosporaceae, Entrophosporaceae, Ambisporaceae) and 4 orders (Glomerales, Gigasporales, Diversisporales, Archaeosporales).

**Table 1** AM fungi species present in the different study areas

| Mycorrhizal species | Number of spores per 100g of soil | | | |
|---|---|---|---|---|
| | Site 1 | Site 2 | Site 3 | Site 4 |
| *A. laevis* | 5 | 6 | 3 | - |
| *A. kitinensis* | 4 | - | - | - |
| *A. capsicula* | 3 | - | - | - |
| *A. cavemata* | 1 | - | - | - |
| *A. scrobiculata* | 5 | - | - | - |
| *A. dilatata* | - | - | 10 | - |
| *A. morrowiae* | - | - | - | 4 |
| *A. excavata* | - | - | - | 7 |
| *A. spinosa* | - | - | - | 2 |
| *Acaulospora* sp.1 | 2 | - | - | - |
| *Acaulospora* sp.2 | - | 8 | - | - |
| *Acaulospora* sp.3 | - | - | 3 | - |
| *Acaulospora* sp.4 | - | - | 4 | - |
| *Am. appendicula* | - | - | - | 3 |
| *E. kentinesis* | 4 | - | - | 2 |
| *E. infrequens* | - | - | - | 4 |
| *G. intraradices* | 3 | 5 | 2 | 15 |
| *G. glomerulatum* | 17 | - | - | 7 |
| *G. microcarpum* | 3 | - | - | 3 |
| *G. aureum* | 4 | - | - | - |
| *G. aggregatum* | 9 | - | - | - |
| *G. macrocarpum* | 5 | - | 4 | 2 |
| *G. versiforme* | 6 | - | - | - |
| *G. claroideum* | 10 | - | - | - |
| *Glomus* sp.1 | - | 4 | - | - |
| *Glomus.* sp.2 | - | - | 2 | - |
| *G. clavisporum* | - | 2 | - | - |
| *G. clarum* | - | 12 | - | - |
| *G. etunicatum* | - | 6 | 5 | 1 |
| *G. monosporum* | - | 3 | - | - |
| *G. geosporum* | - | 7 | 3 | - |
| *G. globiferum* | - | - | 2 | - |
| *G. fecundisporum* | - | - | 5 | - |
| *G. fasciculatum* | - | - | 3 | - |
| *G. lamellosum* | - | - | 1 | 5 |
| *G. badium* | - | - | - | 3 |
| *G. citricola* | - | - | - | 8 |
| *Gigaspora* sp .1 | 7 | - | - | - |
| *Gigaspora* sp. 2 | - | 5 | - | - |
| *Gigaspora* sp .3 | - | 3 | - | - |
| *Gigaspora* sp .4 | - | - | - | 2 |
| *P. scintillans* | - | - | - | 3 |
| *Pacispora* sp.1 | - | 7 | - | - |
| *Pacispora* sp.2 | - | 6 | - | - |
| *Rhizophagus fasciculatus* | - | 4 | - | - |
| *S. nigra* | - | - | 3 | - |
| *S.heterogamma* | - | - | 1 | - |
| *S. castanea* | - | - | **2** | - |
| *S. projecturata* | - | - | - | 5 |
| **Total** | **88** | **78** | **53** | **76** |

The dominant species of endomycorrhizal fungi vary from one site to another; *Glomus glomerulatum and Glomus claroideum* are the most dominant species at site 1, their occurrence frequencies are respectively 8.13% and 3.38% (Fig. 2). In contrast, *Glomus clarum* and *Acaulospora* sp.2 are the most dominant species in Site 2 (Table 1). Similarly, the most commonly encountered species at site 3 were *Acaulospora dilatata, Glomus etunicatum, Glomus fecundisporum*, their occurrence frequencies varied between 1.69% and 3.72% (Fig. 2). In contrast, *Glomus intraradices, Glomus citricola* are the most commonly encountered species at site 4.

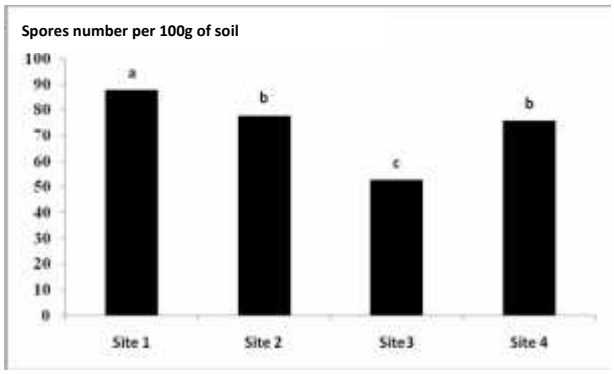


**Fig. 7** Mean spores density of MA fungi in the sugar cane rhizosphere in the studied sites.

The specific richness (Figure 3) also varies according to soil sampling sites. It is 14, 17.16 species respectively in site 2, 4, (1 and 3).

## DISCUSSION AND CONCLUSION

Realized prospection in four sites of Gharb, north western of Morocco, have shown that all roots of sugar cane formed mycorrhizal relation with endomycorrhizal structures: vesicles, arbuscles, internal and external hyphae of endomycorrhizae; the arbuscules are considered as the privileged seat of exchanges of nutrients between the symbiotes (Hause and Fester, 2005).

The mycorrhization frequencies of the roots are so high in the level of the sites 1 (100%) and 3 (96.66%). However, the rhizosphere of the site 3 was low in spores of endomycorrhizal fungi (53 spores per 100g of soil). By cons, it seems that there is a positive relation between the mycorrhizal frequency and the spores number observed in the sugar cane of the sites 1 and 2, respectively 88 and 78 spores/100g of soil. The sporulation may depend on the endomycorrhizal species, the edaphic characteristics of the soil and the climatic conditions. According to Jasper *et al.* (1991), the weak relationship between the formation of endomycorrhizae and the amount of spores they have isolated is due to the fact that some propagules are dormant. In India, Suresh and Nelson (2015) reported that climate seasons influence the distribution and abundance of endomycorrhizal spores in the sugarcane rhizosphere. However, The number of spores increases regularly from July, reaches a maximum value in October (rainy season), decreases in winter and reaches its minimum in March and May (summer).

The observed spore's densities in the study sugar cane rhizosphere (53 to 88 spores per 100 g of soil) are low compared to those observed by Suresh and Nelson (2015) in the sugarcane rhizosphere of Tamil Nadu in India (742 spore / soil 100g). Artib *et al.* (2016) noted 42 to 240 spores per 100g soil in the citrus rhizosphere of the Gharb region, Chliyeh *et al.* (2014) reported (365 spores / 100g soil) in the rhizosphere of the olive tree. Weissenhorn (1994) noted 150 to 200 spores per 100 g of dry soil collected from agricultural soils polluted by atmospheric deposition; Sieverding (1991) counted 120 spores per 100 g of soil under cassava monoculture, 132 under rotating crop and 360 in savanna. In the rhizosphere of the southwestern Moroccan argan tree (900 to 2080 spores per 100 g of soil) (Nouaim, 1994) and of *l'Acacia albida* in Senegal (775 to 1240 spores per 100 g of soil) (Diop *et al.*, 1994). Bouamri *et al.* (2006) noted densities varying between 295 and 1900 spores per 100 g of soil in the Tafilalt palm rhizosphere. Sghir *et al.* (2014) reported for this same species in the regions of Draa and Tafilat, a number of spores ranging from 80 to 132 spores per 100 g. El Asri *et al.* (2014) observed 84-160 spores per 100g of soil in the Carob tree rhizosphere. On the other hand, in the rhizosphere of *Casuarina* sp., a very low spore number of spores was recorded ranging from 2 to 22 spores per 100 g of soil (Tellal, 2008). Gould *et al.* (1996) reported spore numbers varying from 4 to 1576 spores per 100 g of soil in quarried soils restored at different times after revegetation. Mott and Zuberer (1987) found spore densities reaching 9050 to 11470 spores per 100 g of soil in the mulberry soil.

The fungi associated with the roots of the sugarcane belonging to endomycorrhizae are very varied. The preliminary identification (based solely on the morphological criteria of the spores) made it possible to isolate 49 species, divided into 8 genera: *Glomus, Gigaspora, Acaulospora, Entrophospora, Pacispora, Scutellospora, Ambispora, Rhizophagus*. Twenty-one species belong to the *Glomus* genus (*Glomus intraradices, G. glomerulatum, G. microcarpum, G. aureum, G. aggregatum, G. macrocarpum, G. versiforme, G. claroideum, Glomus* sp.1, *Glomus* sp.2, *G. clavisporum, G. clarum, G. etunicatum ; G. monosporum; G. geosporum; G. globiferum ; G. fecundisporum ; G. fasciculatum; G. lamellosum ; G. badium ; Glomus citricola).* Thirteen to the *Acaulospora* genus (*Acaulospora laevis, Acaulospora kitinensis, Acaulospora capsicula, Acaulospora cavemata, Acaulospora scrobiculata, Acaulospora dilatata, Acaulospora morrowiae, Acaulospora excavate, Acaulospora spinosa, Acaulospora* sp.1, *Acaulospora* sp.2, *Acaulospora* sp.3, *Acaulospora* sp.4). Four to the *Gigaspora* genus (*Gigaspora* sp .1, *Gigaspora* sp. 2, *Gigaspora* sp .3, *Gigaspora* sp .4) and to the *Scutellospora* genus (*Scutellospora nigra, S. heterogamma, S. castanea* and *S. projecturata),* Three to the *Pacispora* genus (*P. scintillans, Pacispora* sp.1, *Pacispora* sp.2) And two to the *Entrophospora* genus (*Entrophospora kentinesis, Entrophospora infrequens*). The *Ambispora* genus (*A. appendicula*) and *Rhizophagus* (*R. fasciculatus*) are represented only by one species, respectively *A. appendicula* and *R. fasciculatus*. In different regions of India, the number of endomycorrhizal fungi species associated with the sugarcane rhizosphere is variable, Srikumar *et al* (2009) reported 11 species (*Acaulospora scrobiculata, Gigaspora margarita, Glomus aggregatum, G. deserticola, G. fasciculatum, G.geosporum, G. mosseae, Sclerocystis pachycaulis, S. pakistanica, S. sinuosa* et *Scutellospora heterogama*). Suresh and Nelson (2015) identified 25 species (*Glomus aggregatum, G. fasciculatum, G. mosseae, G. macrocarpum, G. ambisporum, G. fulvum, G. multisubstatum, G. maculosum, G. geosporum, G. scintillans, G. deserticola, G. constrictum, G. clarium, G. palvinatum, G. reticulatum, G. flavisporum, Aculospora bireticulata, A. spinosa, A. elegans, Gigaspora margarita, Gi. candida, Gi. decipiens, Scutellospora nigra, S. minuta, S. calospora*).

According to Datta and Kulkarni (2012), the diversity of the observed mycorrhizal arbuscular (AM) species and their ability to colonize roots are variable in the same plant species and are influenced by the environmental and biological factors. A

mycorrhizal richness was recorded at all the studied sites, according to Tacon (1978), The AM fungi are not specific and there are no natural sites where there is no endophytes; However, The endomycorrhizal fungi differ in their effective and effective powers, which appear to be more or less important depending on the host and the competition between the different endomycorhizogenic species.

The study showed that representatives of the *Glomus* genus are the most dominant species in the sugarcane rhizosphere (21 species). They vary from one site to another, *Glomus glomerulatum* and *G. claroideum* dominate at site 1, *Glomus clarum* dominates in site 2. Similarly, *Glomus etunicatum* and *G. fecundisporum* are the most commonly encountered in site 3 and *Glomus intraradices* and *G. citricola* are the most dominant species at site 4. In India, Suresh and Nelson (2015) also noted the dominance of the *Glomus* genus, followed by the *Acaulospora* genera, *Gigaspora* and *Scutellospora*. Datta and Kulkarni (2012) reported that *Glomus fasciculatum*, *G. fasciculatum*, *G. intraradices*, *G. mosseae* and *G. versiforme* are among the most commonly encountered species in the sugarcane rhizosphere. Zahraeni *et al.* (2014) noted the presence of genera species of *Glomus*, *Gigaspora*, *Acaulospora* and Sclerocystis in the sugarcane rhizosphere developing at three sites in the province of Sulawesi, In Indonesia, with a dominance of representatives of the first two genera. Species of the *Glomus* genus, cosmopolitan fungi, are encountered in many ecosystems (Sýkorová *et al*., 2007). They are reported in different habitats of cold regions, Temperate and tropical soils, in neutral and slightly alkaline soils (Mukerji *et al*., 2002). The dominance of species of the genus *Glomus* has also been demonstrated in the rhizosphere of different plant species developing in different regions of Morocco : The olive tree (Kachkouch *et al.*, 2012, 2014), The oleaster (Sghir *et al.*, 2013), The date palm (Bouamri *et al.*, 2006; Sghir *et al.*, 2014), The Carob (El Asri *et al.*, 2014, Talbi *et al.*, 2015 ), The poplar (Talbi *et al.*, 2014), *Juncus maritimus* (Talbi *et al.*, 2014), *Lycium europaeum* (Touati *et al.*, 2013) and the argan tree (Sellal *et al.*, 2016). This dominance of representatives of the *Glomus* genus has also been reported in several studies in Latin America (Lopes *et al.*, 1983; Cruz, 1989; Guadarrama and Alvarez-Sanchez, 1999), in China (Zhao *et al.*, 2001), In the arid and semi-arid zones of northern Jordan (Mohammad *et al.*, 2003) and in coastal dunes (Nicolson *et al.*, 1979 Giovannetti *et al.*, 1983; Bergen *et al.*, 1984; Schenck *et al.*, 1980; Ragupathy, 1998).

Besides species of the *Glomus* genus, some representatives of the *Acaulospora* genus dominate in some sites. Indeed, of the 13 encountered species, *Acaulospora* sp.2, and *Acaulospora dilatata*, dominate respectively in sites 2 and 3. In general, *Acaulospora* are frequently associated with acidic soils (Abbott, 1991).

The genera of *Gigaspora*, *Scutellospora*, *Entrophospora* and *Ambispora* are represented by only a few species. The genus *Acaulospora*, *Gigaspora* have already been observed in the Sudanian zone of Burkina Faso under the plantations of *Acacia halosericea* and *A. mangion* (Ba *et al.*, 1996), In the Moroccan coastal dunes of Souss Massa (Hatim and Tahrouch, 2007), in soils under argan trees (Sellal *et al.*, 2016) and in the rhizosphere of *Casuarina* sp. In Morocco (Tellal *et al.*, 2008). Species of the *Gigaspora* genus dominate mainly in sandy dunes (Lee *et al.*, 1994, Touati *et al.*, 2013). *Acaulospora* species are frequently encountered in acid soils (Abott, 1991). The encountered endomycorrhizal species in the sugarcane rhizosphere can be selected and exploited to produce vigorous nursery plants. Inoculation of sugarcane cuttings by indigenous CMAs may stimulate the early development of roots and shoots and also protect them from telluric diseases. Indeed, in the olive tree, the inoculation from the beginning of cuttings with a composite endomycorrhizal inoculum stimulates early rhizogenesis and the development of buds (Semane *et al.*, 2016). According to these authors, the presence of endomycorrhizal fungi in the substrate has led to good root and vegetative mass development and an increase in the percentage of successful cuttings.

Interactions between soil microorganisms are among the main determinants of sugar cane yields, but these interactions are still little known (Sebuliba *et al*., 2012). These authors noted that the incorporation of endomycorrhizae into the planting lines significantly improved the yield of sugarcane in ferralsol soils.

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