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# Effect of *Pleurotus ostreatus* Mycelium on the Growth Parameters of Two Tomato Varieties (*Solanum lycopersicum* L) F1 Cobra 26 and Petomech in Daloa (Central West - Côte d'Ivoire)

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**A B S T R A C T**

Tomato cultivation in Côte d'Ivoire is facing problems related to soil depletion. However, mineral fertilization of these soils remains expensive and almost inaccessible to many farmers in rural areas and contributes to environmental pollution. The aims of this work is to improve the growth and production of tomato by using the mycelium of *Pleurotus ostreatus*. Trials were carried out on plants from two tomato varieties F1 cobra 26 and Petomech. Four types of treatments were applied in this study; they are 10g of *Pleurotus ostreatus* mycelium; 5gof *Pleurotus ostreatus* mycelium; NPK and a control. The different treatments were done one week before transplanting and one week after transplanting. At the end of this work, all the treated plants had a significant effect on the different growth parameters studied compared to the control. The plants treated with 10g of *Pleurotus ostreatus* mycelium, one week before transplanting to Cobra 26, gave the best results of collar diameter, plant height and number of leaves. For the treatment one week after transplanting, only the plants treated with 10 g of *Pleurotus ostreatus* mycelium improved the diameter at the collar, the height of the stems and the number of leaves.

## Introduction

In Africa, strong demographic growth is leading to an increase in food needs, including market garden produce. In Côte d'Ivoire, tomato needs were estimated at over 200,000 tons in 2002 (N'zi *et al.*, 2010). Tomatoes are the most consumed vegetable in Côte d'Ivoire. The national production of fresh tomato was 44,078 million tons in 2018 (FAO stat, 2018). However, the development of tomato cultivation, is plagued by enormous difficulties that affect its growth and production. Indeed, the intensification of vegetable cultivation has promoted soil depletion.

The damage caused (mineral element deficiency, physiological diseases) leads to losses of about 70% of the production if sanitary measures are not taken. The means of control applied to date, remains the use of synthetic chemical fertilizers to control the growth and production of crops. These treatments are very expensive for producers and produce adverse effects on all organisms (Agboyi *et al.,* 2016). In addition, they increase the rate of health and environmental risks (Sikora and Fernandez, 2005).

Faced with this challenge, research is directed towards effective and environmentally friendly alternative methods. Thus, certain microorganisms such as arbuscular mycorrhizal fungi (AMF) are used as alternatives to chemical fertilizers. In Côted'Ivoire, studies on soil fertilization using fungal species are very limited. The objective of this work is to improve the growth and production of tomato by using the mycelium of *Pleurotus ostreatus*.

## Materials and Methods

### Presentation of the study area

This study was conducted at the experimental site of Jean Lorougnon Guédé University. This institution is located in the department of Daloa, in the Haut-Sassandra region of west-central Côte d'Ivoire. Chief town of the region, the Daloa city is located at 6°53 north latitude and 6°27 west longitude of Côted'Ivoire. It is a humid tropical zone with dense forest vegetation that is regressing due to the practice of extensive agriculture coupled with the uncontrolled exploitation of forest species (Sangaré *et al.,* 2009).

This region has four seasons: a long rainy season (April to July), a short dry season (July to September), a short rainy season (September to November) and the long dry season (December to March). The soil is ferralitic. The region experiences a decrease in rainfall of about 40% (Ligban *et al.,* 2009). The average annual rainfall is between 1100 and 1230 mm, with an average annual temperature 26.7°C (Kouassi *et al.,* 2019). The soil is of ferralitic type of granitic origin (Koffie and Kra, 2013).

The biological material used in this study consists of plants from two tomato varieties the F1 variety Cobra 26 and the variety Petomech (Fig. 1A). These varieties were chosen for their germination rate of 85% and their purity of 99%. These varieties have a high weight of fruits, their vigor ensures spread out and high quality harvests. The mycelium of *Pleurotus ostreatus was* used as an organic fertilizer (Fig. 1B). Chemical fertilizer NPK 12-22-22 (Fig.1C) was used to compare the effect of organic fertilizer.

### Setting up the nursery

The nursery was carried out in boats made from recycled 25 L drums on a surface of $1m^2$. The sowing consisted in filling half of the barrels with soil taken within the Jean Lorougnon Guédé University. The quantity of tomato seed used was 180 seeds taken from 1 g of each tomato variety. The seeds were covered with soil, from straw and palm leaves. The nursery was regularly watered and protected against pests by covering them with mosquito nets.

### Monitoring and maintenance of the nursery

After the seeds germinated, the straw and palm leaves were removed. Then, a shade was built to protect the plants from the sun. Regular watering (twice a day, morning and evening) was done to allow the plants to be vigorous. The shade was removed as the plants developed. Hoeing was done every two weeks to avoid soil compaction and to facilitate water and air circulation in the soil. The shade cover was completely removed 5 days before transplanting to allow the plants to tolerate the ambient temperature before being transplanted to the field.

### Transplanting tomato plants

Transplanting consisted of transplanting the plants from the nursery onto the different ridges of the plot. Only the most vigorous tomato plants (about 10 cm tall, with two or three true leaves) were transplanted. Transplanting was done in 2 rows with a spacing of 0.3m between two plants and 0.5m between rows. In total, 6 tomato plants were transplanted on each ridge.

### Application of treatments

Four treatments were carried out on the entire experimental plot: Each treatment was applied four times. Each treatment was applied four times, i.e. one week before transplanting, one week after transplanting, four weeks after transplanting and six weeks after transplanting. The amount used was 5 g and 10 g of *Pleurotus ostreatus* mycelium spawn and 3 g of NPK 12-22-22. The treatments were carried out as follows: Treatment 1 (T1): 5 g of *Pleurotus ostreatus* mycelium; Treatment 2 (T2): 10 g of *Pleurotus ostreatus* mycelium; Treatment 0 (T0): control and Treatment 3 (T3): 3g of NPK.

### Maintenance of the plot

The tomato plants were watered morning and evening with a quantity of water of about 60 L. Weeding was done every two weeks on the experimental plot to avoid competition between weeds and tomato plants.

## Results and Discussion

### Effect of treatments on growth parameters one week before transplanting

### Diameter at the collar

The different treatments had an effect on the change in the neck diameter of treated tomato plants one week before transplanting. Statistical analysis of the plant neck diameter data showed that there was a very highly significant difference (P < 0.001) (Table I). However, plants treated with mycelial spawn at the 10 g dose gave the highest mean diameters regardless of tomato variety. Plants from the variety Cobra 26, treated one week before transplanting with 10 g of *Pleurotus ostreatus* mycelium, showed the highest mean collar diameter (8.85 cm).

This value is significantly higher than the value of the other treatments: Control (3.12 cm), NPK (5.55 cm) and 5g *Pleurotus ostreatus* (4.22 cm). For the plants of the Petomech variety, all treatments had almost the same effect on the diameter atthe collar.

### Height of treated tomato plants

The data on the effect of different treatments on the average plant height are presented in (Table I). The analysis revealed a highly significant difference (P< 0.007).

Regarding the variety Cobra 26, tomato plants treated with 10 g of *Pleurotus ostreatus* mycelium spawn showed the greatest height (64.84 cm). This average height is three times that obtained with the control (22.17 cm). The treatment 5g of *Pleurotus ostreatus* mycelium gave (32.72 cm) and the NPK (26.47cm). For the variety Petomech, all treatments had almost the same effect on plant height.

### Number of sheets processed

Table I shows the variation in the number of leaves on tomato plants. The number of leaves on each tomato plant varied according to the treatment applied. Statistical analysis of the leaf number data showed that there was a highly significant difference (P < 0.008) between the different treatments and the control (Table 1).

Mycelial spawn at the 10 g dose gave the highest number of leaves (8). For the treatments with spawn at 5 g, NPK and control, the means obtained are almost identical (4.7; 3.44; 4.55; 4.11; 3; 2.88). In fact, the plants treated with *Pleurotus ostreatus* mycelium at the dose of 10 g, are those that gave more leaves compared to the other treatments.

## Effect of treatments on growth parameters one week after transplanting

### Diameter at the neck of treated plants

Statistical analysis of the seedling crown diameter data showed that there was a very highly significant difference (P < 0.0001) (Table II) between the different treatments. However, plants treated with 10 g of mycelia spawn gave the highest mean diameters of all the treatments higher than those obtained with the control. Among these treatments, the plants treated, one week after transplanting, with 10 g of *Pleurotus ostreatus* mycelium, gave the highest average collar diameter (7.67 cm) for the Cobra 26 variety, which is equal to the double of the controls (3.24cm) for the Cobra variety and (3.04cm) for the Petomech variety (TableII). Also, gave the plants treated with 5g of mycelium of *Pleurotus ostreatus* and 3g NPK gave the same average diameter at the collar (3.74; 3.52 cm).

### Height of treated tomato plants

Data on the effect of the different treatments on the average plant height are presented in (Table.II). The analysis revealed a highly significant difference (P<0.003) between the treatments and the control (Table II). The average height of tomato plants treated with *Pleurotus ostreatus* spawn (27.22 cm) was twice that obtained with the controls (17.13 cm) for the Petomech variety and (14.27 cm) for the Cobra variety. In fact, the treatment with 10 g of mycelium spawn of *Pleurotus ostreatus* allowed to have plants of greater height compared to the plants treated with 5 g *of* mycelium spawn of *Pleurotus ostreatus* and NPK whose average heights are respectively 18.44 cm; 16.28 cm for the variety Cobra; 17.31 cm and 19.77 cm for the variety Petomech (Table II).

### Number of sheets processed

Table 2 shows the variation in the number of leaves on the tomato plants. The number of leaves on each tomato plant varies according to the treatment applied. Statistical analysis of the leaf number data showed that there was a highly significant difference (P < 0.007) between the different treatments and the control (Table II). The treatment with 10 g of *Pleurotus ostreatus* spawn gave the highest mean (8.55 cm) for the variety Cobra 26. Regarding the treatments with the spawn *Pleurotus ostreatus* at the dose of 5 g, the control and the NPK, the averages obtained are almost similar (5.65; 6.66; 4.33 cm) for the variety Cobra T26 and (6.33; 5.54; 5.11 cm) for the variety Petomech. All these treatments contribute to the growth of the tomato plants.

## Effect of treatments on growth parameters one week before transplanting

Plants treated with 10 g of *Pleurotus ostreatus* mycelium showed the largest collar diameters (8.85 cm) for the variety Cobra 26. The same treatment applied to the variety Petomech gave a low average of 3.63 Cm diameter at the neck. These results show the ability of this fungus to stimulate the diameter at the crown for the F1 variety Cobra 26. This value is much higher than the other treatments: Control (3.12 cm), NPK (5.55 cm) and 5g of *Pleurotus ostreatus* (4.22 cm) for the same variety. Indeed, some basidiomycetes fungi are known for several years for their antagonistic properties. They are used as organic fertilizer for several crops Siddiq *et al.,* (2018). The tests carried out during this study showed that the plants treated with 10 g of the mycelium *Pleurotus ostreatus* recorded the greatest height of tomato plants. In fact, the F1 variety Cobra 26 treated one week before transplanting gave the best results compared to the variety Petomech.

These results obtained are consistent with those of Cheng and Tu (1986) who showed in their research work that soybean plants treated with *Glomus clarium* significantly improve the height growth of soybean plants. According to Wang-Bara *et al.,* (2021), the variation in plant height under the effect of different doses of mycorrhiza was increased for three varieties of voandzou, compared to control plants. The 20 g mycorrhiza dose was favorable on plant height growth for all three varieties.

**Table.1** Evolution of treated plants (Cm) one week before transplanting

| Varieties | Treatment | Number of sheets | Diameter at the collar | Height of the plant |
|---|---|---|---|---|
| **F1Cobra26** | BM 10g | $8±1.22^{c}$ | $8.85±1.5^{c}$ | **$64.84±9.86^{d}$** |
| **F1Cobra26** | NPK | $4.77±1.39^{b}$ | $5.55±0.70^{b}$ | **$40.12±11.00^{b}$** |
| **F1Cobra26** | T0 | $3.44±1.13^{ab}$ | $3.12±0.92^{a}$ | **$22.17±7.86^{a}$** |
| **F1Cobra26** | BM 5g | $3.44±1.58^{ab}$ | $4.22±1.13^{a}$ | **$42.05±9.86^{b}$** |
| **Petomech** | BM 10g | $4.55±1.01^{ab}$ | $3.63±0.78^{a}$ | **$36.32±^{bc}$** |
| **Petomech** | NPK | $4.11±1.26^{ab}$ | $4.03±1.15^{a}$ | **$26.47±8.16^{a}$** |
| **Petomech** | T0 | $2.88±0.92^{a}$ | $3.25±0.85^{a}$ | **$21.2±5.82^{a}$** |
| **Petomech** | BM 5g | $3±1.11^{a}$ | $2.96±1.15^{a}$ | **$32.72±^{abc}$** |
| **P-value** | | **0.008** | **P<0.0001** | **0.007** |

For each mean, values with the same letters in the same column are statistically identical at the 5% threshold ANOVA followed by the Newman-keuls test.

**Table.2** Evolution of treated plants (Cm) one week after transplanting

| Varieties | Treatment | Number of sheet | Diameter at collar | Height of the plant |
|---|---|---|---|---|
| **F1Cobra26** | BM 10g | $8.55±1.23^{c}$ | $7.67±1.23^{b}$ | **$27.22±7.40^{b}$** |
| **F1Cobra26** | NPK | $6.66±0.37^{a}$ | $3.74±0.68^{a}$ | **$16.28±2.52^{a}$** |
| **F1Cobra26** | T0 | $4.33±1.11^{b}$ | $3.24±0.91^{a}$ | **$14.27±2.51^{a}$** |
| **F1Cobra26** | BM 5g | $5.55±1.81^{ab}$ | $3.52±0.77^{a}$ | **$18.44±2.69^{a}$** |
| **Petomech** | BM 10g | $5.44±1.23^{ab}$ | $3.52±1.27^{a}$ | **$15.61±5.23^{a}$** |
| **Petomech** | NPK | $6.33±1.65^{a}$ | $3.47±0.84^{a}$ | **$19.77±5.80^{a}$** |
| **Petomech** | T0 | $5.11±1.26^{ab}$ | $3.04±1.02^{a}$ | **$17.13±4.11^{a}$** |
| **Petomech** | BM 5g | $5.55±1.81^{ab}$ | $3.16±0.68^{a}$ | **$17.31±5.93^{a}$** |
| **P** | | **P<0.007** | **P<0.0001** | **P<0.003** |

For each mean, values with the same letters in the same column are statistically identical at the 5% threshold ANOVA followed by the Newman-keuls test.

**Fig.1**Some of the materials used; A: Plants from the two tomato varieties; B: Mycelium of *Pleurotus ostreatus* in bottles and bags; C: Chemical fertilizer NPK12-22-22

According to Wang-Bara *et al.,* (2021), the symbiotic association of voandzou varieties with *Glomus hoi* create a network of filaments in the soil, allowing water and nutrient uptake. This absorption would promote plant growth and amplify the complex physiological effects that will affect plant height. Rajasekaran and Nagarajan (2005) have also shown that the addition of AMF (Arbuscular mycorrhizal Fungi) inoculum in the field improves the growth of several species of *Fabaceae* and Fodder.

Mycelial spawn at 10 g gave the highest number of leaves (8). For the treatments with mycelial spawn at 5 g, NPK and control, the averages obtained are almost the same (4.7; 3.44; 4.55; 4.11; 3; 2.88). The work of Laminou *et al.,* (2009) showed that inoculation with mycorrhizae had a positive effect on the total biomass of the plants.

Gains in height, crown diameter and number of leaves by the F1 Cobra 26 variety treated with 10 g of *Pleurotus ostreatus* mycelium spawn could be due to the mobilization of mineral elements in the rhizosphere.

This growth stimulation would be explained by an increase of nutrient released in the soil by this fungus. Also, Sulochana *et al.,* (1998) demonstrated in their studies that peanut, sorghum and sesame plants treated with mycorrhizal fungi such as *Glomus intraradices* and *Glomus verruculosum* significantly stimulated the growth of these plants thanks to the contribution of certain mineral elements (N PK) in the soil solution.

**Effect of treatments on growth parameters one week after transplanting**

Tomato plants treated one week after transplanting with 10 g of *Pleurotus ostreatus* mycelium recorded the highest collar diameter (7.67 cm). These results are similar to those obtained with 10 g of *Pleurotus ostreatus* mycelium one week before transplanting. Tomato plants treated with 10 g of *Pleurotus ostreatus* mycelium one week after transplanting showed the greatest heights (27.22 cm) compared to the other treatments for both tomato varieties. The smallest heights were recorded with the plants the controls (17.13 cm) for the variety Petomech and (14.27 cm) for the variety Cobra. Ogou *et al.,* (2018) in a study on Soybean, showed that mycorrhizal infection seems to be effective from the 45$^{e}$ DAS (Day After Sowing) thus reflecting a difference in height growth of mycorrhized and non-mycorrhized plants.

The treatment with 10 g of mycelium *Pleurotus ostreatus* gave the most number of leaves for the variety Cobra 26 (8.55) and (5.44) for the variety Petomech. The means of the number ofleaves obtained with the treatments: 5 g of *Pleurotus ostreatus* mycelium (5.55), control (6.66) and NPK (4.33) were almost similar for the variety Cobra 26 and (6.33; 5.54; 5.11) for the variety Petomech.

Haro *et al.,* (2020), in their study on the effect of inoculation of arbuscular mycorrhizal fungi on the growth of *Mucuna pruriens* (L.); showed that the stimulation of growth and biomass between the different treatments compared to the control could be attributed to the effect of the inoculated arbuscular mycorrhizal fungi.

The present study shows that the use of biological agents: the mycelium of *Pleurotus ostreatus* constitutes an alternative method to the chemical control in the field of the improvement of the growth and the development of the crops. Indeed, the results obtained showed that the different treatments generated a satisfactory response more important than the control whatever the parameter considered (Diameter at the neck, Height of the plant, Number of leaves).

In conclusion, this study showed that the use of this fungus contributes to the growth of tomato plants. Moreover, the application of *Pleurotus ostreatus* mycelium in agriculture is a promising approach that will reduce the use of fungicides and growth regulators while minimizing the production cost and the negative impacts on the environment.

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