biology and life sciences forum

Proceeding Paper

The Effect of Effective Microorganisms on the Performance of Tomato Transplants †

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† Presented at the 2nd International Electronic Conference on Plant Sciences—10th Anniversary of Journal Plants, 1–15 December 2021; Available online: https://iecps2021.sciforum.net/.

Abstract: The goal of this study aimed to determine how effectively microorganisms affected the growth and nutrient contents of tomato transplants. There were two treatments: (1) with effective microorganism (EM) treatment; and (2) without effective microorganism treatment–control. The height of tomato transplants was higher in the control treatment compared to the EM treatment. The stem diameters of tomato transplants were larger with EM treatment compared to the control variant. The nutrient content of tomato leaves was very good. The contents of nitrates, N, P, K, Ca, and Mg were higher with EM treatment compared to the control treatment.

Keywords: effective microorganisms; height; nutrient content; stem diameter; tomato; transplants

Citation: Olle, M. The Effect of Effective Microorganisms on the Performance of Tomato Transplants. *Biol. Life Sci. Forum* **2021**, *11*, 68. https://doi.org/10.3390/IECPS2021-12007

Academic Editor: Dimitris L. Bouranis

Published: 1 December 2021

1. Introduction

Effective microorganism (EM) technology was discovered and described in the 1970s [1]. In the beginning, microbes from nature (soil) were isolated and then mixed. The mixture includes lactic acid bacteria, photosynthetic bacteria, and yeast and a pH 3.5 needs to be kept for the solution [2].

An explanation of what benefit EM can produce is as follows: EM can be added to soil to make soil healthy for the growth of plants. EM will start to act in soil in the following way: it suppresses plant pathogens and agents of disease, solubilizes minerals, conserves energy, maintains the microbial balance of soil, increases photosynthetic efficiency, and fixes biological nitrogen [3].

Scientists have shown that EM enhances seed germination and vigor in tomato [4]. EM also increases the yield of tomatoes [5–7].

Photosynthesis and fruit yield of tomato plants were increased by EM inoculation with both Bokashi and chicken manure [7]. EM, used in conjunction with green manure (i.e., Gliricidia leaves), increased tomato yields; by the third year, EM yields were comparable to those obtained using a chemical fertilizer [5].

It is well known that the higher the quality of tomato transplants the higher the yield afterwords. The goal of this study was to determine how effectively microorganisms affected the growth and nutrient contents of tomato transplants.

2. Materials and Methods

The experiments were carried out in the greenhouse at the Estonian Crop Research Institute in the spring of 2014. In the experiment, tomato variety Malle was grown. There were two treatments: (1) with effective microorganism (EM) treatment; and (2) without effective microorganism treatment–control.

Tomato seeds were sown on 21 April 2014, into individual pots (9 cm diameter), where the seedlings were grown until the end of the transplant age. The substrate for conventionally cultivated seedlings and transplants was the peat-based mixture Kekkilä 14-16-18, which also contained magnesium (5%) and limestone (4 kg m^3).

Seeds were soaked in activated EM 1:500 solution half an hour before sowing (treatment 1). Seeds were soaked in water half an hour before sowing (treatment 2). Tomato seeds were sown in limed, fertilized, and activated EM 1:500 solution-treated peat (treatment 1) and in limed, fertilized, and water-treated peat (treatment 2). From 28 April 2014 to 26 May 2014 the EM treatment plants were watered with activated EM solution (1:500) at weekly intervals and control treatment plants were watered at the same time with a solution of Superex (12-5-27).

Each variant consisted of 4 plants. The experiment had four replicates. The experiments were conducted at the same time, i.e., the second experiment was carried out simultaneously. Therefore, the total amount of plants in the trials was 64 and additional plants were grown in a protection strip.

The greenhouse lighting at the plant level was approximately 12,000 lux using high-pressure sodium lamps. The plants were additionally lighted for a period of 18 h (04:00 p.m.–22:00 p.m.). All plants were grown with minimum day and night temperatures of 20 °C and 18 °C, respectively.

On 28 May 2014, the height and stem diameters were recorded.

The contents of nitrates in the raw shoots of tomatoes were measured. The contents of nitrogen, phosphorus, potassium, calcium, and magnesium were determined from dry matter of tomato shoots. Nitrate content was determined from plant extracts using a Fiastar 5000. The copper catalyst Kjeldahl method was used to determine the nitrogen content (984.13).

A Fiastar 5000 (AN 5242; stannous chloride method, ISO/FDIS 15681) was used to determine sporus in Kjeldahl Digest (AN 5242; stannous chloride method, ISO/FDIS 15681). The flame photometric method was used to determine potassium (956.01). Calcium was determined using the o-cresolphthalein complexone method (ISO 3696, in Kjeldahl Digest by Fiastar 5000). A Fiastar 5000 (ASTN90/92; Titan Yellow method) was used to determine the magnesium.

Variance analyses were performed on the data obtained using Excel. *** $p < 0.001$; ** $p = 0.001$–0.01; * $p = 0.01$–0.05; NS not significant, $p > 0.05$.

3. Results

The height of tomato transplants was significantly greater and plants appeared elongated in the control treatment compared to the EM treatment (Table 1). In the experiment, the EM variant plants were 26% smaller than plants in the control group.

Table 1. The height (cm) and stem diameter (cm) of tomato transplants according to treatments (EM, control).

		EM	Control	*p*
Height (cm)	Av.	27.63	37.31	***
	St.dv.	1.50	1.85	
Stem diameter (cm)	Av.	0.98	0.78	***
	St.dv.	0.04	0.04	

*** $p < 0.001$.

The stem diameter of tomato transplants was significantly larger with EM treatment in the experiments compared to control treatment (without EM; Table 1). In the experiments, the plants in EM treatment had 20% larger stem diameters than plants in the control group.

The nitrate content of the tomato transplants was higher in the EM variant than in the control variant (Table 2). The EM variant had 75% more nitrates in the tomato transplants than in the control transplants.

Table 2. The content of nitrates (mg kg^{-1}) in raw tomato shoots and the contents of N, P, K, Ca and Mg (%) in tomato shoot dry matter according to treatments (EM, Control).

The Content of:		EM	Control	p
Nitrates mg kg^{-1}	Av.	1765.2	438.7	***
	St.dv.	244.5	189.6	
N%	Av.	4.09	2.95	**
	St.dv.	0.26	0.35	
P%	Av.	0.74	0.66	*
	St.dv.	0.03	0.05	
K%	Av.	5.02	3.71	**
	St.dv.	0.34	0.45	
Ca%	Av.	2.38	1.95	**
	St.dv.	0.12	0.13	
Mg%	Av.	0.68	0.60	*
	St.dv.	0.05	0.03	

*** $p < 0.001$; ** $p = 0.001–0.01$; * $p = 0.01–0.05$.

The nitrogen content of tomato transplants was higher in the EM variant than in the control variant (Table 2). The EM variant had 28% more nitrogen in the tomato transplants than in the control transplants.

The phosphorus content of tomato transplants was higher in the EM variant than in the control variant (Table 2). The EM variant had 11% more phosphorus in the tomato transplants than in the control transplants.

The potassium content of tomato transplants was higher in the EM variant than in the control variant (Table 2). The EM variant had 26% more potassium in the tomato transplants than in the control transplants.

The calcium content of tomato transplants was higher in the EM variant than in the control variant (Table 2). The EM variant had 18% more calcium in the tomato transplants than in the control transplants.

The magnesium content of the tomato transplants was higher in the EM variant than in the control variant (Table 2). The EM variant had 12% more magnesium in the tomato transplants than the control transplants.

4. Discussion

The height of tomato transplants was significantly greater and plants appeared elongated in the control treatment, in both experiments, compared to the EM treatment. Oppositely, Idris [8] found that EM treatment significantly increased plant height, while in their research plant height in the fruiting phase was considered. We had seen this in transplants height in our research. It could be that EM also increases the height of tomato plants by yielding more primary branches and number of fruits.

The stem diameter of the tomato transplants increased with EM treatment. If stem diameter increases, then the plant can get better the nutrients from the soil. In addition, EM improve mineral solubilization, and therefore tomato plants are more nutritious [3].

It is well known that the quality of tomato transplants positively influences the yield. It is thus important that a transplant is of a good quality, which was the case in the present investigation. Similarly, Pavlovic et al. [9] found, in their study on tomatoes, that a low yield of tomatoes came from poor quality transplants. Mohan [10] found a higher yield and lower glycoalkaloid content in Bokashi-treated (including EM) tomatoes. EM inoculation increased the photosynthesis and fruit yield of tomato plants [7]. For tomatoes, Bokashi and EM1, when used alone, in combination, or in combination with inorganic fertilizer, significantly increased mean fruit weight over untreated controls and total marketable fruits harvested during the crop season [11]. EM applied with a green manure (i.e., Gliricidia leaves) increased tomato yields [5]. In accordance with this, Zanudin [6] found that EM increases the production of tomatoes. A lower number of tomato fruits associated with EM application resulted in improved average fruit weight of tomatoes grown in the greenhouse, possibly as a result of more assimilates being partitioned to the fewer fruits that formed [12]. The application of EM appeared to promote early fruiting in tomatoes [13].

Increased nitrate uptake was found in the present research. This could also have a negative impact on plants because a high nitrate accumulation results in nitrite production, which is converted to nitric oxide by nitrate reductase and is converted into the extremely toxic compound peroxynitrite under aerobic conditions, which is harmful to plant growth [14]. More seriously, peroxynitrite accumulation in humans can lead to chronic heart failure, diabetes, chronic inflammatory diseases, cancer, and neurodegenerative disorders [15].

In the present investigation, it increased phosphorus contents in plants was shown. A high content of this element is needed, especially for good root growth [16].

Data in the present investigation showed that potassium contents increased in plants. A high content of this element is very important to stomatal function and the water relations of plants [16].

EM provides a good start to tomato transplants, because it solubilizes minerals, including Ca, from the substrate. This is very good, because Ca influences the following processes: the incidence of diseases is less in plants with a higher Ca content, were less commonly found on plants with higher Ca contents, and plants had higher transportability and storability when containing more calcium [17,18].

Magnesium contents increased in plants in the present investigation. A higher Mg content could be desirable, because a higher Mg content reduces the incidence of insect pests and diseases [19].

5. Patents

There are no applied patents; however, these results are highly innovative and I consider them as a discovery in terms of the following:

Effective microorganisms (EM) improve the quality of tomato transplants because they remain compact with a greater stem diameter.

Supplementary Materials: The following are available online at: https://www.mdpi.com/article/10.3390/IECPS2021-12007/s1.

Funding: This research was financially supported by the Estonian Agricultural Registers and Information Board, and with the help of the Jaagumäe Agro OÜ and the Estonian Crop Research Institute.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The study reported some data; the author prefers not to publish all core data. Readers are provided an overview of the data on which statistical analyses have done.

Conflicts of Interest: The author declares no conflict of interest.

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