INFLUENCE OF MYCORRHIZAL FUNGI, COCOA POD HUSK BIOCHAR AND PIG MANURE ON THE GROWTH AND HEALTH STATUS OF COCOA PLANTS (*Theobroma cacao* L.) DURING THE NURSERY STAGE

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ABSTRACT

Ensuring the good growth and health of young cocoa trees in the nursery is a major issue for the successful rehabilitation and development of cocoa orchards. Our work aims to investigate possibilities for improving the quality of cocoa tree seedlings in nurseries by investigating the impact of arbuscular mycorrhizal fungi (AMF) in combination with cocoa pod husk biochar and pig manure on the growth performance and health status of cocoa seedlings. The experiment was carried out in a farming environment in Nkolandom, (Southern Cameroon). A completely randomized design was used. Treatments resulted from the combination of two factors: the presence of mycorrhizal fungi and the type of organic fertilizer added to the substrate (simple substrate, substrate + 9 g of biochar per kgof soil, and substrate + 30 g of pig manure per kg of soil). The growth of cocoa seedlings was significantly ($p < 0.05$) improved by biochar and the mycorrhizae-biochar combination, which showed the best results in terms of height (26.62 and 24.63 cm respectively), stem circumference (1.7 and 1.6 cm), leaf area (743.51 and 532.98 cm2), fresh and dry biomass compared to the control and pig manure after twelve weeks in the nursery. Evaluation of health status revealed that mycorrhizal and non-mycorrhizal plants, in combination with biochar, were the least susceptible to the observed symptoms (leaf necrosis and stem lesions) in contrast to pig manure treated plants and the control.

Keywords: Cocoa nursery, Cocoa seedling health, Mycorhizzal fungi, Biochar, Pig manure

1. INTRODUCTION

The cocoa tree (*Theobroma cacao* L.) is one of the most important cash crops valued worldwide.

- Low yields are observed in Cameroon, between 240-300kg.ha^{-1} (Jagoret *et al.*, 2017), which explains the failure of the Cameroonian government to reach the 600,000 t mark hoped by 2020.
- Replanting orchards with quality plant material as a solution to the production problem and to guarantee the sustainability of the sector (Adden *et al.*, 2016)

Given the replanting constraints related to the production of seedlings from the nursery (Wessel and Quist-Wessel, 2015), what is the place for the use of mycorrhizal fungi, cocoa pod husk biochar and pig manure in the process of obtaining quality seedlings in the nursery?

2. MATERIALS AND METHODS

The experimental area was located in Nkolandom, in the Southern region of Cameroon. The potting soil was obtained from a 10 year old cocoa field at 15 cm depth (pH=5.7, OM= 7.8%, available P= 24.5 ppm)

- About 1080 seeds of clone TAFO 79/501 were pre-germinated in the dark at 30°C and grown in polyethylene bags containing 3kg of soil each.
- The biochar used in the trial was produced locally from cocoa pod husks following the method described by Njukeng *et al.* (2017)
- In each inoculated treatment, 15g of inoculums (mixture of pure strains of *Gigaspora margarita* and *Auculospora tuberculata*) was applied according to the method described by Cuenca *et al*. (1990).
- Disease severity (DS) of each plant was visually inspected for symptoms of leaf necrosis and brown stem lesion and recorded using the Horsfall-Barratt scale.

Principal component analysis (PCA) and cluster analysis were performed on all collected phenotypic data to systematically understand the distinct mode of action of different treatments on plant growth and health in the nursery. The statistical comparison between treatments was made by the Duncan Multiple Range Test for p<0.05. All analyses and graphs were performed using R software version 4.1.1.

Table 1 : Summary of trial treatments

Treatments	Signification
Control	Potting soil
PM	Potting soil + pig manure (30g.kg^{-1} of soil)
Biochar	Potting soil + pig manure (9g.kg^{-1} of soil)
Myco	Potting soil + Mycorrhiza (15g/pots)
Myco+PM	Potting soil + Mycorrhiza (15g/pots) + pig manure (30g.kg^{-1} of soil)
Myco+Biochar	Potting soil + Mycorrhiza (15g/pots) + pig manure (9g.kg^{-1} of soil)

3. RESULTS

After 12 weeks of observation, statistically significant differences were found ($p < 0.05$) between all treatments for all the variables (growth and health status). The cluster analysis revealed that the **biochar** and **myco+biochar** treatments significantly increased aerial tissue growth and improved health status 12 weeks after sowing, and had a positive influence on the cocoa tree in the nursery (Fig. 1A, B). The **control** and **pig manure** had mitigated effects on promoting aerial tissue growth in young cocoa trees and were most susceptible to leaf necrosis and stem lesions respectively. In the PCA score plot of cocoa trees in the nursery, PC1 and PC2 accounted for 75.7% and 16% of the total variance respectively, which clearly separates the functions of **biochar**, **myco+biochar**; **pig manure** and **myco+pig manure**.

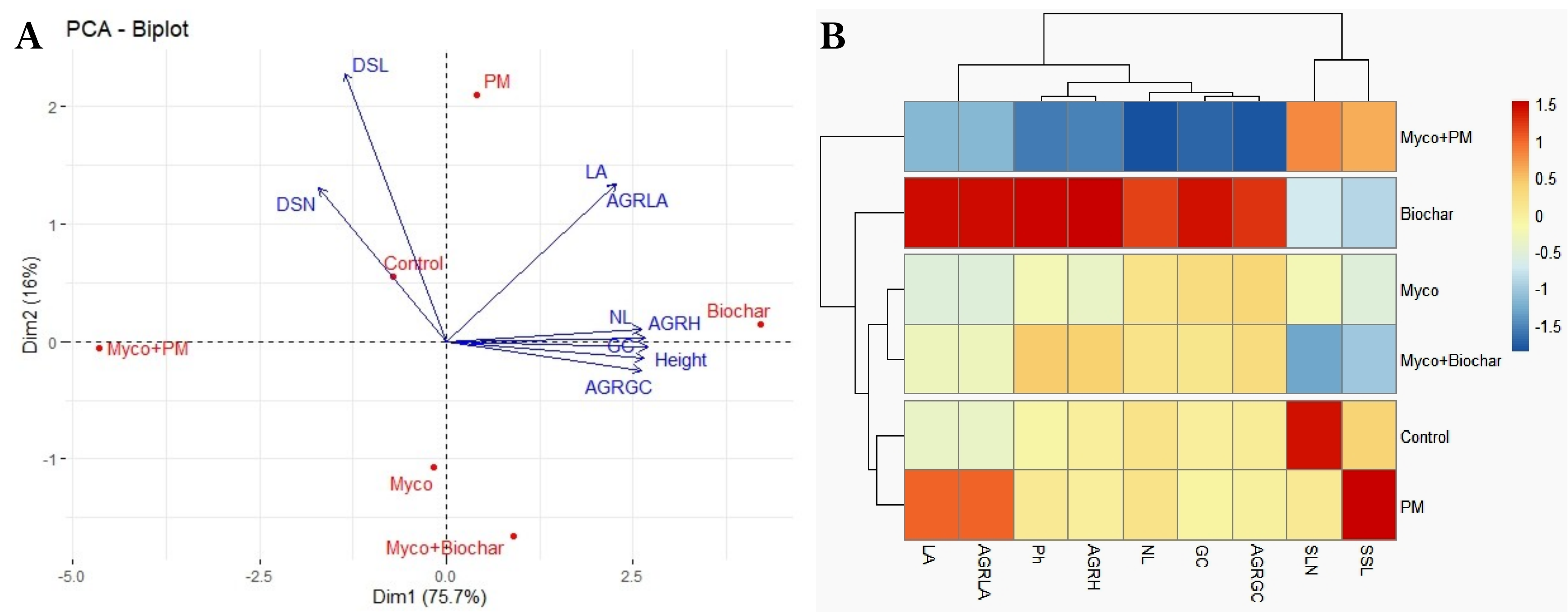

Figure 1 : Different treatments have distinct effects on the growth and health status of cocoa plants. (**A**) Principal component analysis (PCA) of growth and health parameters 12 weeks after sowing and application of treatments.(**B**) Cluster analysis of growth and health parameters 12 weeks after sowing and application of treatments. AGRG=Absolute growth rate of girth; AGRH=Absolute growth rate of height; AGRLA=Absolute growth rate of leaf area; GC=Girth circumference; LA=Leaf area; Ph=Plant height; NL=Number of leaves; SSL=Severity of stem lesions; SLN=Severity of leaf necrosis.

4. CONCLUSION

The **biochar** and **myco+biochar** treatments were the most effective, and improved the growth and health status of the nursery plants, providing a potential basis for the production of quality cocoa plants and promoting their adaptability in their future agroecosystems.

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