Efficiency of *Trichoderma* and *Bacillus subtilis* as growth promoters in eucalyptus *Corymbia citriodora*

Eficiência de *Trichoderma* e *Bacillus subtilis* como promotores de crescimento em eucalipto *Corymbia citriodora*

DOI: 10.55905/oelv21n11-097

Recebimento dos originais: 05/10/2023
Aceitação para publicação: 06/11/2023

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ABSTRACT

The Eucalyptus is of great relevance for Brazil, inserted in the paper and cellulose segment, with significant impact for the country's economy. The microorganisms have a fundamental role for a fertile life in the soil and are essential for plant growth. In this study, the efficiency of *Trichoderma* and *Bacillus subtilis* as growth promoters of Eucalyptus *Corymbia citriodora* was evaluated. The experiment was composed of eight treatments, five treatments being inoculated with *Trichoderma*, two inoculated with bacteria and one treatment control without inoculation with sixteen repetitions. Three evaluations were made at 45, 70 and 90 days after germination. For biomass characteristics, most isolates were superior to the control. In relation to relative efficiency, *Trichoderma* isolates UFT-25, UFT-57, UFT-204 and *B. subtilis* isolate Bs-08 were superior. For the Dickson Quality throughout the period analyzed, several isolates presented superior results to the test sample. It is concluded that the use of *Trichoderma* and *B. subtilis* showed positive results in relation to the control in the initial growth of eucalyptus seedlings *Corymbia citriodora*, indicating a potential for the use of these microorganisms in the production of seedlings of this particular species, with a better result for the *Trichoderma* UFT-204 isolate.
Keywords: fungi, bactéria, inoculants, forest seedlings.

RESUMO
O Eucalipto é de grande relevância para o Brasil, inserido no segmento de papel e celulose, com impacto expressivo para a economia do país. Os microrganismos têm um papel fundamental para uma vida fértil no solo sendo fundamentais para o crescimento vegetal. Neste estudo, avaliou-se a eficiência de *Trichoderma* e *Bacillus subtilis* como promotoras de crescimento de Eucalipto *Corymbia citriodora*. Foram utilizados oito tratamentos, sendo cinco tratamentos inoculados com *Trichoderma*, dois inoculados com *B. subtilis* e um tratamento testemunha sem inoculação com dezesseis repetições. Foram feitas três avaliações, aos 45, 70 e 90 dias após a germinação. Para as características de biomassa a maioria dos isolados foram superiores à testemunha. Em relação à eficiência relativa, os isolados de *Trichoderma* UFT-25, UFT-57, UFT-204 e de *B. subtilis* Bs-08 foram superiores à testemunha. Para o Índice de Qualidade de Dickson ao longo do período analisado, os isolados apresentaram resultados superiores à testemunha. Conclui-se que utilização de *Trichoderma* e *B. subtilis* apresentaram resultados positivos em relação à testemunha no crescimento inicial de mudas de eucalipto *Corymbia citriodora*, indicando um potencial para o uso desses microrganismos na produção de mudas dessa espécie em particular, destaca com um melhor resultado para o isolado de *Trichoderma* UFT-204.

Palavras-chave: fungos, bactérias, inoculantes, muda florestal.

1 INTRODUCTION
The sector related to planted forests has a significant impact on the Brazilian economy, as it is a segment that has a large revenue, generating investments and jobs and collecting taxes in the national industries sector (Iba, 2020). According to the Annual Report of the Brazilian Tree Industry, in 2018 the total planted areas in Brazil reached 7.83 million hectares (Iba, 2019).

The genus *Eucalyptus* is an example of planted trees, being a fast-growing species. It is estimated that there are at least nine million hectares of trees planted for the pulp and paper, steel and charcoal sectors, in addition to other purposes (Iba, 2020). According to Barros (2021), the state of Tocantins alone has around 160,000 hectares of eucalyptus, destined mainly for the charcoal or cellulose segment. In addition, the eucalyptus expansion areas in Tocantins are also destined for research. The expansion of eucalyptus cultivation was remarkable in Brazil, making it one of the main pulp producers. The
species of the genus *Corymbia citriodora* is also the most planted, as its leaves produce essential oils that are widely used in the cosmetics and perfumery industry (Silva, 2018).

Currently, researchers are looking for ecological alternatives for the production of forest seedlings, including to combat diseases and improve the quality of the seedlings. One of these alternatives is the use of microorganisms. The genus *Trichoderma* is one of the most important, as it has antagonistic activity against pathogens that cause diseases in various plants (Adnan et al., 2019). *Trichoderma* species establish molecular interactions with plants, producing metabolites that diffuse into the rhizosphere. In return, the plant produces signaling molecules that encourage the fungus to grow towards it. It is important to highlight that the metabolites produced by *Trichoderma* help absorb nutrients from the soil, which are essential for the plant (Alfiky, 2021).

The use of *Trichoderma*-based inoculants has shown positive results, as observed by Moura (2022) who recorded greater germination and vigor in seedlings of the *Myracrodruon urundeuva* species. Ferreira (2020), when testing *Trichoderma harzianum* in *Moringa oleifera*, seedlings, noticed a greater accumulation of dry mass and, consequently, a uniform germination speed.

According to Ferreira (2019), *Trichoderma* can be a viable alternative that provides environmental benefits, since it minimizes the use of chemicals and soil and water contamination through the interaction between the plant and the organism. Accordingly, Santos (2019) states that the use of *Trichoderma* as a biopromoter of growth in forest species resulted in about twice as much growth in plant seedlings in the nursery.

Some studies also show the use of bacteria as a promising alternative in promoting growth in forest species. *Bacillus subtilis* are commonly used with importance for the agricultural sector, handled for the biocontrol of disease in plants. This is because these bacteria have a symbiotic interaction that provides benefits such as nutrient solubilization and improvements to the soil. In addition, they can be used, according to Schafer (2017), to promote plant growth, increasing nitrogen fixation and solubilization of nutrients that improve the soil.
In view of the aforementioned, this work aims to evaluate the efficiency of different species of *Trichoderma* and *Bacillus subtilis* as plant growth promoters of *Corymbia citriodora* seedlings.

2 MATERIALS AND METHODS

The experiment was carried out in the laboratory of Applied Agromicrobiology and Biotechnology and in the forest seedling nursery of the Center for Environmental Monitoring and Fire Management (CeMAF), located at the Federal University of Tocantins (UFT), University Campus of Gurupi, located in the southern region of State of Tocantins (TO). According to Semplan (2012), the climate is type B1wA’a’ humid with moderate water deficit, (11°48’29” S, 48°56’39” W, 287 m altitude), temperature of 27.0 °C and precipitation of 1400 mm.

The seeds used in this experiment were *Corymbia citriodora*. The different *Trichoderma* and *Bacillus subtilis* isolates were acquired from the bank collection of the Agricultural Microbiology Laboratory, at the Federal University of Tocantins (UFT), Campus of Gurupi-TO. Eight treatments were used, five of which were *Trichoderma* isolates (UFT-37, UFT-25, UFT-57, UFT-201, UFT-204), two *Bacillus subtilis* isolates (UFT-Bs08, UFTBs10) and one control without inoculation.

*Trichoderma* isolates were characterized by sequencing the Translation Elongation Factor (TEF) region and are identified by access codes in GenBank, carried out by Instituto Biológico de São Paulo [Biological Institute of São Paulo] table 1.

<table>
<thead>
<tr>
<th>Isolates</th>
<th>Species Identification</th>
<th>GenBank Access</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>UFT-25</td>
<td><em>T. harzianum</em> CIB T131</td>
<td>EU279988</td>
<td>Hoyos-Carvajal et al (2009)</td>
</tr>
<tr>
<td>UFT-37</td>
<td><em>T. pinnatum</em> CIS 02-120</td>
<td>JN175572</td>
<td>Druzhinina et al (2012)</td>
</tr>
<tr>
<td>UFT-57</td>
<td><em>T. virens</em> CIB T147</td>
<td>EU280060</td>
<td>Hoyos-Carvajal et al (2009)</td>
</tr>
<tr>
<td>UFT-201</td>
<td><em>T. asperelloides</em> GJS 04-217</td>
<td>DQ381958</td>
<td>Samuels et al. (2010)</td>
</tr>
<tr>
<td>UFT-204</td>
<td><em>T. longibranchiatum</em> DAOM 167674</td>
<td>EU280046</td>
<td>Hoyos-Carvajal et al (2009)</td>
</tr>
</tbody>
</table>

Source: Prepared by the authors, 2023.
For \textit{B. subtilis} isolates, a preliminary identification was performed, taking into account the morphological characteristics, based on specialized bibliography (Rabinovitch; Oliveira, 2015). Then, genetic characterization was performed by sequencing the 16S rRNA region. The determination of bacterial genus and species was by comparing the consensus sequence obtained against the NCBI database (2017), using the BLAST tool (Morgulis et al., 2008).

\textit{Trichoderma} spp. were replicated and cultivated separately in a Petri dish containing PDA medium (200 g of potato, 20 g of dextrose, 15 g of agar in 1000 mL of water) and incubated at 25 ± 2 °C with a 12-hour photoperiod in a B.O.D. (Biochemical Oxygen Demand) for seven days, period determined for the growth of colonies of \textit{Trichoderma} spp. After the incubation period, an aqueous suspension of the spores was made, where 20 mL of distilled and sterilized water was added on the plate and the material was scraped to obtain the suspension of the spores, placing them in falcon tubes. The concentration of isolates in each suspension ranged from 1.6 to 1.8 \times 10^8 CFU per mL. Then, 1 mL of suspension was added with the aid of the pipette over the seeds already in the tubes.

\textit{B. subtilis} isolates were replicated in CCY medium (distilled water: 1000 mL, Buffer: 2.5 mL, Nutrients: 10 mL, Salts: 1 mL and Agar: 20 g). The plates were incubated at 25 °C in a B.O.D. chamber, where they remained for three days for the bacteria to grow. At the end of this period, the aqueous suspension was made by adding 20 mL of sterilized saline water (0.85% NaCl$_2$) over the plate. The material was also scraped to obtain the suspension, storing it in falcon tubes. Then, 1 mL of suspension was added with the aid of the pipette over the seeds already in the tubes.

For planting the seeds, the commercial substrate Tropstrato Florestal® was used, which is made from a mix of coconut fibers and rice husks. The seeds were placed in trays containing tubes with dimensions of 125 mm in height, upper diameter of 2.8 cm, lower diameter of 1.0 cm, which hold a volume of 50 cm$^3$ each. The total sum of tubes corresponds to 256 units. The seeds were placed with the aid of tweezers. Three to four seeds were arranged in each tube. After ten days, thinning was performed, leaving only one plant per tube.
Three evaluations were made at 45, 70 and 90 days after germination. The characteristics analyzed were height (H), stem diameter (SD), shoot dry mass (SDM) of aerial part, root dry mass (RDM) and total dry mass (TDM). The height was determined with the aid of a graduated ruler (mm), the SD was measured with the aid of a caliper, and the biomass was determined after drying in an oven at 65 °C for 72 hours, weighed on a precision scale (0.0001 g).

Dickson Quality Index (DQI) and Relative Efficiency (RE) calculations were performed. The DQI was determined as a function of height, collar diameter, shoot dry mass and root dry mass, considering the following formula: DQI = TDM (g) / {H (cm) / SD (mm) + SDM of aerial part (g) / RDM (g). The relative efficiency was calculated at 90 days, following the formula (SDM of aerial part inoculated with the isolates / SDM of aerial part without inoculant) x 100).

The experiment was in a completely randomized design, with eight treatments and four replications. The data obtained was subjected to analysis of variance and the Skott-Knott mean comparison test at 5%, with the aid of the SISVAR 5.6 software (Ferreira, 2011).

3 RESULTS AND DISCUSSION

At 45 days for plant height, the isolates UFT-25, UFT-37, UFT-204, UFT-201 and Bs-08 were superior (p<0.05) in relation to the control and among these the isolates UFT-37, UFT-201 and UFT-Bs08 were superior (p<0.05) (Table 2). For Root Length (RL) all isolates were superior to the control (p<0.05). For SD there were no significant differences between treatments. For SDM of aerial part, all isolates, with the exception of UFT-204, were superior to the control (p<0.05). For RDM, all isolates were superior to the control (p<0.05) and among these the UFT-25 isolates were superior (p<0.05). For TDM all isolates were superior to the control and among them the UFT-25 isolate was superior (P<0.05) (Table 2).
Table 2. Average values of height (H), root length (RL), stem diameter (SD), shoot dry mass (SDM) of aerial part, root dry mass (RDM) and total dry mass (TDM) of *Corymbia citriodora* inoculated with *Trichoderma* and *Bacillus subtilis*.

<table>
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<tr>
<th>Isolates</th>
<th>H (cm)</th>
<th>RL (cm)</th>
<th>SD (mm)</th>
<th>SDM (mg)</th>
<th>RDM (mg)</th>
<th>TDM (mg)</th>
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<td></td>
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<td>45 DAS</td>
<td></td>
<td></td>
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<tr>
<td>Control</td>
<td>9.6 c</td>
<td>9.3 b</td>
<td>0.010 a</td>
<td>63.0 c</td>
<td>50.0 d</td>
<td>113.0 d</td>
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<td>UFT-25</td>
<td>10.8 b</td>
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<td>89.0 a</td>
<td>91.0 a</td>
<td>180.0 a</td>
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<td>UFT-37</td>
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<td>13.9 a</td>
<td>0.010 a</td>
<td>74.0 b</td>
<td>80.0 b</td>
<td>154.0 b</td>
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<td>UFT-57</td>
<td>9.5 c</td>
<td>15.5 a</td>
<td>0.010 a</td>
<td>89.0 a</td>
<td>72.0 c</td>
<td>161.0 b</td>
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<td>11.2 b</td>
<td>14.1 a</td>
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<td>61.0 c</td>
<td>73.0 c</td>
<td>134.0 c</td>
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<td>12.8 a</td>
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<td>81.0 a</td>
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<td>13.4 a</td>
<td>14.5 a</td>
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<td>146.0 c</td>
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<td>UFT-Bs10</td>
<td>8.9 c</td>
<td>12.9 a</td>
<td>0.010 a</td>
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<td>71.0 c</td>
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<td>C.V (%)</td>
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<td>140.0 e</td>
<td>53.0 c</td>
<td>193.0 f</td>
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<td>69.0 b</td>
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<td>14.8 c</td>
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<td>140.0 e</td>
<td>76.0 b</td>
<td>216.0 e</td>
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<td>C.V (%)</td>
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<tr>
<td>Control</td>
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<td>492.0 c</td>
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<td>C.V (%)</td>
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</tr>
</tbody>
</table>

Means followed by equal letters in the columns do not differ from each other by the Skott-Knott test at 5%. *Trichoderma* isolates (UFT-25, UFT-37, UFT-57, UFT-201 and UFT-204). *Bacillus subtilis* isolates (UFT-Bs-08 and UFTBs10). Source: Prepared by the authors, 2023.

At 70 DAS, for plant height, all treatments with *Trichoderma* and *Bacillus*, with the exception of *B. subtilis* UFT-Bs10, were superior (p<0.05) to the control. For RL, the UFT-25 and UFT-37 isolates were superior to the other treatments. For SD, the *Trichoderma* isolates UFT-37, UFT-57, UFT-204 and UFT201 were superior (p<0.05) to...
the other treatments (Table 2). For SDM of aerial part and TDM, the *Trichoderma* UFT-204 isolate was superior (p<0.05) to the other treatments. As for RDM, all isolates were superior to the control and among them the isolates of *Trichoderma* UFT-37, UFT-57, UFT-201 and UFT-204 were superior (P<0.05).

At 90 DAS, for plant height, the *Trichoderma* UFT-201 isolate was superior (p<0.01) to the other treatments. In RL, all *Trichoderma* isolates were superior (p<0.05) to the other treatments and the control (Table 2). For SD, the *Trichoderma* UFT-25 and UFT-201 isolates were superior (p<0.05) to the other treatments and the control. As for MSPA, the *Trichoderma* UFT-204 isolate was superior (p<0.05) to the other treatments and the control (Table 2). For RDM, the *Trichoderma* UFT-37 isolate was superior to the other treatments and the control. For TDM, the *Trichoderma* UFT-37 and UFT-204 isolates were superior (p<0.05) to the other treatments (Table 2).

As for the Relative Efficiency, for the SDM of aerial part of the treatments inoculated with *Trichoderma* spp. and *Bacillus* compared to the control, the *Trichoderma* UFT-204 isolate was superior (p<0.05) to the other treatments (Figure 1A), followed by treatments with UFT-25, UFT-Bs08, UFT-37 and UFT-57, also higher than the control. For RDM, the *Trichoderma* UFT-37 isolate was superior (p<0.05), followed by treatments with UFT-25 and UFT-204, which were also superior to the control (Figure 1B). As for TDM, the *Trichoderma* UFT-37 and UFT-204 isolates were superior (p<0.05) to the other treatments, followed by treatments with UFT-25, UFT-57 and UFT-Bs08, which were also superior to the control (Figure 1C).

Considering some *Trichoderma* isolates, it is possible to state that there is an increase in the total surface of the root system, which allows greater access to the mineral elements present in the soil. Some isolates are able to solubilize and make elements such as phosphates, iron, copper, manganese and zinc available to plants and can also improve other plant uptake mechanisms (Bononi et al., 2020; Chagas Junior et al., 2022).

According to Rolim (2017), fungi of the genus *Trichoderma* are considered growth promoters and have potential for seed germination and growth during the initial phase of plant development. After a study using *Trichoderma* spp., Steffen et al. (2019) realized that it was possible to promote initial growth in the species *Corymbia citriodora*,
resulting in seedlings with greater height, volume and greater fresh mass of the root system.

Figure 1. Relative efficiency for the shoot dry mass of the aerial part (A), of the root (B) and total (C) of *Corymbia citriodora* of the treatments inoculated with *Trichoderma* and *Bacillus subtilis* in relation to the control without inoculation.

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Considering the positive results with the inoculation of microorganisms, such as those of the *Trichoderma* species, it was possible to perceive that such microorganisms can act in the plant producing substances that promote plant growth. This is the case of the genus *Trichoderma*, which changed the scenario of biological disease control in Brazil. This genus is widely used as *Trichoderma*-based biofungicides, mainly in soybean, cotton, corn, bean, strawberry and among others (Meyer et al., 2019).

The use of inoculants is of great value and still needs more studies, mainly in the use of forest species. In view of this, Azevedo et al. (2017) evaluated the development and also the quality of *Eucalyptus camaldulensis* clonal seedlings when colonized by *Trichoderma* spp. From the collected data, it was possible to conclude that the use of these fungi can be a promising technique, which can be applied in several sectors, such as forest nurseries for large-scale production. In addition to playing a role in the biocontrol of phytopathogens, they are also able to promote growth in forest seedlings.

According to Santos et al. (2020), the use of *Trichoderma* spp. it is viable for forest species, mainly in nurseries, where environmental conditions can be controlled. This increases the chances of germination, in addition to increasing the mass of roots, shoots and dry mass. The use of *Trichoderma* has its positive points, as it optimizes the production of seedlings and, consequently, reduces deforestation in native forests.

The genus *Bacillus* is composed of bacteria that can act by interacting with the roots of plants. The main beneficial activities include mineral solubilization, nitrogen
fixation and the production of growth promoting hormones (Saravanakumar et al., 2016; Shafi et al., 2017). Raasch et al. (2013) noted that the use of *Bacillus* promoted a higher rate of root emission, better quality of seedlings and an increase in the growth of eucalyptus mini-cuttings.

Some works point to the use of *Bacillus* in the promotion of growth and root development in several crops and, mainly, in the eucalyptus crop (Moreira; Araújo, 2013; Rasch et al., 2013). Many of them indicated an increase in root dry mass. In studies by Santos et al. (2018), it is possible to find significant differences in *Pinus taeda* in the increment of dry mass, both in the aerial part and in the part of the roots.

Table 3 demonstrates positive results in relation to the Dickson Quality Index, over the analyzed period. At 45 DAS, isolates UFT-25 and UFT37 were superior to the other treatments, followed by treatments with isolates UFT-201 and UFT-Bs08, which were also superior to the control (p<0.05). At 70 DAS, the treatments with the isolates UFT-204, UFT-Bs08 and UFT-Bs10 were superior to the other treatments (p<0.05). At 90 DAS, treatment with the UFT-201 isolate was superior, followed by the UFT-25, UFT-37, UFT-204 and UFT-Bs08 isolates, which were also superior to the control.

Table 3. Average values of the Dickson Quality Index (DQI) in the species *Corymbia citriodora*, at 45, 70 and 90 days after sowing cultivated with plant growth promoting micro-organisms.

<table>
<thead>
<tr>
<th>ISOLATES</th>
<th>45 DAS</th>
<th>70 DAS</th>
<th>90 DAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>0.11 b</td>
<td>0.15 e</td>
<td>0.47 c</td>
</tr>
<tr>
<td>UFT-25</td>
<td>0.16 a</td>
<td>0.23 d</td>
<td>0.77 a</td>
</tr>
<tr>
<td>UFT-37</td>
<td>0.12 b</td>
<td>0.35 c</td>
<td>0.69 a</td>
</tr>
<tr>
<td>UFT-57</td>
<td>0.16 a</td>
<td>0.41 b</td>
<td>0.49 c</td>
</tr>
<tr>
<td>UFT-204</td>
<td>0.11 b</td>
<td>0.60 a</td>
<td>0.68 a</td>
</tr>
<tr>
<td>UFT-201</td>
<td>0.11 b</td>
<td>0.43 b</td>
<td>0.53 b</td>
</tr>
<tr>
<td>UFT-Bs08</td>
<td>0.10 b</td>
<td>0.20 d</td>
<td>0.58 b</td>
</tr>
<tr>
<td>UFT-Bs10</td>
<td>0.15 a</td>
<td>0.15 e</td>
<td>0.52 b</td>
</tr>
<tr>
<td>C.V%</td>
<td>5.9</td>
<td>6.8</td>
<td>6.0</td>
</tr>
</tbody>
</table>

Means followed by the same lowercase letter in the column do not differ from each other by the Skott-knott test at 5% probability. *Trichoderma* isolates (UFT-25, UFT-37, UFT-57, UFT-201 and UFT-204). *Bacillus subtilis* isolates (UFT-Bs-08 and UFT-Bs10). Source: Prepared by the authors, 2023.

In the case of the Dickson Quality Index (DQI), used to certify the quality of seedlings, the indicators of SDM of aerial, TDM, H and SD of the roots of the seedlings are
taken into account (Medeiros, 2018). According to Caldeira et al. (2013), the DQI can vary according to the management of each species, as well as the place where it is stored. The local aspects, considered by Caldeira et al. (2013), are the proportion of substrate, the volume of the container and also the age at which the plant is evaluated.

Chagas Junior et al. (2021) found, in *Eucalyptus urophylla* at 25 DAS, the best Dickson Quality Index. At 50 DAS in the species *E. brassiana* there was a result similar to the isolated UFT-204, proving to be statistically superior in relation to the control. For the UFT-201 isolate, it was also observed, in the study by Chagas Junior et al. (2021), the occurrence of the DQI index 0.13 at 75 DAS. Comparing with Table 3, the UFT-37 isolate obtained a DQI of 0.68 at 90 DAS; that is, it was higher than that obtained for *E. urophylla*.

According to Azevedo et al. (2017), in their study with *Trichoderma* spp., there was an increase and better performance in all analyzed variables. Not only in the eucalyptus species, *Trichoderma* spp. obtained satisfactory results, but also in other forest species. Pinheiro (2017) observed that the presence of *Trichoderma* promoted a sharp increase in *Jacaranda micrantha* seedlings. Peccatti (2020) and Missio (2018) also found that isolates such as *Trichoderma* spp. positively influenced the growth of *Bauhinia forficata* seedlings. Riberio et al. (2023) also reported that isolates of *Trichoderma asperelloides* and *T. virens* promoted plant growth in Paricá (*Schizolobium amazonicum*), Fava-Tamboril (*Enterolobium maximum*) and Amarelão (*Apuleia leiocarpa*) seedlings.

For the *Bacillus subtilis* isolates, it was possible to conclude that the inoculation of these batteries also promoted the growth of *Corymbia citriodora* plants. According to Triboni (2021), this is related to the biological properties that this microorganism presents, which is mainly due to its ability to fix nitrogen and solubilize nutrients. According to Romagna (2019), *Bacillus* genera are able to produce compounds that stimulate growth and improve plant stress, resulting in an interaction with their roots. The inoculation of *Trichoderma* and *Bacillus subtilis* to the substrate also provided positive effects on the accumulation of biomass and seedlings of *Eucalyptus urograndis*, demonstrating these microorganisms as growth promoters for this forest species (Luciano et al., 2023).
It is important to emphasize that the use of microorganisms such as *Trichoderma* and *Bacillus* can be beneficial for the production of seedlings of several plant species, not just for the eucalyptus *Corymbia citriodora*. However, it is necessary to take into account the particularities of each species and the cultivation conditions in which the seedlings are produced to evaluate the effectiveness of these microorganisms. In addition, it is important that these results be validated through rigorous scientific studies that consider factors such as the genetic variability of the plants, the cultivation conditions, the type of soil and other factors that may affect the growth and development of the seedlings.

**4 CONCLUSIONS**

The use of *Trichoderma* and *Bacillus subtilis* showed positive results in the initial growth of eucalyptus seedlings *Corymbia citriodora*, indicating a potential for the use of these microorganisms in the production of seedlings of this particular species, with a better result for the species of *Trichoderma longibranchiatum UFT-204*.

**ACKNOWLEDGMENT**

The Federal University of Tocantins (UFT), Campus de Gurupi, the Graduate Program in Forestry and Environmental Sciences (PPGCFA) and CNPq.
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