Efficient symbiotic microbiodiversity for crop development in different agroecological zones of Senegal.

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Introduction

The global prevalence of undernutrition, affecting more than 820 million people, highlights the urgency of achieving the Sustainable Development Goal "Zero Hunger" by 2030. In Senegal, where 77% of the workforce is engaged in family farming, low soil fertility and climate constraints limit the productivity of staple crops. Agroecology emerges as a credible alternative to strengthen food sovereignty and the resilience of agricultural systems(Wu et al., 2024). In this context, the BioMicNet project (Research and Innovation Network on Microbial Inoculation of Crops as a Lever for Agroecological Transition in Senegal), funded by ARES, aims to develop innovative solutions based on fungal microbiodiversity to improve agricultural productivity while preserving natural resources. The general objective of this thesis is to enhance the productivity of groundnut, millet, cowpea, tomato, and onion through the inoculation of arbuscular mycorrhizal fungi (AMF).

the stages of spore extraction

a solution of 100g of soil with 1 litre of water.

Recovery of spores retained by the 50µm sieve in centrifuge tubes

collection of spores at the interface of the two 20% and 60% sucrose solutions after centrifugation

spores collected for counting and identification

The potentiel mycorhizien infectieux

Preparation of soil dilutions with a final mass of 100g of soil at a rate of 5 pots/dilution

Sowing maize seeds at a rate of 2 seeds per pot

Watering and monitoring of crops for 45 days before harvest in the greenhouse

Trapping culture

Preparation of sterilised beach sand

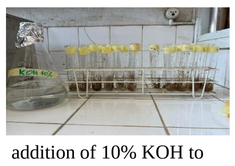
Inoculation with soil samples taken from the ZSP and the two ZBA areas 200g

followed by sowing millet, cowpea, peanut, onion and tomato seeds

watering and monitoring of the crop in the greenhouse for 2 months

Root Colouring

Tomato and onion roots rinsed with water Then placed in tubes



addition of 10% KOH to tubes containing roots

after placing in a bain-marie for 30 minutes at 90°C Add trypan blue after washing the KOH with water.Place in a water bath for 30 minutes at 80°C.

Then mount the slide and cover slip for observation.

Material and Methods

The activities began with soil and root sampling.

- Samples were taken from four areas, with three sites targeted in each area and three plots per speculation targeted at each site. In the sylvopastoral zone (ZSP) and the groundnut basin zone (ZBAN and ZBAS), cowpea, millet and groundnut plots were targeted. In the niaye zone ZN, in addition to soil samples from tomato and onion plots, root samples were also taken.
- Samples obtained :
  - 32 composite soil samples per site and per crop
  - 18 root samples per plot and per crop (MrO-TnO-KrO; onion sample ID and MrT-TnT-KrT: tomato sample ID)

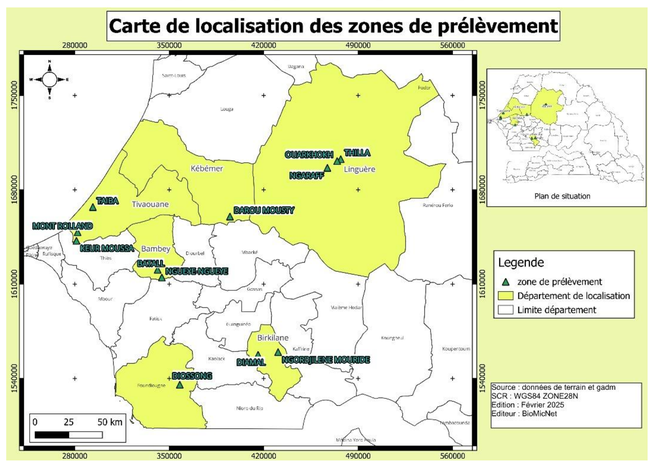


Figure 1: Map of sampling locations (Gadm data)

Root sampling

Soil sampling

Plant material:

- Violet de GALMI onion variety, COBRA tomato variety, 55 437 peanut variety, YACINE cowpea variety, SOUNA 3 millet variety, Zea mays

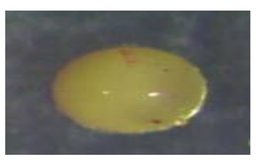
Method of study:

With the soil samples collected, the following manipulations were carried out:

- Spore extraction with wet sieving of the soil, followed by spore counting and morpho-anatomical characterisation of the CMA spores observed on each soil type;
- Study of mycorrhizal potential using the MPN technique (soil dilution technique) lasting one and a half months, using maize as a trap plant; coloration was performed and all-or-nothing counting was used to determine the MPN
- Subsequently, with soil samples from the silvopastoral zone and the peanut basin zone, trapping was carried out using targeted crops (millet, peanuts, cowpeas, tomatoes and onions) grown on a composite substrate of the sampled soils and Sangalkam beach soil in unequal proportions in order to trap the healthiest spores, find non-spore-forming species during these periods and perform a monospore analysis
- Genetic characterisation of ACMs by root metabarcoding after two months of trapping is planned. soils) lasting one and a half months
- part of the sampled roots was used to determine the rate of mycorrhization(Table 1) and the other part was stored at -20°C for genetic analysis

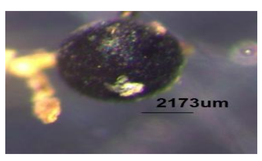
First Results

The number of spores present in 100g of soil varies greatly depending on the site, probably due to differences in agroecological conditions and soil management.

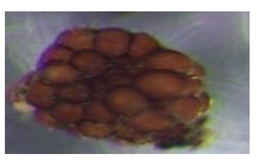


Spore de *Giaspora sp.*

Spore de *Rhizophagus sp*

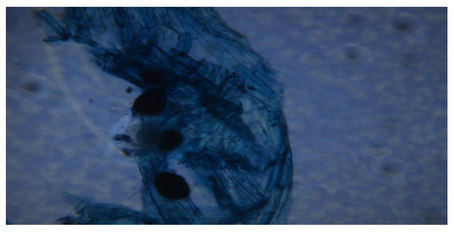


Spore de *Rococetra gregaria*

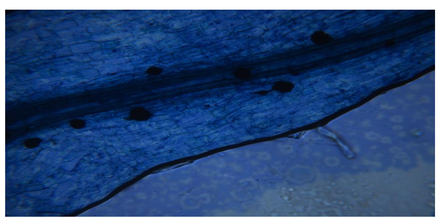


Spore de *Sclerocystis sp.*

Diversity of mycorrhizal spores present at different sites by INVAM The spores were identified according to colour, size, shape, attachment hyphae and consistency.



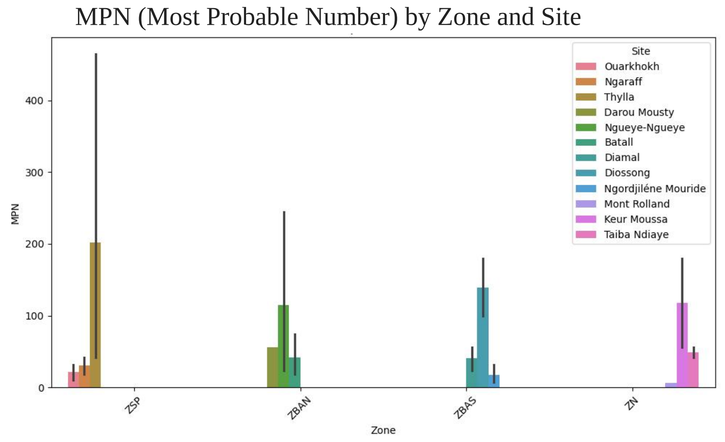
Appearance of mycorrhizal onion roots (X40)



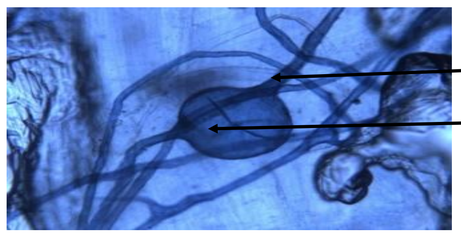
Appearance of mycorrhizal tomato roots (X40))

Colouring of tomato and onion roots revealed the presence of vesicles and hyphae characteristic of mycorrhization.

MPN (Most Probable Number) by Zone and Site



A comparative study shows that the MPN assessed per 100g of soil does not always follow the same trend as the number of spores per 100g of soil. This may indicate that the quality or viability of spores varies from one site to another.



Structures such as hyphae and vesicles were observed osn maize roots, indicating the presence of mycorrhization..

Table1: Frequency and intensity of mycorrhization of tomato and onions roots

ID sample	Frequency(%)	Intensity
MrO	70	8,35
MrT	47,3	3,22
KrO	59,3	1,92
KrT	39,6	0,76
TnO	68,3	15,66
TnT	56,3	8,41

The table shows the results of the mycorrhization parameters for tomato and onion roots. The average mycorrhization rates reach ~40% for tomatoes and ~60% for onions.seedling

Conclusions

The preliminary results reveal a high diversity of arbuscular mycorrhizal fungi across the sampled sites, with significant differences between agroecological zones. This variability suggests that local environmental conditions strongly influence fungal community composition. Future studies will focus on the characterization and selection of efficient indigenous fungal strains, followed by the formulation of inocula. These inocula will be tested under semi-controlled conditions and validated in the field to establish a robust database that supports the development of sustainable agricultural practices in Senegal.

References

Wu, Y., Chen, C., & Wang, G. (2024). Inoculation with arbuscular mycorrhizal fungi improves plant biomass and nitrogen and phosphorus nutrients: a meta-analysis. BMC Plant Biology, 24:960.