



EFFECT OF VERMICOMPOST ASSOCIATED WITH MYCORRHIZAL FUNGI ON THE GROWTH OF EGGPLANT IN ORGANIC GREENHOUSE AGRICULTURE †

[EFECTO DE LA VERMICOMPOSTA ASOCIADA A HONGOS MICORIZALES SOBRE EL CRECIMIENTO DE BERENJENA EN AGRICULTURA ORGÁNICA DE INVERNADERO]

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SUMMARY

Background. In West Africa, the eggplant crop participates in the fight against rural poverty, hunger and malnutrition due to their higher nutritional contents. However, this crop is faced with several constraints including poor soils and low yielding cultivars. It is known that mycorrhization of plants improves plant nutrition while preserving them from certain pests. **Objective.** To evaluate the combination of mycorrhization and vermicompost effect on eggplant plants growth and yield. **Methodology.** A consortium of arbuscular mycorrhizal (AM) from forest soils was trapped using maize roots and used as inoculum for eggplant, Djamba F1 variety. A trial using this inoculum combined or not to vermicompost was carried out for 90 days under a greenhouse. Selected soil properties, eggplant growth and yield indicator were recorded at the end of trial. **Results.** As expected, soil vermicompost alone or combined to inoculum displayed an increase of soil parameter such as pH, exchangeable base cations, total organic matter, total nitrogen compared to control and soil with AM alone. Soil with AM alone had a limited impact on the growth and yield of eggplant. In contrast, all treatments including vermicompost (vermicompost alone and vermicompost + AM) showed a significant increase of eggplant growth parameters and yield's indicators. **Implications.** These results highlighted a need to carry out a screening of mycorrhizal fungi from eggplant production areas to isolate and identify the efficient strains of mycorrhizal fungi for symbiosis with eggplant under tropical conditions. **Conclusion.** The vermicompost significantly improved the growth of the eggplant. Its coupling with a consortium of spores of the genera results in better plant growth and yield. This combination has a significant effect on the studied parameters (height, crown diameter, biomass and yield).

Keywords: Organic agriculture; mycorrhization; organic matter; soil.

RESUMEN

Antecedentes. En África Occidental, el cultivo de berenjena participa en la lucha contra la pobreza rural, el hambre y la desnutrición debido a su buen contenido nutricional. Sin embargo, este cultivo se enfrenta a varias limitaciones, incluidos suelos pobres y cultivares de bajo rendimiento. Se sabe que la micorrización de las plantas mejora la nutrición de las plantas al mismo tiempo que las preserva de ciertas plagas. **Objetivo.** Evaluar el efecto de la combinación de micorrización y vermicomposta en el crecimiento y rendimiento de berenjenas. **Metodología.** Se capturó un consorcio de micorrizas arbusculares (MA) de suelos forestales utilizando raíces de maíz y se utilizó como inóculo para berenjena, variedad Djamba F1. Se realizó un ensayo con este inóculo combinado o no con vermicompostaje durante 90 días bajo invernadero. Propiedades seleccionadas del suelo, el crecimiento de la berenjena y el indicador de rendimiento se registraron al final del ensayo. **Resultados.** Como se esperaba, la vermicomposta en el suelo solo o combinado con el inóculo mostró un aumento de los parámetros del suelo, como el pH, los cationes básicos intercambiables, la materia orgánica total, el nitrógeno total en comparación con el

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control y el suelo con AM solo. El suelo con AM sólo tuvo un impacto limitado en el crecimiento y rendimiento de la berenjena. En contraste, todos los tratamientos que incluyeron vermicomposta (vermicomposta solo y vermicomposta + AM) mostraron un aumento significativo de los parámetros de crecimiento de la berenjena y los indicadores de rendimiento. **Implicaciones.** Estos resultados destacaron la necesidad de realizar un cribado de hongos micorrízicos de las áreas de producción de berenjena para aislar e identificar las cepas eficientes de hongos micorrízicos para la simbiosis con la berenjena en condiciones tropicales. **Conclusión.** Lal vermicomposta mejoró significativamente el crecimiento de la berenjena. Su acoplamiento con un consorcio de esporas de los géneros da como resultado un mejor crecimiento y rendimiento de la planta. Esta combinación tiene un efecto significativo sobre los parámetros estudiados (altura, diámetro de copa, biomasa y rendimiento). **Palabras clave:** Agricultura orgánica; micorriza; materia orgánica; suelo.

INTRODUCTION

Agriculture in sub-Saharan Africa, which is highly dependent on climatic conditions, is threatened by the adverse effects of climate change (Arodokoun *et al.*, 2012). In the current state of knowledge, climate change negatively affects agricultural yields through its impacts on plant growth, development and varietal diversity (Rahman *et al.*, 2015). According to Scheelbeek *et al.* (2018), eggplant (*Solanum melongena* L.) is one of the most affected plants among the most vulnerable crops. Eggplant is an herbaceous plant of the Solanaceae family, native to Asia. It is one of the 40 most produced vegetable species globally (FAO, 2008). Global eggplant production was estimated at 54 million tons in 2018 on about 1 million hectares (FAO, 2020) Eggplant has a very low caloric value but is considered one of the healthiest vegetables because of its high content of vitamins, minerals and bioactive compounds for human health (Docimo *et al.*, 2016). The fruits and leaves of this plant are consumed by the population (CNRA, 2013). Unfortunately, the production system of this crop in sub-Saharan Africa remains traditional, characterized by low yields (CNRA, 2013). Current intensification programs involve the overuse of chemical inputs (fertilizers, pesticides and herbicides) in production systems, which has substantially increased yields (FAO, 2011). However, the cost of chemical inputs is inaccessible to producers and their use leads to long-term degradation of soil quality followed by pollution of aquatic ecosystems (Suhag *et al.*, 2016). In such a context, ensuring the food security of populations and protecting the environment are two major challenges that the scientific community will have to face to ensure sustainable agricultural production in western Africa (Masse *et al.*, 2013).

One way of thinking about this is to intensify agricultural production based on the principles of organic farming. Indeed, organic agriculture is the efficient production of high-quality agricultural products to protect and improve the natural environment as well as the social and economic conditions of farmers (Landais, 1998). Therefore, this model is based on ecological processes and functionalities that allow for the control of bio-aggressors, the reduction of nuisances, the better use

of non-renewable resources, such as water, soil or the improvement of ecological services (Bonny, 2011). Thus, in this model of agriculture, soil fertility management is partly ensured by good management of organic matter obtained in various ways (vermicompost, compost, poultry droppings, cow dung) and by the use of soil microorganisms such as mycorrhizal fungi and nitrogen-fixing bacteria (Gilly and Eghball, 2002). Using organic matter (compost) as mulch, in the soil, or as potting media is beneficial (Giusquiani *et al.*, 1995). Compost contains a full spectrum of essential plant nutrients, especially macro and micronutrients often absent in synthetic fertilizers. Its application in the cropping system improves soil properties by buffering the soil, neutralizing both acid and alkaline soils, bringing pH levels to the optimum range for nutrient availability to plants. Compost helps sandy soil retain water, nutrients and bacteria in compost break down organics into plant-available nutrients. Some bacteria convert nitrogen from the air into a plant available nutrient. In literature, it is underlined that arbuscular mycorrhizal fungi (AMF) facilitate host plants to grow vigorously under stressful conditions. This soil-borne fungi can significantly improve plant nutrient and water uptake in addition to resistance to several abiotic stress factors.

However, few investigations have been conducted in a tropical context, especially in West Africa, to evaluate the combined effect of microorganisms associated with organic matter on soil fertility and yield of eggplant crops in organic farming. Therefore, this study was undertaken to evaluate the combined effect of vermicompost associated with mycorrhizal fungi on soil properties and eggplant growth in controlled conditions. The final goal is to contribute to the intensive and organic production of eggplant.

MATERIALS AND METHODS

Plant growth

The cultivation trials started with preparing an inoculum from forest soil. For this purpose, maize was used as a host plant to multiply arbuscular mycorrhizal fungi (AMF). Maize seeds were disinfected with 2.4% calcium hypochlorite solution

for 30 minutes and rinsed 3 times with sterile distilled water. They were then germinated on an agar medium in an oven for 5 days at a temperature of 30°C. The seedlings were transferred into a device containing a substrate containing fungal spores extracted from forest soil. Forty-five days after transplanting, the maize plants were cut at the stem base to harvest the roots. The roots and rhizosphere soil were collected and air-dried for 5 days. Mycorrhization of the roots was later checked using the root staining technique described by Philips and Hayman (1970). Additionally, fungal spores were extracted from maize growth substrate using the wet sieving method described by Brundrett *et al.* (1995). The isolated spores were observed with a high resolution stereo-microscope (Bestscope BS-3014A®) and, their viability was estimated, considering their morphology, turgidity, color and damage. Thus, counting was carried out taking into account alive, dead and total spores. The mycorrhizal roots were finely cut and mixed with fungal spores (~ 2500 alive spores) from rhizospheric soil to form the inoculum.

After mycorrhizal inoculum production, eggplant seeds 'Djamba F1' from the semivoire® group were sown in a flat plastic seedling tray with 72 cell plug (6.5 cm) deep containing coconut chips for seedlings. Thirty days later, seedlings were transplanted in 20 PVC (polyvinyl chloride) pots (Length: 47 cm and diameter: 50 cm) containing sterile forest soil, with three plants per pot. After two weeks, the two least vigorous plants were removed from the pots to leave only one plant. The substrate was then amended with vermicompost and mixed or not with the inoculum. The experimental design included four treatments. These treatments were **T0** (Control, soil without amendment or mycorrhizal inoculum), **T1** (Soil + 30g inoculum), **T2** (Soil + 1kg vermicompost) and **T3** (Soil + 30g inoculum and 1 kg vermicompost). The treatments were arranged in a factorial experiment with randomized complete block design in 5 replicates.

During the growth experiment, plants were manually watered three times by week with 100 ml of water per pot. Growth measurements (height, stem diameter, number of leaves) were registered weekly during the experiment. After 3 months of growth, eggplants were removed from pot culture, the roots and shoots were harvested for total biomass determination. The total biomass obtained was oven-dried at 70°C and weighed after 72h. A fraction of fresh roots was transferred to the laboratory to evaluate the rate of mycorrhizal colonization.

Chemical and microbial analyses

The analyses focused on the chemical and microbiological properties of the soil. These analyses concerned pH, total organic carbon (TOC),

total nitrogen (N-total), available phosphorus (P), exchangeable bases (Ca^{2+} , Mg^{2+} , Na^+ and K^+), and CEC (Cation exchange capacity). These chemical analyses were carried out according to the classical laboratory methods (AFNOR) and the base saturation (BS) representing the percentage of CEC occupied by bases (Ca^{2+} , Mg^{2+} , K^+ , and Na^+) were calculated from exchangeable bases. The rate of mycorrhizal colonization of eggplant roots was estimated according to the method described by Trouvelot *et al.* (1986). Microbiological analyses were performed on soil's total enzymatic activity. Enzymatic activity was analyzed by the photometric method where the hydrolytic cleavage of fluorescein diacetate (FDA) to fluorescein by several soil enzymes following the method developed by Green *et al.* (2006).

Statistical analysis

Data on the efficiency of eggplant production and the effect of soil treatments were subjected to analysis of variance (ANOVA) using Statistica version 7 software. Means were compared using the Newman-Keuls test at the 5% threshold.

RESULTS

Soil chemical and microbiological characteristics

The results of the chemical analysis indicate that the soil is acidic with a pH < 6, and the vermicompost has an alkaline pH close to 8. A slight increase in pH in the growing media is observed after the application of vermicompost. The average pH values of the growing media are between those of the soil and the vermicompost. However, this increase in relation to the application of vermicompost does not induce significant differences ($p > 0.05$) between the pH values of the substrates (Table 1). The organic matter content decreases from vermicompost to control soil. The organic matter data of the growth substrates are intermediate between these two extreme values (vermicompost and soil). The organic matter content of the crop substrates increases with the addition of vermicompost to the soil, but the differences are not statistically significant ($p > 0.05$). This observation is also true for the total nitrogen content in substrates. The C/N ratios indicate the value of 13 in the vermicompost while these ratios are on average close to 11, without a significant difference ($p > 0.05$) between the substrates and the soil. Cation exchange capacity (CEC) is low in the control soil and increases proportionally to the addition of vermicompost to soil without reaching the CEC value of vermicompost (Table 1). The analysis of variance showed a significant difference ($p < 0.05$) between the vermicompost and the substrate (treatment T3) on the one hand and the other substrates (T2, T1, and T0) on the other hand.

Table 1. Selected chemical characteristics of vermicompost and a composite sample of control soil (T0) and soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3) for eggplant growth.

Treatments	pH	MO (%)	N-total (%)	C/N	Phosphorus (ppm)	CEC	BS (%)
T0	5.37	4.87	0.27	10.66	38.00	9.33	32.79
T1	7.13	9.62	0.53	10.63	56.33	11.80	48.29
T2	7.73	13.18	0.73	10.57	57.67	16.93	62.07
T3	7.60	10.58	0.58	10.61	41.00	27.33	64.53
Vermicompost	7.90	28.98	1.30	12.96	88.00	29.80	58.99

The exchangeable base analyses show a proportion of calcium on the exchange complex ranging from 37% to 67% in the substrates and 47% in the vermicompost (Figure 1).

Calcium is followed by magnesium, whose proportion varies from 13% to 19% in the substrates and is 46% in the vermicompost. Potassium has the lowest proportion of exchangeable bases. The saturation rate in the substrates and the vermicompost is higher than in the control soil (Table 1). The saturation level increased with the addition of vermicompost. The results indicate high levels of available phosphorus in the control soil, substrates and vermicompost with the highest level in vermicompost and the lowest in control (Table 1).

Figure 2 shows the soil enzyme activity determined in the different substrates used for eggplant growth. The data indicate a low enzyme activity for the control soil compared to the other substrates. The highest total activity was obtained with treatment

T2, which was 3% and 32% higher than T3 and T1, respectively. However, the analysis of variance shows that there is no significant difference between treatments (T1, T2, and T3).

Eggplant growth and yield indicators

The plant growth indicators are height, stem diameter, and total plant biomass. The evolution of eggplant plant height during the experiment is presented in Figure 3. The data show a regular growth of plants up to 56^{eme} days after transplanting. Statistical analysis revealed a significant difference ($p < 0.05$) in plant height growth. The highest plant height was obtained with treatment T2 with an average of 76.8 ± 2.70 cm on the 56th day after transplanting, followed by treatment T3 with an average height of 64.2 ± 4.72 cm. On the other hand, the lowest heights were observed with treatments T0 and T1 with an average height of 23.4 ± 5.67 cm and 26.8 ± 3.97 cm respectively at 56th day after transplanting.

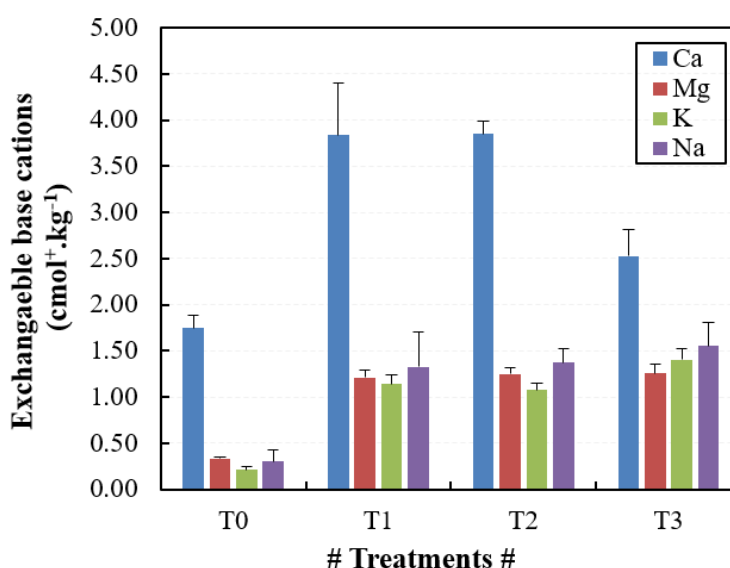


Figure 1. Exchangeable base contents in soil of control soil (T0) and soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Bars indicate the standard deviation of six replicates of each sample.

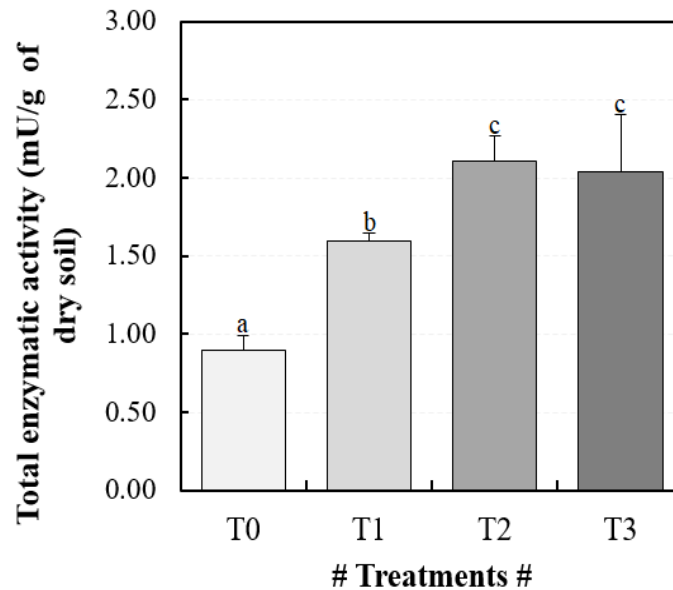


Figure 2. Total enzymatic activity of soil of control soil (T0) and soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Bar indicate the standard deviation of six replicates of each sample. The same letter on each histogram do not differ from each other at $p > 0.05$ ($n = 6$).

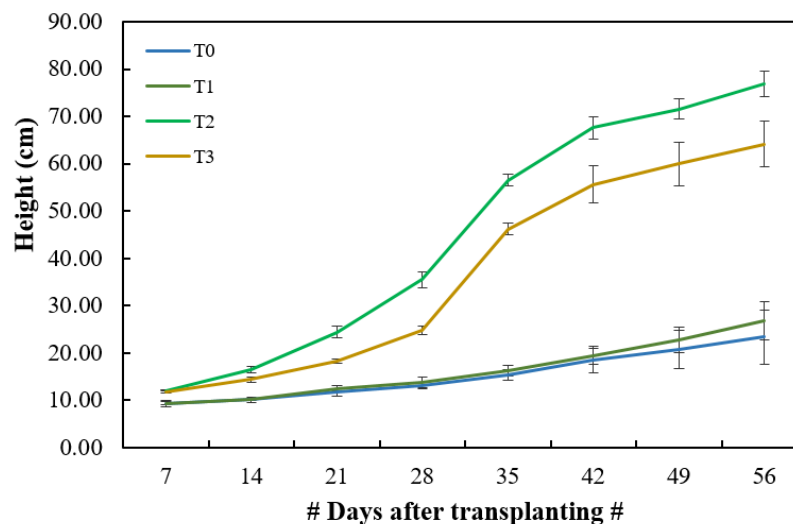


Figure 3. Overtime evolution of the height of eggplants grown on control soil (T0) and soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Bars indicate the standard deviation of six replicates of each sample.

Figure 4 shows the stem diameter of plants. Data allow distinguishing the plants from treatments T0 and T1, which have the smallest stem diameters, from treatments T2 and T3, which have the highest diameters during eggplant experiment growth. The evolution of the diameter at the stem collar section shows an increase in the diameter of the plants for treatments T0 and T1 until the 21st day after transplanting, then a reduction of the stem diameter growth until the 56th day after transplanting. On the

other hand, for treatments T2 and T3, the diameter at the stem collar section shows a regular increase to reach the average values at 56th day after transplanting respectively of 1.00 ± 0.10 cm and 1.16 ± 0.08 cm.

At the end of the growth experiment, weighted root and shoot dry biomass of plants under the different treatments are presented in Figure 5.

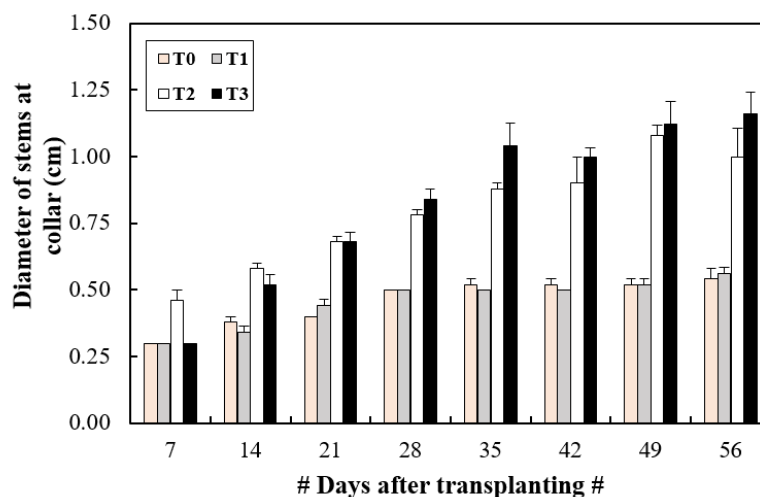


Figure 4. Overtime variation in stem diameter of eggplants grown on control soil (T0) and soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Bars indicate the standard deviation of six replicates of each sample.

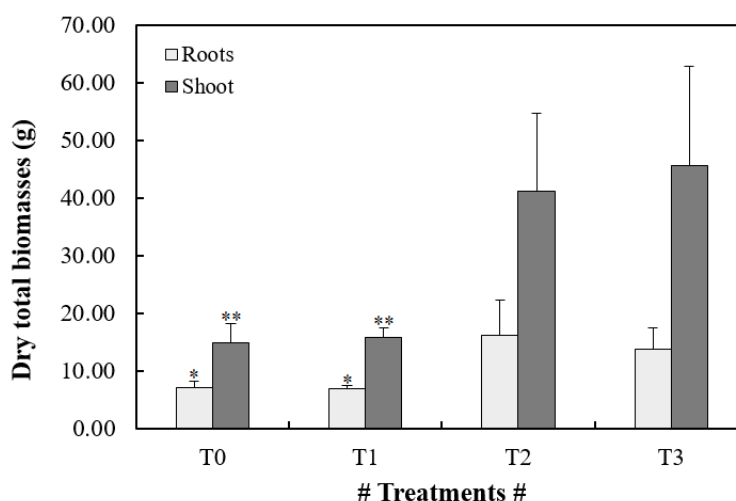


Figure 5. Total biomasses (root and shoot) of eggplants grown on control soil (T0) and soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Bars indicate the standard deviation of six replicates of each sample and star's number indicates no difference in each organ's group (root or shoot) at $p > 0.05$ from each treatment

The analysis of variance shows that the treatments have a highly significant effect ($p < 0.05$) on the biomass of plants. The biomasses of plants with T0 and T1 treatments do not show any significant difference. These biomasses are broadly lower and significantly different from those of plants with treatments T2 and T3, giving respective total average biomasses of 53.38 ± 14.79 g and 59.48 ± 17.48 g. The statistical analyses allow us to distinguish the treatments in two groups, T0 and T1 on the one hand and T2 and T3 on the other. At the end of the crop, the balance of indicators shows that treatments T2 and T3 present the best growth parameters (Table 2).

Yield's indicators were showed in Table 3. Results about number of fruit, weight and diameter of fruit highlighted that the importance of organic matter for eggplant productivity. All soil treatment with vermicompost showed significant ($p < 0.05$) higher number of eggplant fruit and consequently the weight of fruit per plant. Plants grown on soil with vermicompost+AM and vermicompost alone produce about 2.5 and 6 times higher fruit compared to plant grown on soil with AM alone and control, respectively. Soil treatment did not induce significant ($p > 0.05$) change in the fruit diameter with a mean value of 46 ± 4 mm per fruit.

Table 2. Growth indicators of plant grown in control soil (T0), soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Value is mean of six replicates with standard deviation. Mean value with same letter do not differ from each other at $p>0.05$.

Treatments	Stem diameter (cm)	Height (cm)	Number of leaves per plant	Total biomass (g)
T0	0.46 ±0.014a	15.31 ±1.153a	5.52 ±0.303a	22.02±3.44a
T1	0.46 ±0.014a	16.44 ±1.113a	5.67 ±0.323a	22.86±1.82a
T2	0.79 ±0.036b	45.14 ±3.948c	21.25 ±2.221b	57.38±14.79b
T3	0.83 ±0.049b	36.92 ±3.389b	22.62 ±2.475b	59.48±17.48b

Table 3. Eggplant yield indicators after two harvests of fruit of plant grown in control soil (T0), soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Value is mean of six replicates with standard deviation. Values with the same letter do not differ from each other at $p>0.05$ (n = 6).

Treatments	Number of fruit (per plant)	Weight of fruit (g)	Diameter of fruit (mm)
T0	1±0.4a	113±29.2a	43±2.9a
T1	3±1.3a	163±12.5a	42±2.5a
T2	7±3.1b	504±45.8b	48±3.8a
T3	8±2.3b	808±112.5c	53±3.1a

Mycorrhizal infection potential of soil and plants infection

The density of viable spores in the rhizosphere soil of eggplant plants is indicated in Figure 6. For 100g of soil, about 4600 spores were collected in the soil substrate. The distribution of spores according to size classes indicates that more than 70% of the spores have a larger size than 45µm. Indeed, the quantities of spores obtained in the 45µm and 50µm fractions represent respectively 36% and 38% of the collected

spores, significantly higher than those of the 80µm and 150µm fractions which represent respectively only 20% and 6% of spores (Figure 6).

The ability of the consortium AM in the inoculum to establish symbiosis with this eggplant variety was assessed by the mycorrhization of roots. The observed eggplant root samples showed the presence of mycorrhiza structure in roots from treatments T1, T2, and T3 (Figure 7).

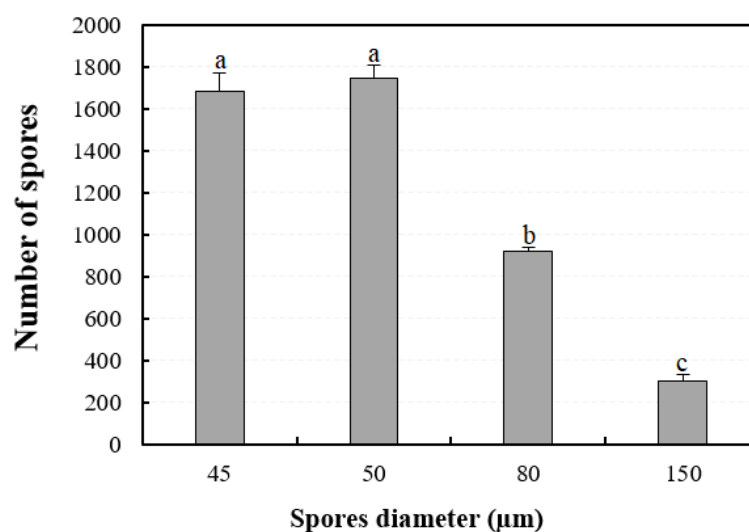


Figure 6. Spores density (Number of spores/100g) classified by particle size obtained using the wet sieving method. Bars indicate the standard deviation for 15 sampling and the same letter on each histogram do not differ from each other at $p>0.05$ (n = 15).

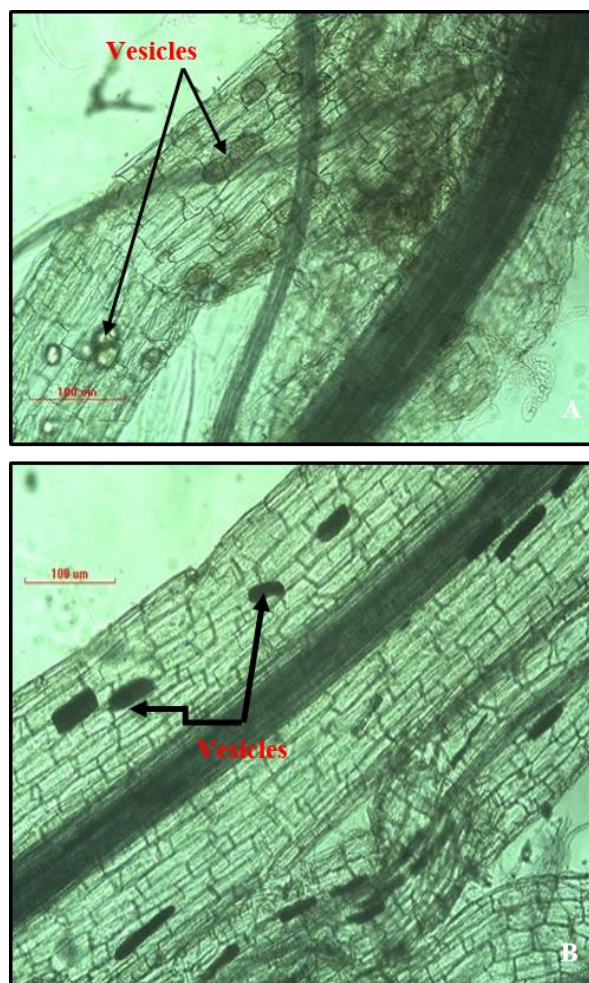


Figure 7. Different fungal structures in roots observed under a stereo-microscope ($\times 40$), obtained with eggplant grown in soil with mycorrhizae alone (T1) (A) and vermicompost alone (T2) and mycorrhizae + vermicompost (T3) (B).

Only the roots from treatment T0 did not show mycorrhiza structures. The mycorrhiza infection of eggplant plants was characterized by a total frequency mycorrhization ranging from 65% to 80%, mycorrhization intensity (%) from 25% to 30%, and an arbuscular content (%) from 0.5 to 3%. These mycorrhization parameters were higher with plants from treatment T3 (Table 4).

Table 4. Mycorrhization parameters of eggplant roots grown in control soil (T0), soil with mycorrhizae alone (T1), vermicompost alone (T2) and mycorrhizae + vermicompost (T3). Values were calculated using the method described by Trouvelot *et al.* (1986).

Mycorrhization parameters	T0	T1	T2	T3
Frequency (%)	0	73.33	66.67	80.00
Intensity (%)	0	31.27	24.97	38.50
Arbuscular content (%)	0	2.86	0.50	0.87

DISCUSSION

The chemical analysis of the soil reveals that the soil used in the study is acid soil. Regarding the culture substrates, the highest values of pH values were obtained with treatments T2 and T3. The application of organic matter improves the acid-base status of soils (Gnimassoun *et al.*, 2020). This improvement is proportional to the dose of compost applied to soil. Organic products contain organic anions whose negative charge is neutralized by cations (potassium, calcium, magnesium and sodium). The biological oxidation of these organic anions has an effect similar to that of the bases contained in basic mineral amendments (Bouthier and Houot, 2012). Total nitrogen and available phosphorus contents follow the same trends, i.e. improved contents in the substrates with treatments T2 and T3. This could derive from a higher mineralization rate of organic matter in these soils, resulting in a C/N ratio close to 10. Indeed, it is known that in conditions with C/N ratio between 8 and 10, the soil has a good biological

and microbiological functioning with as a consequence a good mineralization of nitrogen into nitrates, available by plants (Babaammi, 2015). Soils treated with vermicompost the highest CEC and exchangeable base values in the trials (Vasanthi and Kumarasamy, 2015). Soil organic matter amendments also improve the exchange complex and exchangeable bases rate in the soil (Jien and Wang 2013, Mensah and Frimpong, 2018) This is due to the fact that organic matter contributes to the constitution of soil cation exchange capacity and this contribution is paramount in tropical soils with low exchange activity. Organic application will therefore increase the ability of the soil to store and return the necessary cations (K, Mg, Ca, Na) to the plants in an easily available form.

For microbiological analysis, the total enzyme activity in the substrate soils also correlated with the input of vermicompost. The number of microorganisms (bacteria and fungi) and their enzyme activities are more abundant in vermicompost than in classical compost (Devi *et al.*, 2009). The application of vermicompost therefore increases the number of microorganisms and consequently the enzymatic activities of the soil (Deng *et al.*, 2017; Przemieniecki *et al.*, 2021). The current research showed that the application of vermicompost resulted in a reduction of carbon and a change in the C/N ratio close to the optimal values, as demonstrated in this study. Furthermore, Przemieniecki *et al.* (2021) show that the C/N ratio is inversely correlated with the presence of *Clostridium* spp, Actinomycetes and Pseudomonadaceae and *Bacillus* spp, bacterial groups responsible for the decomposition of organic matter and nitrogen storage in soil. This dependence leads to an increase in biological life and biological processes in the soil with a consequent increase in the concentration of soil enzymes. These soil enzymes would then be involved in the transformation of P, C and N, which are important soil properties affecting its health and productivity and this at very low doses of compost (Uz *et al.*, 2014). This activity is also a result of the presence of fungi in the vermicompost (Houngnandan *et al.*, 2009). These results are in agreement with our observations showing mycorrhization of plants from treatment T2 (application of vermicompost alone). The inoculation of eggplant variety showed good mycorrhization of roots which was reflected in high frequency and intensity of mycorrhizal colonization during this study. Indeed, the frequency and intensity of mycorrhization of eggplant is significantly higher than *Zea mays* and *Citrullus lanatus* grown under similar climatic conditions (Houngnandan *et al.*, 2009, Hamza, 2014). This high colonization observed in eggplant is even more important when the substrate contains vermicompost. The synergy between vermicompost and mycorrhization results in excellent biomass production. This is in agreement

with data in literature (Santana *et al.*, 2018, Oliveira *et al.*, 2015), whose results also indicate a significant increase in plant dry biomasses. However, other studies found conflicting results. For example, Bachman and Metzger (2008) reported no significant response in plant biomass after the addition of vermicompost. These conflicting results could be due to the application rate of vermicompost (Oliveira *et al.*, 2015). Atiyeh *et al.* (2001) showed that maximum plant growth responses are obtained when the substrate contains between 20-40% vermicompost. Beyond this, the application of vermicompost no longer stimulates plant growth. The highest biomass was obtained with the vermicompost-mycorrhizae couple, suggesting that the activity of mycorrhizal fungi could improve water retention in substrates and increase nutrient uptake by plants. The positive role of mycorrhizal fungi is widely reported in the literature (Bouwmeester *et al.*, 2007). Mycorrhizal fungi could also stimulate the root system. This in turn improves nutrition efficiency and plant growth resulting in a rather low root to shoot ratio (Gryndler *et al.*, 2002).

CONCLUSION

The present study on the cultivation of eggplant in greenhouse has contributed to the reflection on the possibility of intensive and organic production of this crop through the use of vermicompost associated with mycorrhizal fungi. The results of the chemical analyses reveal that the application of vermicompost has a significant effect on the improvement of the chemical and biological properties of the soil and on the development and growth of the eggplant. Regarding mycorrhization, the results of this study show that the inoculum made from forest soil contains mycorrhizal fungi and which is rich in propagule to mycorrhize eggplant. This richness is evidenced by the abundance of spores isolated from this soil. The frequency and intensity of mycorrhizal colonization of eggplant plants by the roots of this host plant showed that the native inoculum infected the roots of eggplant plants. The coupling of vermicompost with a consortium of spores of the genera results in better plant growth. This combination has a significant effect on the studied parameters (height, crown diameter, biomass and yield). Moreover, the treatment with vermicompost alone revealed an additional mycorrhizal fungi illustrated by the presence of mycorrhizal structures on the roots. Thus, the vermicompost significantly improved the growth of the eggplant. These results open a way to be explored for ecological intensification of peasant agriculture in the sub-Saharan region. In this perspective, it would be necessary to carry out molecular biology analyses to identify the mycorrhizal fungi, to carry out an in-depth analysis of the vermicompost in order to isolate the strain of fungus to make a specific inoculum for eggplant. In addition, a screening of mycorrhizal

fungi from eggplant production areas will be carried out to isolated and identify the most efficient strains for symbiosis with eggplant under tropical conditions.

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