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Growth promotion and productivity of lettuce using *Trichoderma* spp. commercial strains

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ABSTRACT

The aim of this study was to evaluate four strains of *Trichoderma* spp. (*T. harzianum* IBLF 006 WP, *T. harzianum* IBLF 006 SC, *T. harzianum* ESALQ 1306 and *T. asperellum* URM 5911) for seedling growth promotion in laboratory and head lettuce yield in field conditions. The experiment was carried out in a completely randomized design with four treatments (strains): IBLF 006 WP, IBLF 006 SC, ESALQ 1306 and URM 5911 and a non-inoculated (without *Trichoderma*) control. Each treatment consisted of 200 seeds, arranged in four replicates. Lettuce seeds cv. Astra were treated with 2 mL *Trichoderma* suspension (2.5 x 10^8 conidia mL^{-1} per each 100 g seeds) and submitted to growth assay in laboratory up to 7 days after sowing. For field experiment, we opened furrows, which were manually sprayed with 5 x 10^7 conidia mL^{-1}. Afterwards, seedlings were transplanted (4 to 6 leaves of head lettuce cv. Mauren) and harvested 40 days later. Each treatment consisted of four replicates (1.2 x 1.2 m, 16 plants per plot) arranged in randomized blocks. In both experiments, a control without *Trichoderma* application was included, and we evaluated shoot length, root and total length, shoot, root and total fresh mass and shoot, root and total dry mass, shoot mass ratio, root mass ratio and shoot/root ratio. The germination (%) was evaluated by laboratory tests, whereas in field experiment, height, stem diameter, head diameter, number of leaves and yield were evaluated. The *T. harzianum* strain ESALQ 1306 provided the best head lettuce growth rate in laboratory test, which was confirmed in field experiment, in which the productivity (50.2 t ha^{-1}) was superior when compared to the other strains (41.38 to 44.23 t ha^{-1}) and the control (30.18 t ha^{-1}).

Keywords: *Trichoderma harzianum*, *Trichoderma asperellum*, *Lactuca sativa*, biological control, horticulture.

RESUMO

Promoção do crescimento e da produtividade de alface pelo emprego de cepas comerciais de *Trichoderma* spp.

O objetivo deste trabalho foi avaliar quatro cepas de *Trichoderma* spp. (*T. harzianum* IBLF 006 WP, *T. harzianum* IBLF 006 SC, *T. harzianum* ESALQ 1306 e *T. asperellum* URM 5911) na promoção do crescimento de plântulas em laboratório e na produtividade de alface americana em campo. O delineamento experimental foi inteiramente casualizado com quatro tratamentos (cepas): IBLF 006 WP, IBLF 006 SC, ESALQ 1306 e URM 5911 e um tratamento sem inoculação com *Trichoderma* que foi incluído como testemunha. Cada tratamento teve 200 sementes, dispostas em quatro repetições. Para tanto, sementes de alface cv. Astra foram tratadas com 2 mL de suspensão de *Trichoderma* (2,5 x 10^8 conídios mL^{-1} para cada 100 g de sementes) e submetidas a teste de crescimento em laboratório até os 7 dias após o semeio. Para o experimento em campo realizou-se a abertura dos sulcos, os quais receberam 5 x 10^7 conídios mL^{-1} com auxílio de um pulverizador manual, seguido de transplantio de mudas (4 a 6 folhas) de alface americana cv. Mauren e colheita aos 40 dias após o transplantio. Cada tratamento foi composto por quatro repetições (1,2 x 1,2 m, com 16 plantas em cada parcela) dispostas em blocos casualizados. Em ambos incluiu-se uma testemunha sem aplicação de *Trichoderma.* Avaliou-se o comprimento da parte aérea, da raiz e total, massas fresca e seca da parte aérea, da raiz e total, razão de massa da parte aérea, razão de massa da raiz e razão parte aérea/sistema radicular. No experimento em laboratório avaliou-se o percentual de germinação, enquanto que no experimento em campo avaliou-se a altura, diâmetro do caule, diâmetro da cabeça, número de folhas e produtividade. A cepa *T. harzianum* ESALQ 1306 proporcionou melhor crescimento de alface americana em laboratório, o que foi confirmado em campo, cuja produtividade (50,2 t ha^{-1}) foi superior às demais cepas (41,38 a 44,23 t ha^{-1}) e à testemunha (30,18 t ha^{-1}).

Palavras-chave: *Trichoderma harzianum*, *Trichoderma asperellum*, *Lactuca sativa*, controle biológico, horticultura.

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Lettuce is one of the most widely cultivated leaf vegetables in Brazil; it is grown by small farmers, being a crop of great economic and social importance. Due to wide adaptation to different climatic conditions, short cycle, low production cost, low susceptibility to several pests and diseases, and also post-marketing safety, this crop allows successive cultivations all year long (Medeiros *et al*., 2007). The state of Goiás is one of the main lettuce producers: in 2016, the state commercialized 1479 tons (CEASA-GO, 2016). The increasing population growth and constant changes in dietary habits make the consumer of leaf vegetables more demanding concerning product quality. That's why, lettuce consumption tends to increase and, consequently, the need to produce it in quantity and with superior quality (Barros Júnior *et al*., 2010).

Trichoderma fungus is considered a free-living soil microorganism, which survives in tropical and temperate regions, being three species (*T. harzianum*, *T. virens* and *T. viride*) the most used in biological control of diseases and on growth promotion of several crops (Hoffmann *et al*., 2015). Many studies point out the use of *Trichoderma* to promote initial growth of many commercial crops, such as tomatoes and beans (Chacón *et al*., 2007; Guimarães *et al*., 2014), as well as an increase in grain yield and leaf crops (Azevedo Filho *et al*., 2011; Carvalho *et al*., 2015a).

The most common method of application of *Trichoderma* is seed treatment. However, for some crops which are initially installed in seedbeds, when aiming to colonize soil by certain strains of *Trichoderma*, treatment of substrate or cultivation soil per application via furrow or superficial is an efficient method (Carvalho *et al*., 2015b).

Some isolates of *Trichoderma* provide plant growth stimulus, producing antibiotics, enzymes and metabolites, whose activities are comparable to plant hormones (Carvalho *et al*., 2011a). Several strains are excellent producers of secondary metabolites, being volatile or non-volatile and supposed biosynthesizers of non-ribosomal peptides, terpenoids, pironas and polyketides and auxin analogs (Machado *et al*., 2012). *Trichoderma* spp. insertion into soils poor in mineral nutrients increases the solubilization of these nutrients. The same act as root growth biostimulant, increasing the assimilation of essential nutrients for the plant and contributing to obtain greater productivity, besides promoting root system protection against soil pathogens (Benítez *et al*., 2004). Such insertion is highly desirable because, in addition to the described benefits, it is possible to reduce or abolish the use of highly soluble chemical fertilizers, which for sustainable agricultural production cause damages to the environment (Azarmi *et al*., 2011).

Many studies on using live strains for the treatment of seeds and substrates for initial growth promotion of several crops or even in disease control can be found in literature. However, knowledge gaps concerning potential productivity of lettuce with live strains of *Trichoderma* spp. can be verified. The aim of this study was to evaluate four commercial products based on *Trichoderma* spp. in seedling growth promotion and head lettuce productivity in field.

MATERIAL AND METHODS

Evaluated commercial strains

The commercial strains evaluated in this study were T*richoderma harzianum* IBLF 006 WP (Ecotrich WP; Ballagro Agro Tecnologia Ltda., Piracaia-SP, Brazil), *Trichoderma harzianum* IBLF 006 SC (Predatox SC; Ballagro Agro Tecnologia Ltda., Piracaia-SP, Brazil), *Trichoderma harzianum* ESALQ 1306 (Trichodermil; Koppert Biological Systems, Piracicaba-SP, Brazil) and *Trichoderma asperellum* URM 5911 (Quality WG*;* Laboratório de BioControle Farroupilha Ltda, Patos de Minas-MG, Brazil).

Initial growth of lettuce seedling using seed treatment with suspension of *Trichoderma* spp.

Head lettuce seeds, cv. Astra, were treated with 2 mL of *Trichoderma* suspension (2.5 x 10^8 conidia mL^{-1} for each 100 g seeds). Afterwards, the seeds were uniformly distributed on blotting paper sheets, contained in gerbox-type transparent acrylic boxes (11 x 11 cm). Then, these seeds were kept in a BOD type seed germinator (Fanem 347®), at 25ºC, for seven days. We used completely randomized experimental design, with four treatments (strains): IBLF 006 WP, IBLF 006 SC, ESALQ 1306 and URM 5911. One treatment, without *Trichoderma* inoculation, was included as control. In each treatment, 200 seeds were divided into four replicates (Gerbox) of 50 seeds (Carvalho *et al*., 2011b).

Germination (%) was obtained by evaluating normal seedlings (absence of necrosis and pathogen in seedlings, seminal and secondary roots without deformation and discounting the dead seeds), shoot length (SL), root length (RL), total length (TL = SL + RL), shoot fresh mass (SFM), root fresh mass (RFM), total fresh mass (TFM = SFM + RFM), shoot dry mass (SDM), root dry mass (RDM), total dry mass (BIO = SDM + RDM), shoot mass ratio (SMR = SDM/BIO), root mass ratio (RMR = RDM/BIO) and shoot/root ratio (S/R = SDM/RDM). In order to obtain SDM and RDM, shoots and roots were taken out and dried in an oven at 65ºC until constant mass in order to obtain values in milligrams.

Productivity of lettuce plants and their components in field using planting furrow treatment with suspension of *Trichoderma* spp.

The experiment was carried out in an experimental area at Universidade Estadual de Goiás, Campus Ipameri, (17º43'02''S, 48º08'37'W, 794 m), in 2017, in Typic Hapludox. The soil presented the following chemical properties: pH in $CaCl_2$= 5.7; MO= 22.7 g dm^{-1}; P= 27.1 mg dm^{-1}; K= 0.31 $cmol_c$ dm^{-1}; Ca= 2.70 $cmol_c$ dm^{-1}; Mg= 1.10 $cmol_c$ dm^{-1}; H+Al= 2.50 $cmol_c$ dm^{-1}; S= 2.7 mg dm^{-1}; B= 0.26 mg dm^{-1}; Fe= 43.7 mg dm^{-1}; Mn= 35.3 mg dm^{-1}; Cu= 2.31 mg dm^{-1}; Zn= 21.7 mg dm^{-1} and the following textural composition: clay = 320 g kg^{-1}; silt = 200 g kg^{-1} and sand = 480 g kg^{-1}. Throughout the experiment, manual irrigation was performed daily.

The experiment was installed in a 40.8 m^2 area (34.0 x 1.2 m); soil was plowed and harrowed. Afterwards, seedbeds were prepared with a plow. Chemical fertilizations, as well as soil correction, were done according to Yuri *et al*. (2002). Then, furrows were opened and 40 mL of *Trichoderma* spp. suspension (5 x 10^7conidia mL^{-1}) was applied per linear meter using a manual sprayer (550 mL), totalizing 2 x 10^9 conidia per linear meter in the furrow (Carvalho *et al*., 2011a).

Right after spray application, head lettuce seedlings, cv. Mauren with 4 - 6 leaves, grown in 200-cell styrofoam trays, filled with inert substrate, based on peat, carbonized rice chaff, vermiculite and ashes, were manually transplanted

(4 plants per 1.2 linear meter). The experimental design was of randomized blocks with four treatments (strains): IBLF 006 WP, IBLF 006 SC, ESALQ 1306 and URM 5911 and one control without *Trichoderma* spp. inoculation. Each treatment was composed of four experimental plots with four planting lines, 1.2x1.2 m total area with 16 plants spaced 0.3x0.3 m, plus 0.5 m of a seedbed without lettuce planting for separation between plots.

Forty days after seedling transplant, four central plants of each plot (useful area) were manually harvested to measure height (H), stem diameter (SD), head diameter (HD), number of leaves (NL), shoot fresh mass (SFM), root fresh mass (RFM), total fresh mass (TFM), shoot dry mass (SDM), root dry mass (RDM), total biomass (BIO), shoot mass ratio (SMR), root mass ratio (RMR), shoot/root ratio (S/R) and productivity, using a caliper, a precision scale and a graduated scale. One control treatment was included in order to compare the treatments. Weed control was manually performed. The authors did not verify any pests or diseases.

Statistical analysis

Experimental data were submitted to variance analysis (ANOVA) and to Scott-Knott test (P≤0.05), using computer statistical software SISVAR 5.3 (FERREIRA, 2011).

RESULTS AND DISCUSSION

In relation to germination percentage (GP), *T. harzianum* strain ESALQ 1306 and *T. harzianum* IBLF 006 SC were superior to the other treatments, providing 93.50% and 93% of PG. Followed by treatments *T. harzianum* IBLF 006 WP and *T. asperellum* URM 5911 and the control, which showed the lowest PG (82%) (Table 1). *T. harzianum* strain ESALQ 1306 showed a superior increase when compared with the other treatments in relation to shoot length (SL= 2.46 cm), root length (RL= 4.96 cm) and total length (TL= 7.41 cm). For the other strains values of SL, RL and TL ranged from 1.76 to 1.83 cm, 3.78 to 4.27 cm, 5.62 to 6.03 cm, respectively. Control showed the lowest values of SL, RL and TL: 1.54, 3.27 and 4.82 cm, respectively.

For total fresh and total dry mass, *T. harzianum* strain ESALQ 1306, again, showed to be superior to the other treatments, considering TFM of 23.62 mg and BIO of 1.55 mg, respectively. The control treatment showed the lowest values, 12.40 mg and 0.76 mg for TFM and BIO, respectively. In relation to ratios, *T. asperellum* URM 5911 and the control showed lower S/R (2.73 and 2.61, respectively) inferior to the other treatments which value of S/R ranged from 2.85 to 2.95 (Table 1).

In relation to plant height (H) and stem diameter (SD), *T. harzianum* strain ESALQ 1306 was superior than the other strains (18.65 cm and 15.28 mm), followed by *T. asperellum* URM 5911 (15.75 cm and 14.38 mm), which was the second best treatment (Table 2). Evaluating head diameter (HD) and number of leaves (NL), *T. harzianum* strain ESALQ 1306 was superior to the other treatments, providing 13.50 cm and 28.12 leaves. The other strains were superior when compared to the control (10.46 cm and 22.45 leaves), with values for HD ranging from 12.06 to 12.59 cm and NL ranging from 25.31 to 25.75. For fresh and dry mass, *T. harzianum* ESALQ 1306 was superior to the other treatments, showing TFM of 462.0 g and BIO of 18.92 g, respectively. The control provided the lowest values, 276.98 g and 10.26 g for TFM and BIO, respectively. For ratios, no differences among treatments for SMR, RMR and S/R were no noticed. For productivity, *T. harzianum* ESALQ 1306 was superior to the other ones (50.20 t ha^{-1}), followed by *T. asperellum* URM 5911, *T. harzianum* IBLF 006 SC and *T. harzianum* IBLF 006 WP which provided about 44.23, 42.77 and 41.38 t ha^{-1}, respectively. All strains were superior compared with the control, which provided 30.18 t ha^{-1} (Table 2).

Seed germination and seedling vigor are decisive factors for crop production success and presence of hormones, promoters and growth inhibitors are essential for germination physiological process (Ferreira & Borghetti, 2004).

The strains used in this study provided positive and beneficial effects on lettuce seed germination. These results were already expected, according to the information found in literature (Oliveira *et al*., 2018), since seed germination can be favored by the action of *Trichoderma* spp. strains. This situation might be related to the fact that lettuce seeds have lower concentrations of reserve substances for germinative process when compared with grain-producing species. Thus, germination process and initial seedling development seem to be stronger influenced by exogenous growth regulators, when associated with microorganisms (Schlindwein *et al*., 2008). Germination (%), emergence and emergence speed index are promoted when seeds are inoculated with *Trichoderma* spp. This fact is attributed to growth regulator liberation mechanism and nutrient solubilization (Hajieghrari, 2010; Wesam *et al*., 2017).

Those seeds treated with *Trichoderma* spp. presented length gain. Probably, the most likely mechanism to promote initial growth is via direct, it means, production of hormones or analogues (Wesam *et al*., 2017). We noted that the seeds showed low or no occurrence of harmful pathogens to germination, refuting indirect initial growth promotion, through harmful pathogens to germination and emergence.

For fresh mass and total biomass accumulations, the strain ESALQ 1306 was also superior to the other treatments. However, the other strains also showed results superior to the control. This can be explained in the study carried out by Chacón *et al*. (2007), in which these authors state that tomato plants inoculated with *T. harzianum* showed increased root proliferation and, as a consequence, an increase in sanity and water and nutrient absorption capacity, promoting, as observed by Machado *et al*. (2012), an increase of fresh mass of several plant parts.

H and SD are productive variables, which allow greater separation capacity among evaluated strains when comparing with HD and NL. According to Trani *et al*. (2006), NL is a trait directly related to cultivation temperature and photoperiod. Due to this characteristic,

Table 1. Characteristics of head lettuce seedlings, cv. Astra, treated with commercial strains of *Trichoderma* spp. Ipameri, UEG, 2017.

Treatment	Germination (%)[1]	Shoot length (cm)	Root length (cm)	Total length (cm)	Shoot fresh mass (g)	Root fresh mass (g)	Total fresh mass (g)
T. harzianum IBLF 006 WP	90.00 b	1.76 c	4.27 b	6.03 b	12.14 c	4.94 c	17.09 c
T. harzianum IBLF 006 SC	93.00 a	1.82 b	3.86 c	5.69 c	11.62 c	4.72 c	16.35 d
T. harzianum ESALQ 1306	93.50 a	2.46 a	4.96 a	7.41 a	15.96 a	7.66 a	23.62 a
T. asperellum URM 5911	85.50 c	1.83 b	3.78 d	5.62 c	13.12 b	5.45 b	18.58 b
Control	82.00 d	1.54 d	3.27 e	4.82 d	7.97 d	4.42 d	12.40 e
CV (%)	3.41	7.50	6.85	5.79	4.36	4.89	3.87

	Shoot dry mass (SDM) (mg)	Root dry mass (RDM) (mg)	Total biomass (BIO) (mg)[2]	Shoot mass ratio (SMR)[3]	Root mass ratio (RMR)[4]	Shoot/root ratio (S/R)[5]
T. harzianum IBLF 006 WP	0.66 c	0.23 c	0.89 c	0.74 a	0.26 b	2.87 a
T. harzianum IBLF 006 SC	0.66 c	0.22 c	0.88 c	0.75 a	0.25 b	2.95 a
T. harzianum ESALQ 1306	1.15 a	0.40 a	1.55 a	0.74 a	0.26 b	2.85 a
T. asperellum URM 5911	0.78 b	0.29 b	1.07 b	0.73 b	0.27 a	2.73 b
Control	0.55 d	0.21 d	0.76 d	0.73 b	0.27 a	2.61 b
CV (%)	3.76	4.12	3.27	1.19	3.35	4.46

Averages followed by same lowercase letters in the column do not differ statistically, Scott-Knott test ($P \leq 0.05$); [1]emergence at 7 days after sowing date; [2]BIO= SDM + RDM; [3]SMR= SDM/BIO; [4]RMR= RDM/BIO; [5]S/R= SDM/RDM.

the variables HD and NL may be directly related to weather conditions, and the strains may cause only secondary effects on lettuce cultivars. In relation to SD, this characteristic defines seedling's field performance after planting (Souza *et al*., 2006), due to the ability to form new roots, a fact that is directly influenced by rhizosphere colonized by *Trichoderma* spp. with consequences on productivity (Carvalho *et al*., 2011a).

Values of H, SD, HD and NL were similar to the ones obtained in other studies with head lettuce (Table 2). The study carried out by Blind & Silva Filho (2015), for instance, obtained 12.1 to 17.5 cm for HD of head lettuce cv. Balsamo. Santi *et al*. (2013) obtained SD ranging from 16 to 18 mm and NL ranging from 24.1 to 28.2 in head lettuce fertilized with filter cake. The treatments with *Trichoderma* spp. resulted, in relation to the control, a gain of 41 to 91% of H, highlighting growth-promoting effect of the used strains. Silva *et al*. (2015), using different isolates of *Trichoderma* spp., observed similar effect; the increase in plant height was up to 34% in relation to the control, though.

Although fresh mass of plants is a less frequent component of evaluation in scientific studies on plant growth promotion, the authors highlight the importance to evaluate the strain effect on obtaining root fresh mass since it exploits a greater soil volume and they are also important in plant adaptation in environments with lower quantity of nutrients (Hartwigsen & Evans, 2000).

So, considering that many strains of *Trichoderma* ssp. can help in nutrient solubilization (Benítez *et al*., 2004), the authors verified that *T. harzianum* ESALQ 1306 has potential to act as a nutrient solubilizer. Thus, we verified that the statistical superiority of *T. harzianum* ESALQ 1306 in laboratory for RFM, SFM, TFM, RDM, SDM and total biomass was also reproduced in field. One explanation for this event lies in the fact that, when one strain of *Trichoderma* establishes a relationship with rizosphere, plant growth is stimulated. This growth is related to rhizosphere competence, it means, the capacity the strains have to colonize the plant rizosphere and not only to produce growth hormones or analogues (Carvalho *et al*., 2011a).

Carvalho *et al*. (2015b) stated that, after being applied to a soil in which beans were grown, the strain of *T. harzianum* ESALQ 1306 was recovered, after the crop cycle, showing populations which ranged from 50 to 100 UFC/g soil. Moreover, not only the ability to colonize roots, but plant growth promotion also depends strongly on the interaction between the isolate and the tested plant species, as well as the conditions of the experiment conduction.

For lettuce productivity, treatment with *T. harzianum* ESALQ 1306 was considered satisfactory (50 t ha^{-1}), since the average of head lettuce productivity using organic fertilizers is higher than 43.1 t ha^{-1}, according to Sediyama *et al*. (2016). The other strains had productivity inferior than the productivity of ESALQ 1306, ranging from 41 to 44 t ha^{-1}. The other strains were superior to the control (30.18 t ha^{-1}), though. Similar productivities were found by Yuri *et al*. (2002), in head lettuce cultivars (Cassino, Legacy, Lucy Brown, Lorca, Lady and Raider) grown in south region of Minas Gerais at 800 m altitude, in typic distrophic Red Latosol, with a commercial production from 28.9 to 42.6 t ha^{-1} of harvest in March.

Thus, the strains IBLF 006 and URM 5911 could not be ruled out, because not all the efficient bioagents in promoting crop growth have equal efficiency for controlling diseases (Carvalho *et al*., 2015a,b).

In relation to the ratios in the laboratory experiment, the treatments with *T. asperellum* and the control were inferior to the other treatments for SMR and S/R; the authors suppose that the reduced biomass allocation to root system in seedlings treated with *T. asperellum* can be related to water availability to seedlings, since these seedlings were irrigated daily during the test with gerbox and, no water restriction was noticed (Guimarães *et al*., 2014). Contrary to what was observed in the laboratory, the seedlings did not obtain significant difference in relation to ratios in field experiment. This can be explained by the fact that *Trichoderma* fungus has differential reaction depending on the environment to which it is submitted (Akrami *et al*., 2011).

The results of head lettuce growth promotion showed in the treatment with *T. harzianum* ESALQ 1306 in laboratory were confirmed in the field when productivity and their components were evaluated. The authors recommend the use of strain *T. harzianum* ESALQ 1306 for growth promotion and head lettuce productivity, since the use of this strain for growing soil treatment provided an increase in productivity.

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Table 2. Characteristics of head lettuce cv. Mauren treated with commercial strains of *Trichoderma* spp. Ipameri, UEG, 2017.

Treatment	Height (cm)	Stem diameter (mm)	Head diameter (cm)	Number of leaves	Shoot fresh mass (g)	Root fresh mass (g)	Total fresh mass (g)
T. harzianum IBLF 006 WP	14.12 c	13.66 c	12.37 b	25.75 b	372.50 b	8.08 c	380.58 b
T. harzianum IBLF 006 SC	13.78 c	13.80 c	12.06 b	25.31 b	385.00b	7.95 c	392.95 b
T. harzianum ESALQ 1306	18.65 a	15.28 a	13.50 a	28.12 a	451.87 a	10.48 a	462.35 a
T. asperellum URM 5911	15.75 b	14.38 b	12.59 b	25.43 b	398.12 b	9.07 b	407.20 b
Control	9.77 d	10.70 d	10.46 c	22.45 c	271.62 c	5.31 d	276.98 c
CV (%)	4.78	6.24	6.96	4.99	13.89	16.63	13.69

	Shoot dry mass (mg)	Root dry mass (mg)	Total biomass (BIO) (mg)[1]	Shoot mass ratio (SMR)[2]	Root mass ratio (RMR)[3]	Shoot/root ratio (S/R)[4]	Yield (t/ha)
T. harzianum IBLF 006 WP	13.89 b	0.74 c	14.64 b	0.94 a	0.05 a	20.15 a	41.38 b
T. harzianum IBLF 006 SC	14.62 b	0.72 c	15.35 b	0.95 a	0.04 a	21.10 a	42.77 b
T. harzianum ESALQ 1306	17.83 a	1.09 a	18.92 a	0.94 a	0.05 a	16.28 a	50.20 a
T. asperellum URM 5911	14.86 b	0.85 b	15.72 b	0.89 a	0.05 a	18.18 a	44.23 b
Control	9.74 c	0.50 d	10.26 c	0.94 a	0.05 a	18.21 a	30.18 c
CV (%)	15.38	17.98	14.62	10.32	24.09	25.56	13.89

Averages followed by same lowercase letters in the column do not differ statistically, Scott-Knott test ($P \leq 0.05$); [1]BIO= SDM + RDM; [2]SMR= SDM/BIO; [3]RMR= RDM/BIO; [4]S/R= SDM/RDM.

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