The combination of a consortium of arbuscular mycorrhizal fungi with reduced doses of fertilizers enhances the growth and yield of vegetable crops in southern Benin

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Presented by :

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PLAN

- ❑ Introduction
- ❑ Materials & Methods
- ❑ Results & Discussion
- ❑ Conclusion & Perspectives

Soil degradation **major threat to food security**

Aguégué et al. (2021)

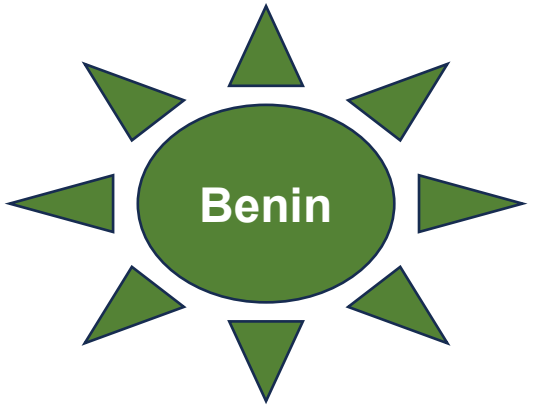
Soil fertility
(sub-Saharan Africa)

reduced

- Erosion
- Overexploitation
- excessive use of mineral fertilizers

Onguene, 2000

As a result : Agricultural productivity declines, particularly among smallholder vegetable producers



- **Strong agricultural pressure driven by intensive vegetable production**
- **Tomato and pepper cultivation play a strategic role:** representing a major source of income and food for local communities

However, their production remains constrained by declining soil fertility and the high cost of agricultural inputs, which also pose significant environmental concerns.

Agricultural practices that help reduce soil degradation while sustainably improving productivity and agroecosystem health deserve to be promoted.

Madigan et al., 2007

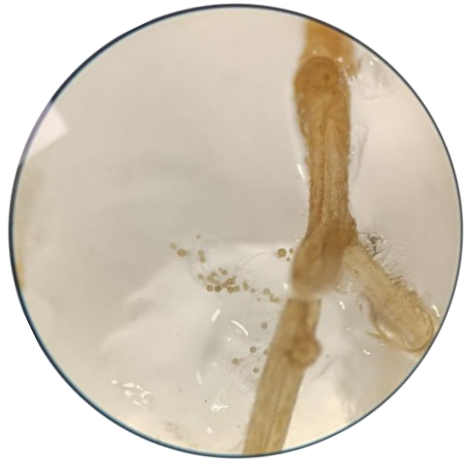
Among these practices is the use of beneficial soil microorganisms.

AMF used in pot-based co-culture experiments

- **Arbuscular mycorhizal fungi (AMF)**
- **Sustainable strategy :**

  - Enhance nutrient uptake.
  - Improve tolerance to abiotic stresses
  - Strengthen protection against soil-borne pathogens
  - Reduce reliance on chemical fertilizers.

Bolan et al., 2011 ; Wu et al., 2024



AMF *in vitro* culture

AMF : largely unknown among vegetable growers in Benin

In the context of diversifying and strengthening agricultural value chains to ensure food security, integrating these microorganisms into soil management strategies can provide substantial benefits for crop productivity.

❑ Objective:

To evaluate the potential of native AMF strains from Benin to enhance the growth and yield of tomato and African round pepper in the southern region of Benin

❑ Study Framework

- LBTMM / FAST / UAC

Figure 2: LBTMM Production unit

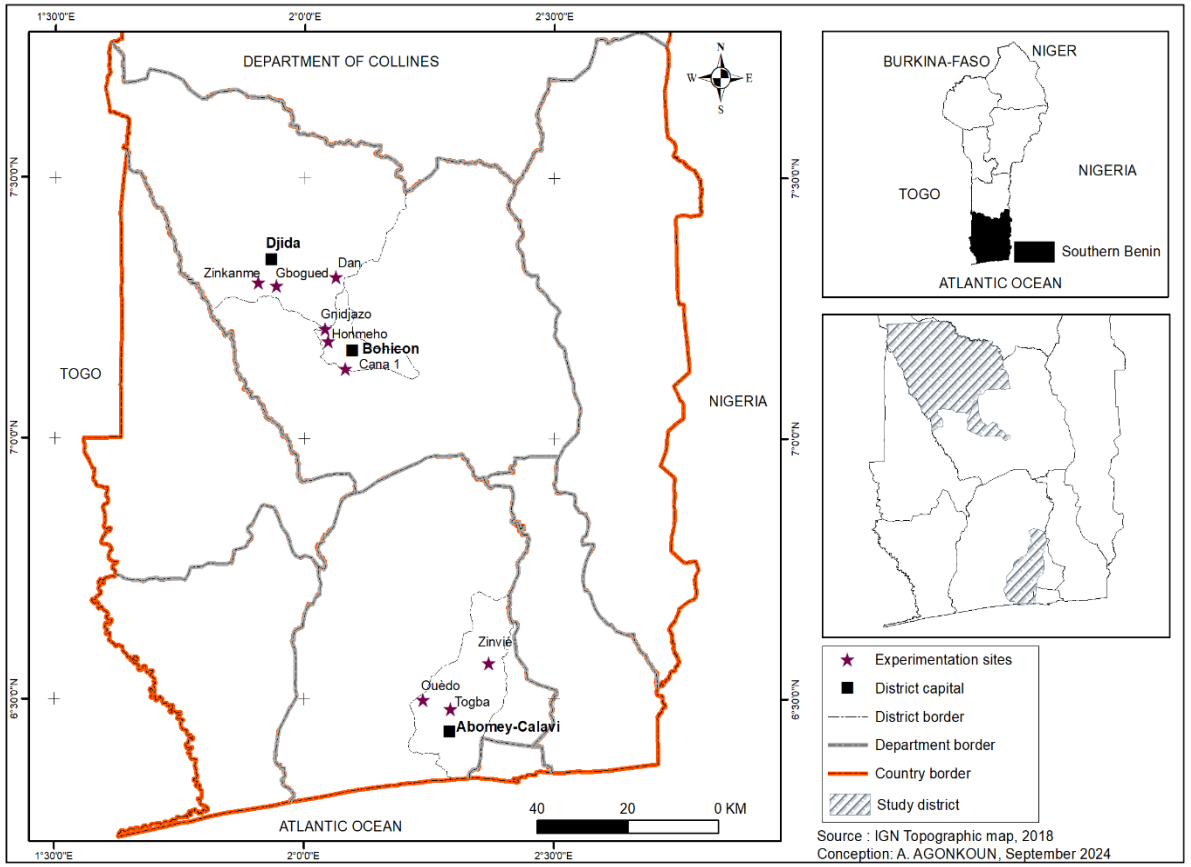


Figure 3: Map showing the location of the experimental sites.

❑ Matériel

- **Inoculum:**
  - *Rhizophagus intraradices*
  - *Funneliformice geosporum*
  - *Glomus caledonius*

AMF Inoculum

- **crop seeds :**
  - Tomato, cultivar Akinkon (100-day cycle)
  - Round pepper cultivar Malanville (100-day cycle

❑ Inoculation and Nursery

- **Coating**

Fernández et al., 2000

Substrate Preparation

Air-Drying

Figure 7: Coating the seeds

❑ Inoculation and Nursery

- **Nursery**

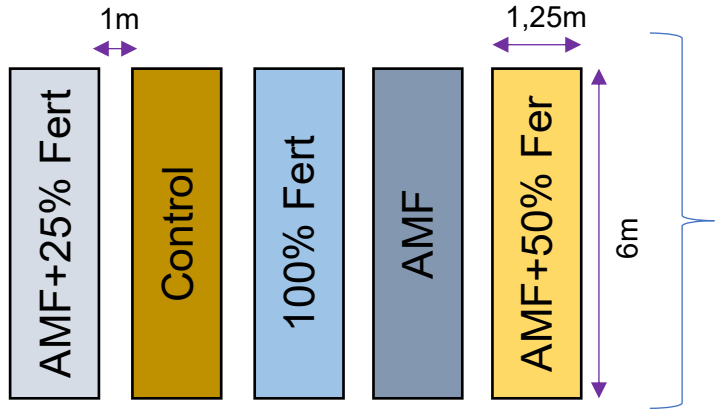
2 seeds per cell

Shading

Figure 8: Establishment of the nurseries

❑ Transplanting

- Experimental design



Ab-Calavi **(3 sites)**

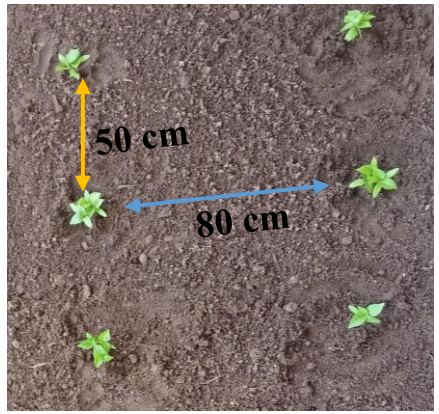
Bohicon **(3 sites)**

Djidja **(3 sites)**

Figure 9: Schematic representation of the experimental design

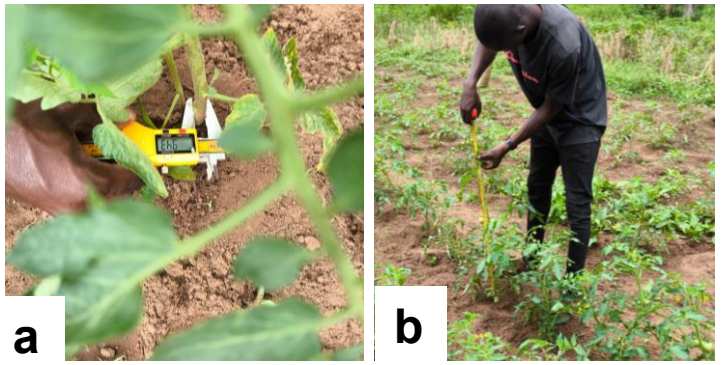
- Technical production practices Mensah et al. (2019)

4 true leaves



Monitoring and data collection

- Growth parameters (70 DAS)



a **b**

Figure 10: Collection of growth data.
a: Stem diameter (DAC); **b:** Plant heigh

- Yield was assessed (at harvest)

(Hamid et al., 2010)

$$\mathbf{Y\ (t/ha)} = \frac{\mathbf{P\ (kg)\ x\ d}}{\mathbf{1000}}$$

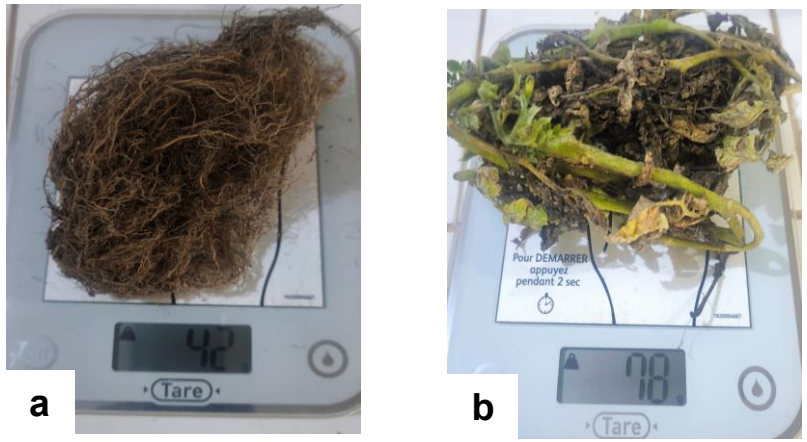
Y = Yield (t/ha) of the edible part;

P = Mass of the edible part per plant

d = Plant density per hectare

Figure 11: Collection of yield data.

- Biomass assessment



a **b**

Figure 12: Biomass weighing. **a:** Roots; **b:** Stem

-Drying at 55 °C for 72 hours

$$\mathbf{M\ (\%)} = \frac{\mathbf{BS\ (g)}}{\mathbf{BF\ (g)}} \times \mathbf{100}$$

Ullah et al., 2023

BS: Dry biomass
BF: Fresh biomass

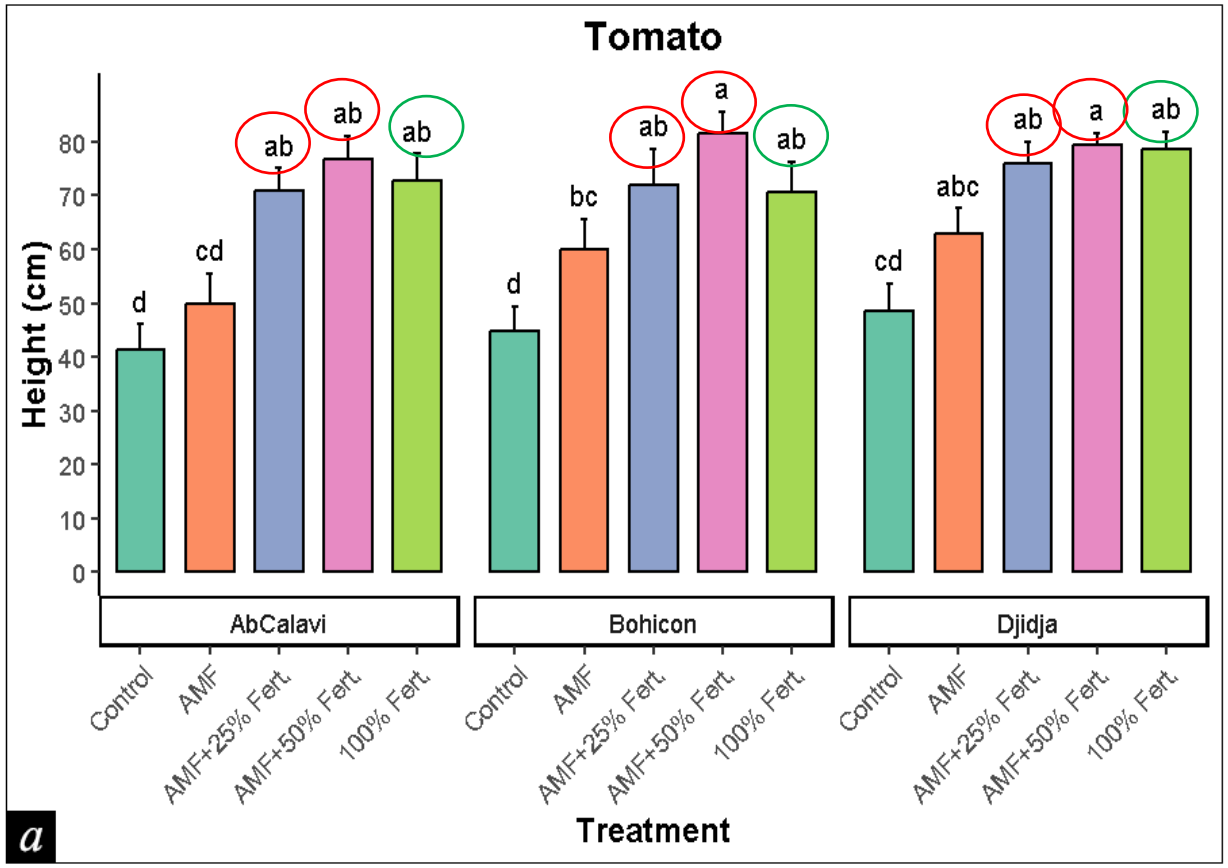
✓ **Microsoft Excel 2019**

- Data processing

✓ **RStudio**

- Two-way ANOVA
- Tukey test
- Graphs
- $p < 0.05$

❑ Effect of AMF on plant growth



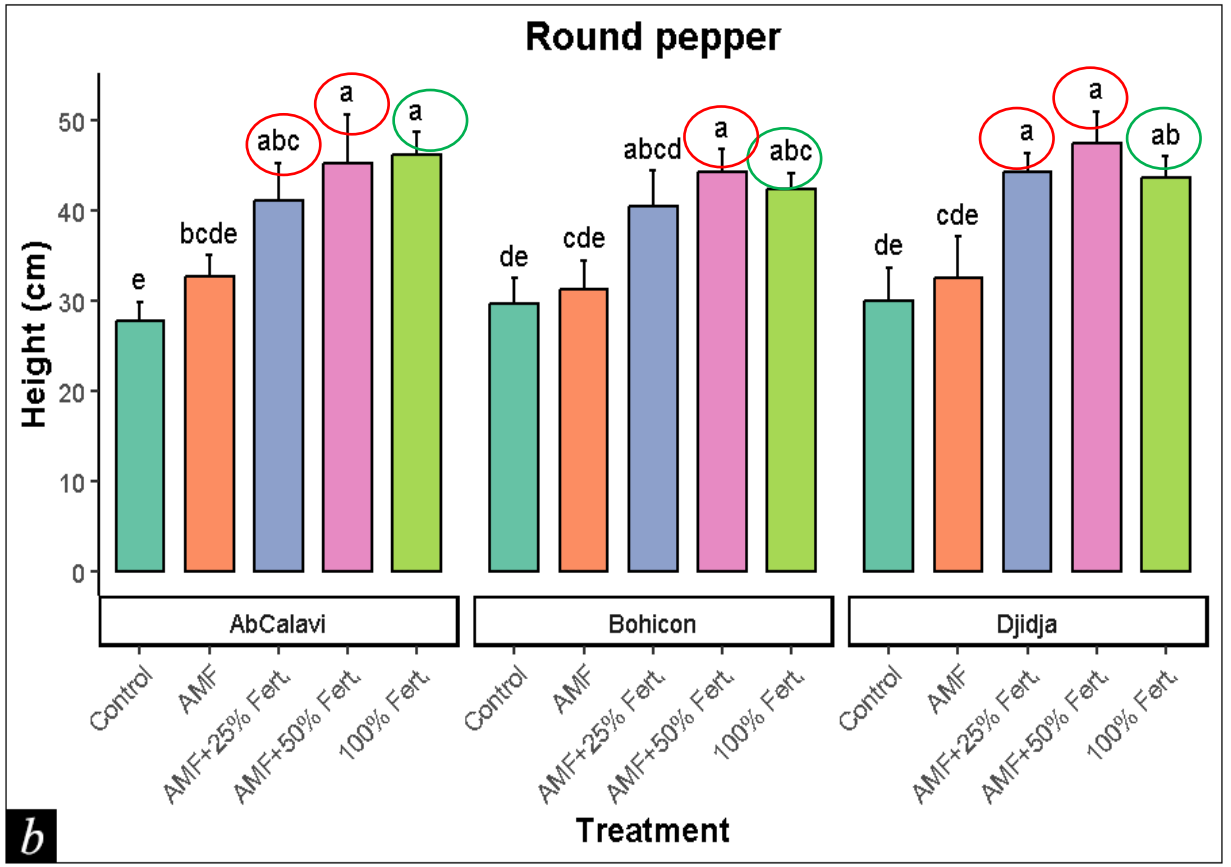
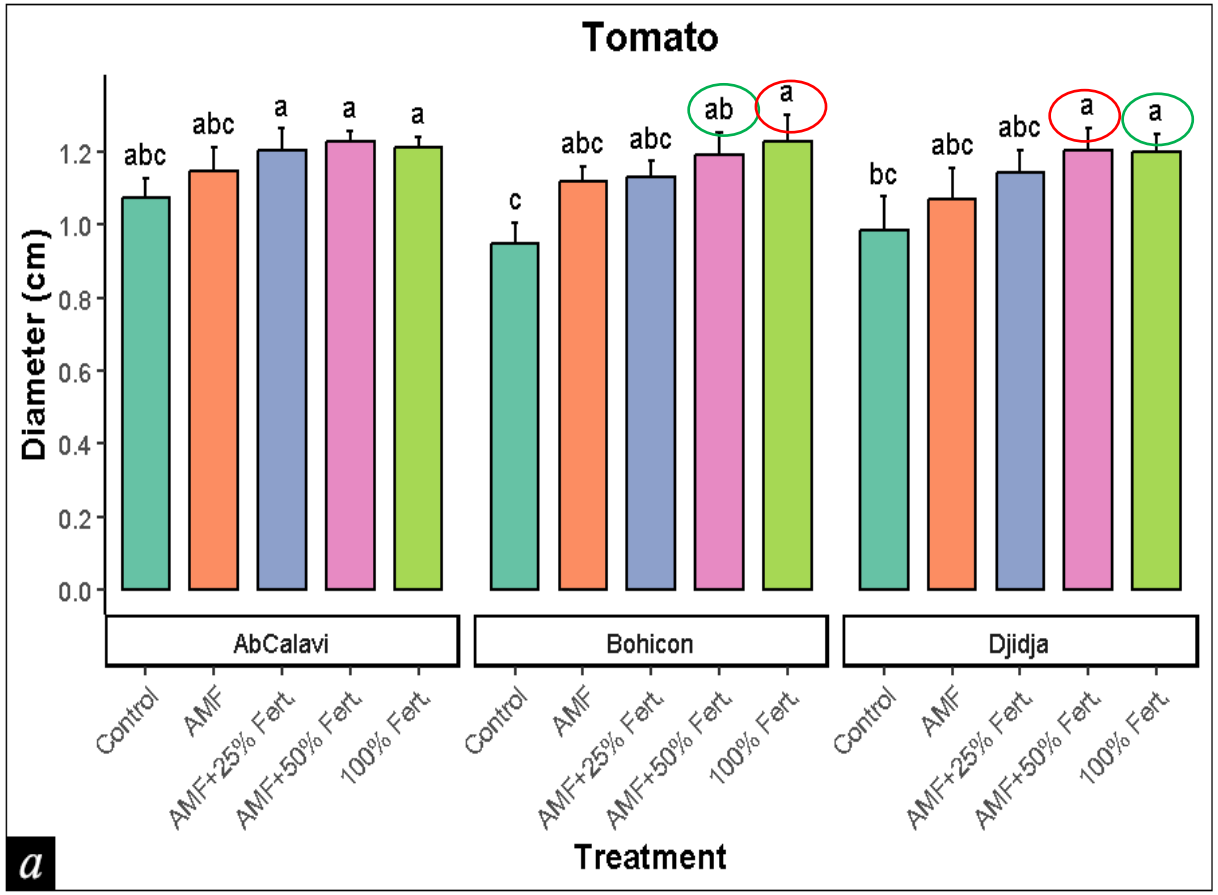


Figure : Effect of AMF on plant height, **a:** Tomato; **b:** Pepper

(Tran et al., 2022
Begum et al. (2019)

❑ Effect of AMF on plant growth



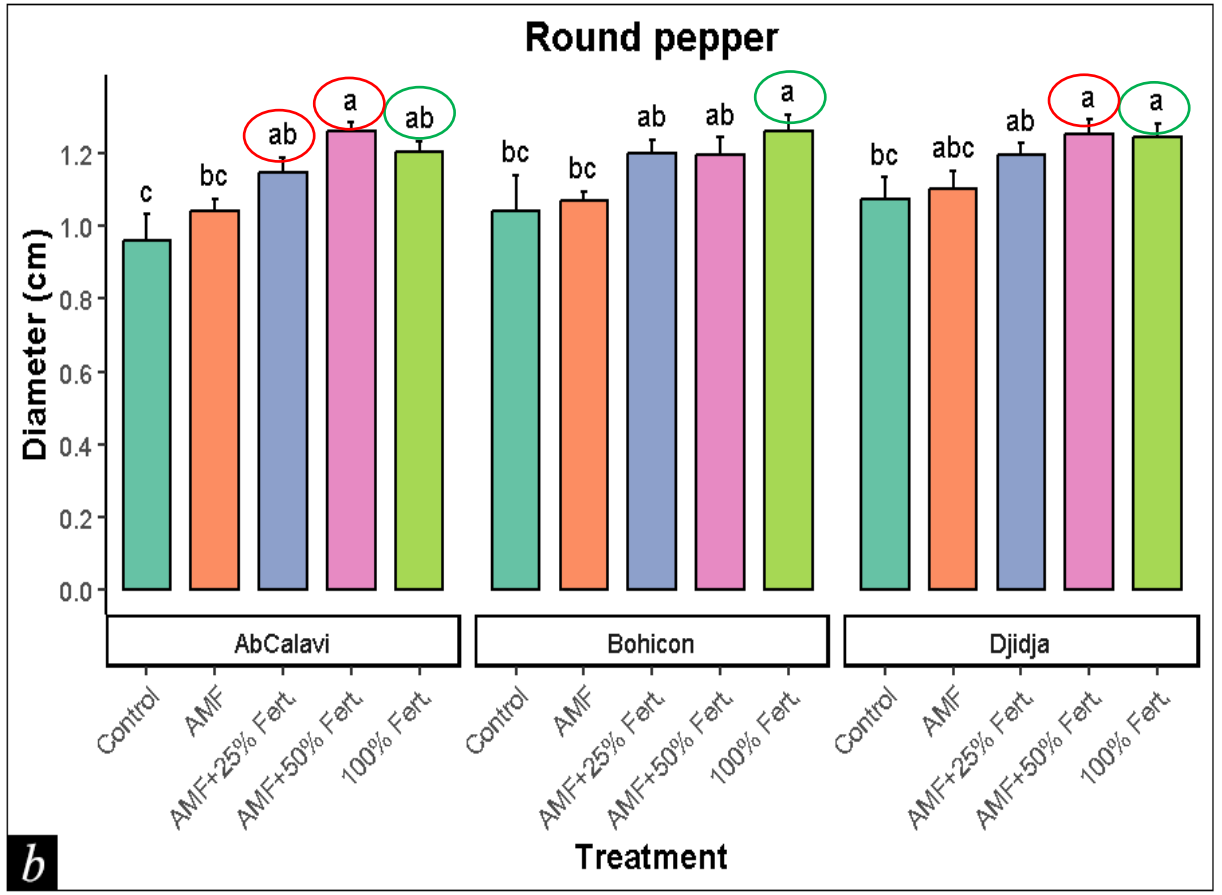


Figure : Effect of AMF on plant stem diamter **a:** Tomato; **b:** Pepper

Wu et al., 2009
Lehmann & Rillig, 2015

❑ Effet des CMA sur le rendement en fruits

Tableau I: Effet des CMA sur le rendement en fruits

Zones	Treatment	Fruit Yield (t.ha^{-1})		TFW (g)	
		Tomato	Pepper	Tomato	Pepper
Ab.Calavi	Control	5.9 ± 1.37 ^{e}	3.43 ± 0.34 ^{d}	107.59 ± 10.21 ^{c}	12.36 ± 1.36 ^{c}
	AMF	7.42 ± 0.51 ^{de}	3.90 ± 0.77 ^{cd}	118.72 ± 9.12 ^{abc}	16.25 ± 3.08 ^{bc}
	AMF+25% Fert.	8.93 ± 1.03 ^{bcd}	4.94 ± 0.52^{abc}	132.07 ± 16.86 ^{ab}	16.52 ± 2.95 ^{bc}
	AMF+50% Fert.	**10.15 ± 0.35 ^{abc}**	**5.22 ± 0.76 ^{ab}**	**137.16 ± 13.96 ^{a}**	**18.56 ± 3.44 ^{ab}**
	100% Fert.	**10.17 ± 0.71 ^{abc}**	5.08 ± 0.73 ^{ab}	**138.34 ± 12.31 ^{a}**	**18.91 ± 3.12 ^{ab}**
Bohicon	Control	7.06 ± 1.09 ^{e}	3.24 ± 0.24 ^{d}	109.15 ± 6.87 ^{c}	12.56 ± 2.30 ^{c}
	AMF	8.71 ± 0.98 ^{cd}	4.18 ± 0.57 ^{bcd}	119.64 ± 10.1 ^{abc}	15.94 ± 1.57 ^{bc}
	AMF+25% Fert.	9.63 ± 0.61 ^{abc}	5.12 ± 0.40 ^{ab}	134.06 ± 16.69 ^{ab}	16.05 ± 1.91 ^{bc}
	AMF+50% Fert.	**10.56 ± 0.66 ^{a}**	**5.66 ± 0.8 ^{a}**	**140.6 ± 13.34 ^{a}**	**18.68 ± 3.91 ^{ab}**
	100% Fert.	10.32 ± 0.94 ^{ab}	5.56 ± 0.58 ^{a}	131.94 ± 15.39 ^{ab}	18.06 ± 3.52 ^{ab}
Djidja	Control	6.51 ± 1.52 ^{e}	3.67 ± 0.55 ^{d}	104.6 ± 15.59 ^{c}	12.92 ± 1.07 ^{c}
	AMF	8.92 ± 0.93 ^{bcd}	3.89 ± 0.31 ^{cd}	112.58 ± 5.9 ^{bc}	16.38 ± 2.11 ^{bc}
	AMF+25% Fert.	9.96 ± 0.67 ^{abc}	5.00 ± 0.61 ^{ab}	137.91 ± 16.63 ^{a}	16.17 ± 2.65 ^{bc}
	AMF+50% Fert.	**10.94 ± 0.64 ^{a}**	**5.69 ± 0.85 ^{a}**	**134.85 ± 7.5 ^{ab}**	**21.51 ± 2.73 ^{a}**
	100% Fert.	10.52 ± 0.75 ^{a}	5.09 ± 0.86 ^{ab}	134.78 ± 18.66 ^{ab}	18.3 ± 3.02 ^{ab}
	Significance	***	***	***	***

The values are expressed as the means ± SD. Means sharing at least a letter in the same column are not significantly different at the 5% thresbold according to ANOVA followed by Tukey test (p≤0.05, n=9). *** = p < 0.001 (highly significant).. Ab.Calavi : Abomey-calavi.

Xie et al., 2023

Zhang et al., 2023

❑ Conclusion

Inoculation with arbuscular mycorrhizal fungi (AMF) can be an effective strategy to enhance the growth and yield of tomato and pepper under field conditions. Indeed, plants of both crops exhibited improved vegetative development and higher yields following AMF application, particularly when combined with 50% of the recommended dose of mineral fertilizers.

This outcome is supported by the high root colonization observed in inoculated plants, which promoted better uptake of phosphorus and other essential nutrients, thereby contributing to the optimization of agronomic performance.

❑ Perspectives

It would be relevant to extend investigations to other strategic vegetable crops in order to confirm and generalize the potential of AMF in diversified production systems.

Long-term evaluation of the effect of AMF on soil fertility and the resilience of agroecosystems to abiotic stresses deserves further investigation.

Further studies should examine the interactions between AMF and different types of organic amendments or biofertilizers, with the aim of developing integrated technical practices that are more environmentally friendly and economically accessible to farmers

The implementation of participatory trials with farmers would be a crucial step to adapt AMF inoculation practices to local realities and promote their large-scale adoption within a framework of sustainable agroecology.

THANK YOU FOR YOUR ATTENTION