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# Effect of *Trichoderma* and Nitrogen Fertilizer on the Growth and Yield of Tomato

[1]Nasser Fahem Yasir , [1]Ali A. Al-Salihy

[1]Institute of Genetic Engineering and Biotechnology for Postgraduate Studies, University of Baghdad, Iraq

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**Abstract:** An experiment was conducted in a greenhouse, located in the College of agriculture, Wasit University, Iraq. Tomato was planted and grown in winter season (November 2020 - April, 2021). The experiment aimed to study the effect of *Trichoderma* and nitrogen fertilizer on the growth and yield of tomato. Treatments comprised no application treatment as a control (T1), 100 kg N / $h^{-1}$ application ( T2), 160 kg N / $h^{-1}$ application (T3), 200 kg N / $h^{-1}$ application (T4), 0 kg N / $h^{-1}$ application with 100 g of Trichoderma (T5), 100 kg N / $h^{-1}$ application with 100 g of Trichoderma (T6), 160 kg N / $h^{-1}$ application with 100 g of Trichoderma (T7) and, 200 kg N / $h^{-1}$ application with 100 g of Trichoderma (T8). A randomized completely block design (RCBD) was used with three replicates. Treatment (T6) showed a significant superiority .in plant height (cm), leaf area **(**$dm^2$. $Plant^{-1}$**)**, leaves number (leaf. $Plant^{-1}$), leaf chlorophyll content (SPAD), Plant dry weight (g), fruit weight (g. $fruit^{-1}$) an**d** yield (kg. $Plant^{-1}$) compared to the control which showed the lowest average of all traits.

**Keywords:** *Trichoderma*, Tomato, Fertilizer, Yield.

**Corresponding author:** (Email:nafahim@uowasit.edu.iq).

## Introduction

As a result of rising population, changing environmental conditions and ineffective sustainable agriculture methods, food security has become a significant concern. Increasing output while lowering the risks of impacting environments in order to grow vegetables in a healthy way through sustainable agriculture, also known as an environmentally friendly system as well as producing healthy meals that minimize pollution is needed (1). Trichoderma species are fungus that can be found in almost all soil types and other environments, such as *T. harzianum*, *T. viride*, *T. koningii*, *T. hamatum*, and other Trichoderma species (2). Trichoderma colonizes the root surface or cortex and thrives in environments with plenty of healthy roots (3). They have developed a variety of mechanisms to eliminate fungal attacks as well as to promote root growth (4). Trichoderma has the ability to produce antibiotics, parasitize other fungi, and compete with pathogenic bacteria. All these features are proposed as explanations for how Trichoderma promotes plant growth and development (5). Mycoparasitism, antibiosis, toxin degradation, deactivation of pathogenic enzyme pathways, pathogen resistance, nutrient uptake enhancement, solubilization, sequestration of inorganic nutrients, and root hair development promotion are some of the mechanisms that Trichoderma use to improve plant growth (6). Trichoderma promotes plant hormone production, which promotes root growth and root hair formation, resulting in more efficient nitrogen, phosphorus, potassium, and micronutrient utilization, as well as increases seedling vigor and germination (7).

Tomato (*Lycopersicum esculentum* L.) is widely grown in many parts of the world due to their flavor, color, and nutritional value. The fruits contain certain amount of nutrients such as potassium in addition to contents of acids such as ascorbic (vitamin C), citric, and malic acids as well as E vitamin, some phenolic compounds, as well as carotene and lycopene pigments (8). It is an important vegetable because of its culinary value and high nutritious content (9). Tomatoes are the primary dietary source of antioxidants, which is linked to a variety of health advantages, including a lower risk of heart disease and cancer (10). The purpose of this study is to determine the impact of Trichoderma on tomato vegetative development and production.

## Materials and Methods

### Description of the experimental site

The experiments were conducted in greenhouses, located in College of Agriculture, Wasit University, Iraq. The tomato was planted and grown in winter season, November, 2020 through April, 2021. soil was sterilized with 2% formalin, then tilled  and covered with polyethylene for 48 h before being exposed for 7 days. After that, according to the instructions, the 10 kg pots were filled with sterile soil incorporated with potassium sulfate and triple superphosphate fertilizers before planting. Urea fertilizer was applied in two batches: one after the seedlings were planted and the other after a month.

### Tomato Seeds

Tomato seeds (Majd cultivar) are a limited-growing hybrid produced by Seminis Company in a nursery located in Wasit University. Healthy 30-day-old seedlings were planted in 10 kg pots; each pot contained one plant.

### *Trichoderma harzianum* Isolation

The study was conducted with one isolate of *T. harzianum* collected in 2020 from soil samples originating from Agricultural College fields in Wasit University, Wasit province of Iraq. *T. harzianum* was isolated from rhizospheres of healthy tomato plants. *Trichoderma* isolated in PDA culture media after 7 days of incubation at 28±2°C showed differences in mycelia culture growth and patterns of sporulation (Figure 1). The characters of mycelia colour patterns varied noticeably between the *Trichoderma* isolates, from colourless to yellow and white; their shapes consisted of concentric rings, and hyphae were septated, smooth-walled, and hyaline. The conidia were green to yellow-green or dark green colour and their shapes were rough and subglobose. Conidia production was more intense in the centre but declined toward the margins. (11).

*T.harzianum* fungus was added at a concentration of 100 g per pot to the root zone of the plants according to the treatments. The experiment involved no application treatment as a control (T1), 100 kg N / $h^{-1}$ application ( T2), 160 kg N / $h^{-1}$ application (T3), 200 kg N / $h^{-1}$ application (T4), 0 kg N / $h^{-1}$ application with 100 g of *Trichoderma* (T5), 100 kg N / $h^{-1}$ application with 100 g of Trichoderma (T6), 160 kg N / $h^{-1}$ application with 100 g of Trichoderma (T7) and, 200 kg N / $h^{-1}$ application with 100 g of Trichoderma (T8).

**Figure 1:** *Trichoderma* ***harzianum*** **isolates on potato dextrose agar after 7 days of incubation**

## Studied Traits

Plant height was measured from the area where the stem contact the soil to the growing apex of the longest branch of the plant by metric measurement tape and for three plants. The leaf area was calculated by implementing the dry weight method, which include 15 leaf disks of known size were taken and dried until the stability of weight and three plants from each experimental unit were collected and dried in an electric oven at 70 °C. Then, from the total dry weight of plant leaves, the leaf area was calculated by the following formula: -

Leaf area (dm2) = leaf area of disks x total dry weight plant leaves / dry weight of disks. The average of total number of leaves per a plant was calculated for three plants. Chlorophyll percentage in tomato leaves was determined using SPAD (model 502, Minolta, Japan), 15 days after adding the last application of fertilizers, the reading was taken from 3 plants per experimental unit. When leaves were well developed and fully sized at most physiological activity, leaf chlorophyll content was measured using SPAD and the average of three measurements reported (12). Plant dry weight was determined at the end of the experiment. The stem of plants (two plant for each of three blocks per potting mix treatment) was cut at the soil surface and the aboveground part. Samples were dried at 70°C until a constant dry weight recorded. Fruit weight was recorded by dividing the total weight by the cumulative number of fruits.Yield was calculated by taking the cumulative experimental unit yield and dividing on the number of plants and recording the average.

## Statistical Analysis

The experiments was designed using a completely randomized blocks design (CRBD) with three replications .Data were analyzed using ANOVA analysis and Genstat software was applied. The comparison between means were tested by LSD at a probability level of 0.05 according to (13).

## Results and Discussion

The results of Figure (1) shows that the treatment of Trichoderma plus nitrogen fertilizer at 100 kg ha$^{-1}$ (T6) was significantly affected plant height, as its reached 40 cm compared to the control treatment, that reported the lowest height, 34.33 cm with significant differences with the other treatments. Figure (2) identifies that plants treated with Trichoderma plus nitrogen fertilizer at 100 kg ha$^{-1}$(T6) showed significantly influence on leaf areas. It reported the highest average of plant height at 246.29 cm$^2$. Plant $^{-1}$. With significant differences in comparison with the control that reported the lowest plant height.It is clear from the data of figure (3) that the number of leaves increased when the various treatments were added to the plant, while the treatment of Trichoderma with nitrogen fertilizer at the level of 100 kg (T6) were significantly affected the number of leaves for each plant reaching of 23.67 leaf. Plant$^{-1}$. Compared to the checkup treatment, that recorded the lower number of leaves and reached 17.5 leaf. Plant$^{-1}$ with no significant differences in relation to other treatments. Figure 4 showed that the chlorophyll content of tomato leaves increased significantly with all treatments compared with the control. Trichoderma with nitrogen at a level of 100 kg (T6) was superior as it produced the highest average of chlorophyll in leaves (46.7) and no significant differences with the other treatments was reported. As for the comparison treatment (T1), it gave the lowest average of chlorophyll, (33.93). Figure (5) record the significant effect of the fixed factors on the dry weight of tomato plants. The results showed that plant dry weight increased significantly when Trichoderma was treated with nitrogen at a level of 100 kg (T6). Also, it was statistically superior by giving the highest average of dry weight (5.37)g. while, control treatment (T1) reported the lowest average of dry weight of (3.85) g .The results of Figure (6) indicated that the average fruit weight of the tomato was significantly increased when Trichoderma was added with nitrogen at a level of 100 kg (T6). It was superior by giving the highest value of fruit weight of (45.15 g) with significant differences with all other treatments. For the lowest average fruit weight (3.85 g), presented in the comparison treatment (T1).Yield of plant increased significantly with the application of Trichoderma and 100 kg of nitrogen (T6) (Figure 7). This treatment was superior by giving the highest yield per plant (1.383) kg. The results showed significant differences with all other treatments. Whereas, the no nitrogen and fungus treatment (T1) showed the lowest average fruit weight, 0.863 kg. Plant $^{-1}$. The previous results showed that treating the soil with *Trichoderma harzianum* fungus in combination with nitrogen fertilizer 100 kg.h$^{-1}$ led to a positive and significant result in plant height, leaf area, number of leaves, dry weight per plant, plant chlorophyll content, weight of the fruit and yield of individual plant. This indicates that the fungus *T. harzianum* has reduce the severity of plant diseases by inhibiting pathogens in the soil through their highly potent antagonistic and mycoparasitic activity. Application of this Trichoderma increased tomato growth and was statistically significant. (PGPF) comprises many genera of different fungi, such as those that provide multiple benefits to host plants without causing them pathogenicity and without harming the environment through direct or indirect mechanisms. These include regulation of hormonal balance, solubilization and mineralization, production of volatile organic compounds and microbial enzymes, suppression of alleviation of abiotic stresses and plant pathogens. These mechanisms lead to increased crop yield through direct or indirect mechanisms such as improving germination, root formation, plant growth, seedling viability, flowering, and photosynthesis (5, 10). According to this study, tomato the treatment of Trichoderma and nitrogen fertilization (160 kg. ha-1) was significantly superior to the rest of the other laboratories in the characteristics of vegetative growth and yield. Treated tomatoes with Trichoderma reduce the use of chemical fertilizers. It is therefore recommended that studying of the effect of Trichoderma fungus on other plants.

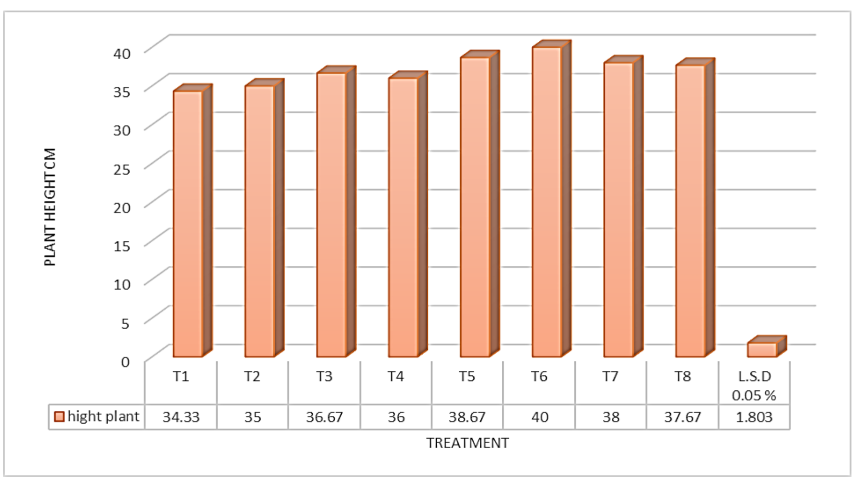


**Figure 2: Effect of Trichoderma and nitrogen fertilizer on plant height (cm).**

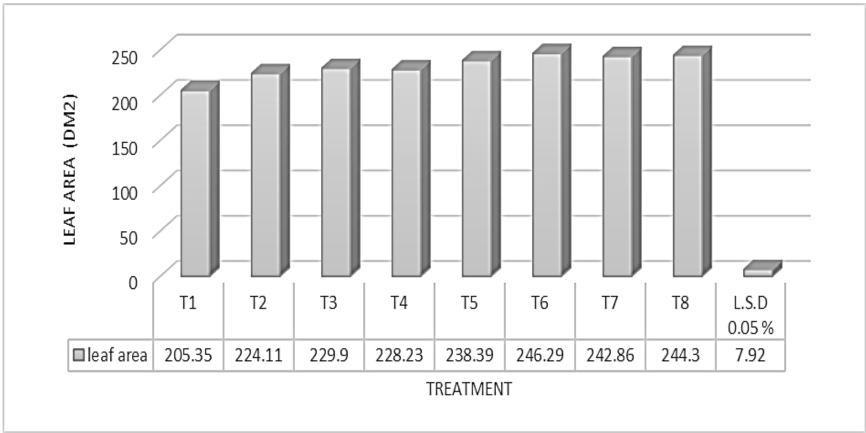


**Figure 3: Effect of *Trichoderma* and nitrogen fertilizer on leaf area ($dm^2$).**

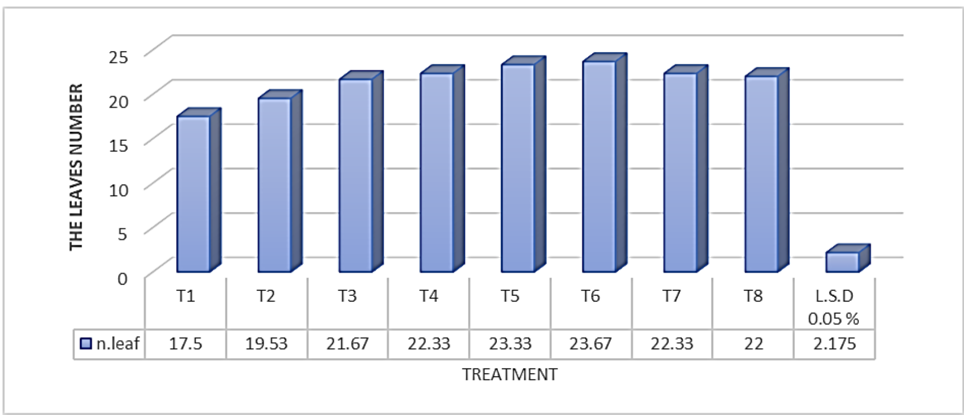


**Figure 4. Effect of *Trichoderma* and nitrogen fertilizer on the leaves number.**

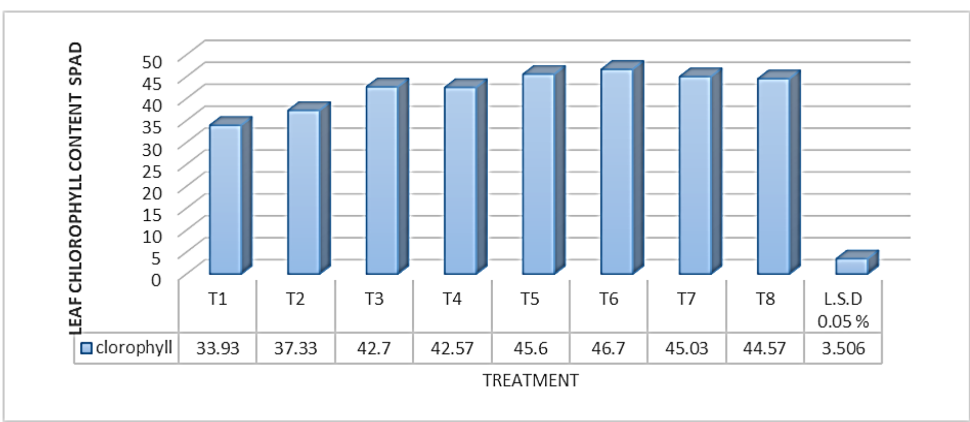


**Figure 5:Effect of *Trichoderma* and nitrogen fertilizer on Leaf chlorophyll content (SPAD).**

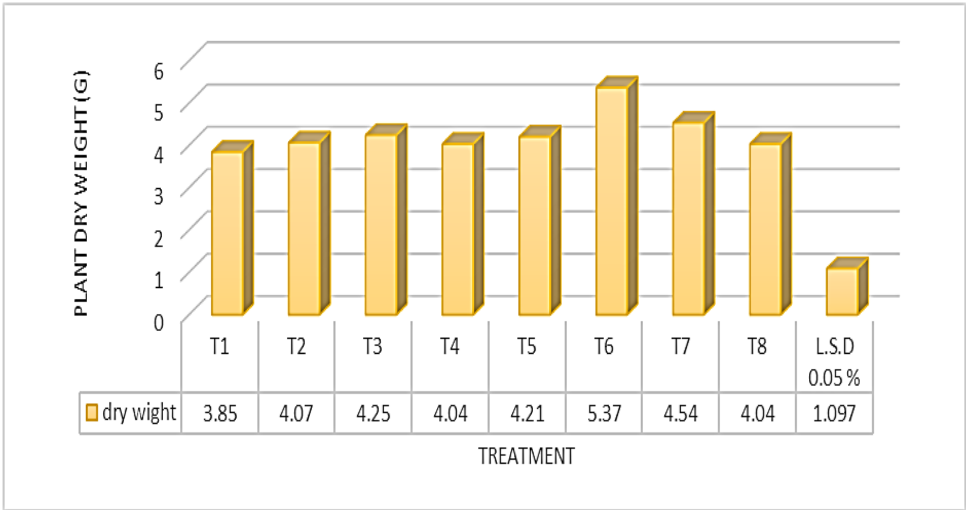


**Figure 6: Effect of *Trichoderma* and nitrogen fertilizer on plant dry weight (g).**

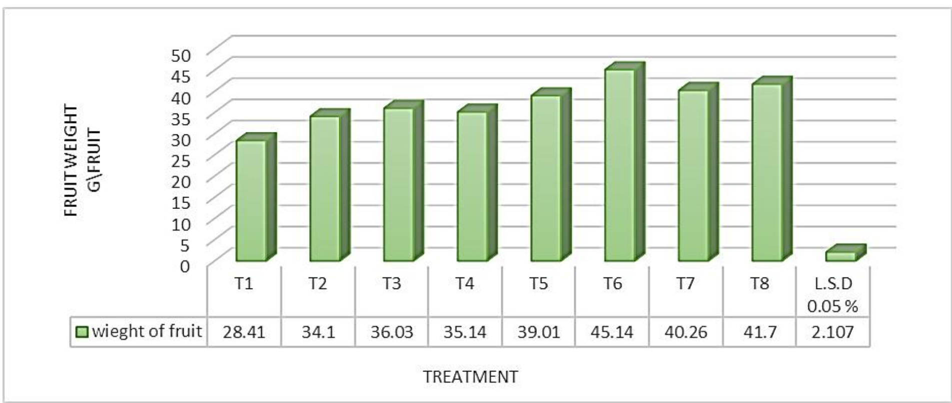


**Figure 7: Effect of *Trichoderma* and nitrogen fertilizer on the fruit weight (g\fruit).**

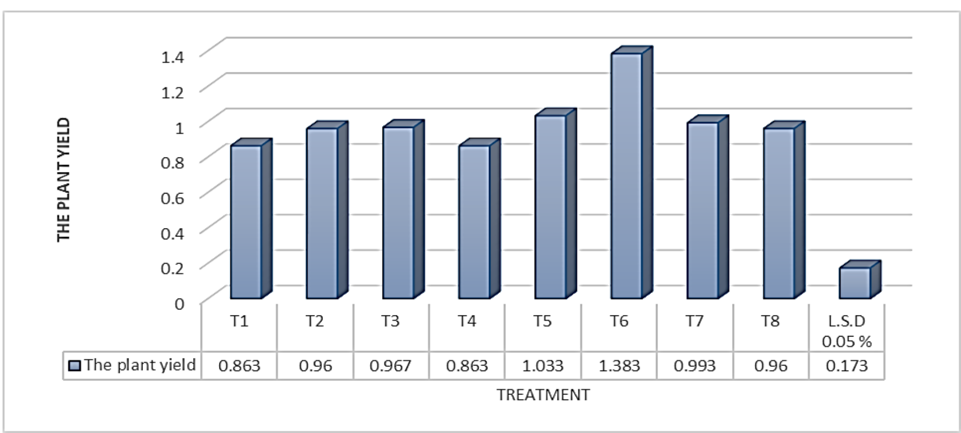


**Figure 8: Effect of *Trichoderma* and nitrogen fertilizer on the plant yield.**

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