INDIAN JOURNAL OF SCIENCE AND TECHNOLOGY

RESEARCH ARTICLE

Effect of Vermicompost and Organic Fertilizer on Improved Growth, Productivity and Quality of Tomato (*Solanum lycopersicum*) Plant

Srinivasan Nithya[1], **O S Sethuraman**[2]*, **K Sasikumar**[2]

1 Research scholar, Department of Zoology, Kandaswami Kandar's college, Namakkal, Tamil Nadu, India
2 Assistant Professor, Department of Zoology, Kandaswami Kandar's college, Namakkal, Tamil Nadu, India

OPEN ACCESS

Received: 20-07-2023
Accepted: 26-09-2023
Published: 12-01-2024

Citation: Nithya S, Sethuraman OS, Sasikumar K (2024) Effect of Vermicompost and Organic Fertilizer on Improved Growth, Productivity and Quality of Tomato (*Solanum lycopersicum*) Plant. Indian Journal of Science and Technology 17(2): 142-148. https://doi.org/10.17485/IJST/v17i2.1821

* **Corresponding author**.

jayasamys@gmail.com

Funding: None

Competing Interests: None

Published By Indian Society for Education and Environment (iSee)

ISSN
Print: 0974-6846
Electronic: 0974-5645

Abstract

Objectives: This study's objective was to assess the growth and yield of tomato plants (*Solanum lycopersicum*) grown in vermicompost comprised of various mixtures of paper mill sludge and sugar mill press mud along cow dung. **Methods:** Vermicomposting experiments with paper mill sludge and sugar mill press mud along cow dung in plastic containers at room temperature and humidity using the earthworm species *Perionyx excavatus*. T1 is soil alone (control), T2 is soil with inorganic fertilizer, T3 is soil and compost, T4 is soil with compost and inorganic fertilizer, T5 is soil with vermicompost A, T6 is soil with vermicompost B, and T7 is soil with vermicompost C. **Findings:** The vermicompost (T6) demonstrated the greatest improvement in growth parameters and productivity of tomato plants (T6), i.e. plant height (76.15cm), Fruit diameter (4.14cm), Fruit weight (91.35 g), Number of fruits per plant (90.38), and yield (8.25kg). Then fruit compounds lycopene (0.589 mg/100 ml), beta-carotene (0.297 mg/100 ml), and total chlorophyll (0.556 mg/100 ml) quantity was increased. In this tomato plant experiment, vermicompost outperformed when compared commercial chemical fertilizer, compost, and the control. **Novelty:** This investigation emphasizes on the industrial waste such as sugar mill press mud and paper mill sludge. This undecomposed industrial organic waste converted into value added product through the modified innovating vermicomposting process improve the nutritional value and increase the growth of the tomato plant also high stock density of *Perionyx excavatus*.

Keywords: Paper mill sludge and sugar mill press mud, *Solanum lycopersicum*, lycopene, β-carotene, *Perionyx excavatus*

1 Introduction

The industries of paper and pulp mills are extremely important to the functioning of the global economy as well as to the continuation of human life. The passage of time has revealed a significant rise in the total amount of paper produced across the planet. In the intervening time, the United States of America has established itself as the world's top manufacturer of paper. On the other hand, projections made by the Confederation of European Paper Industries (CEPI) indicate that the amount of paper that will be consumed on a global scale would increase to more than 500 million tons by the year 2025[(1)]. According to Ganguly and Chakrabarti[(2)], India stores around 2.6% of the world's total paper production in order to meet the demands of the country's economy. Developing countries like India confront substantial challenges when it comes to the management of trash. These challenges are caused by the high organic content of these countries. A substantial amount of damage is done to the natural environment by the sludge residue left over from paper mills, which pollutes the air, water, and land.

Also, India's sugar business makes more than 1 million tones of press sludge every day. Because of the way this waste is made, businesses have trouble getting rid of it in a safe way. Press mud is mostly made up of fibers, colloids, cane wax, albuminoids, inorganic ions, soil particles, and a small amount of sugar. It is a dark brown, fuzzy, amorphous material. Press mud is hard to move because it is sticky, smells bad, and has a lot of water in it. So, most companies treat their press mud close to where they are. The press mud is one of the most useful leftovers from farming that can be used on a large scale. Worm composting is a healthy way to get rid of rice stalks in an effective way. Vermicompost is a useful soil-like material that is made when earthworms and microorganisms work together the primary organic matter decomposers are microorganisms[(3)]. This is a more efficient, cost-effective, and environmentally friendly way to break down organic wastes. It has been said that the hormones and plant growth regulators in vermicompost help legumes, veggies, cereals, and ornamental plants, among others, grow better. The suitable biodegradation strategy in which earthworms and microorganisms significantly influence organic solid wastes. Vermicomposting, which employs numerous earthworm species, has gained popularity among ecologists in recent years[(4)].

This study evaluated the impact of vermicompost on the development and yield of tomato plants by incorporating it into the soil. Diverse organic residues have been converted into vermicompost utilizing diverse earthworm species. The earthworm species *Perionyx excavatus* was chosen for this study due to its high reproductive rate, voracious feeding behavior, 1–3 year lifespan, ability to withstand extreme climatic conditions, and its ease of handling. Before being used as fertilizer, the composted material must be completely stabilized to prevent oxygen depletion and nitrogen mineralization from having a negative influence on plant growth. Therefore, the current study included 30 days of pre-decomposition and 90 days of vermicomposting to assure the complete stabilization of the vermicompost. The majority of previous studies focused on comparing the influence of innovative vermicomposting process on plant growth parameters relative to the control soil. However, we have also investigated the impact of vermicompost on the development and yield of tomato plants in comparison to commercial organic fertilizer and compost. For optimal growth and development, tomato plants require a high nitrogen and nutrient content. As a result, it is a suitable method for determining the vermicompost's nutrient-providing capacity for plant growth. The purpose of this investigation was to determine the effect of modified vermicomposting process derived from various combinations of paper mill sludge, cow dung, and sugar mill press mud on the growth and yield of tomato plants.

2 Methodology

2.1 Vermicomposting

The paper mill sludge was collected from TNPL, Pugalur, Tamil Nadu, India. Sugar mill press mud (SPM) was collected from the Mohanur Sugar Mill Factory, Mohanur, Namakkal, Tamilnadu, India. Cow dung (CD) was collected from cow sheds and allowed to settle over several weeks before being used in the experiment. The worm *Perionyx eavatus* was found within 10 miles of the Pugalur area. In 75 cm, 60 cm, and 45 cm plastic containers with varied quantities of earthworms, the substrates were given a 15-day initial decomposition period (Figure 1). Cow dung was used to build the vermibeds. Each container received different ratio of paper mill sludge, sugar mill press mud, and cow dung. The feedstock was frequently moistened with distilled water to adequate moisture (80%), and it was pre-decomposed for 30 days to stabilize it and offer an optimal environment for earthworm growth. The earthworms were inserted into the vermibeds on the thirty-first day. The feedstock was subjected to vermicomposting for a period of 90 days. Manual mixing of the feedstock was done on a frequent basis to ensure proper aeration and respiration. All experiments were carried out in triplicate in a shady environment at room temperature. The feedstock, vermicompost, and compost (control) samples were characterized in terms of pH, moisture content, total nitrogen (TN), total organic carbon (TOC), potassium (K), C:N ratio, and phosphate (P) (Atomic Absorption Spectrophotometer) for evaluation of physicochemical changes using standard methods (BOFFO 1985).

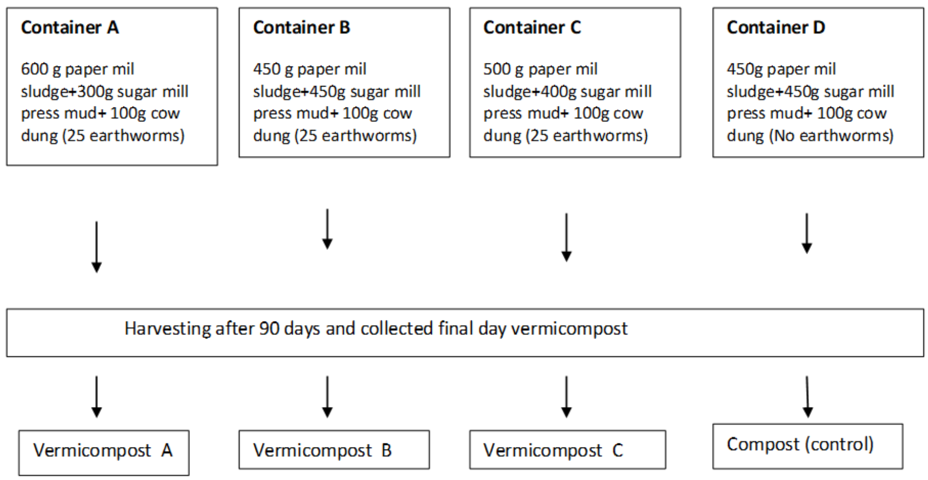

Fig 1. Vermicomposting experimental setup

2.2 Plant Studies

To study the impact of several soil amendments on tomato plants (*Solanum lycopersicum*) growing under ambient settings, three different types of vermicompost (A, B, and C), compost, and a readily available organic fertilizer (Fresh Essentials) were mixed with the soil. One control T1 and six different treatments T2, T3, T4, T5, T6 and T7 were tested in containers that were 32 cm, 28 cm, 28 cm.

T1: Only soil (control) (6 Kg)
T2: Soil (4.5 Kg) + Inorganic fertilizer that is NPK (1.5 Kg)
T3: Soil (4.5 Kg) + Compost (1.5 Kg)
T4: Soil (4.5 Kg) + Compost (0.75 Kg) + Inorganic fertilizer that is NPK (0.75 Kg)
T5: Soil (4.5 Kg) + Vermicompost A (1.5 Kg)
T6: Soil (4.5 Kg) + Vermicompost B (1.5 Kg)
T7: Soil (4.5 Kg) + Vermicompost C (1.5 Kg)

Tomato seedlings were collected from Sembaruthi Nursery, Namakkal, Tamilnadu, India. Three seedling was planted in each pot. We measured the number of leaves, plant height, and stem diameter of tomato seedlings to determine their initial growth characteristics. The number of leaves was determined by hand counting. A scale was used to measure the plant's height from the soil line to the top of the main stem, while a vernier caliper was used to measure the diameter of the stem. The plants were watered regularly as per requirements. All growth parameters were measured after every 15 days, starting from transplantation of the seedlings. The number of tomatoes was counted manually after 30 days of flowering. The weight of the tomatoes is measured after 50 days of flowering using a weighing balance also above growth parameters of the tomato plants, i.e. plant height, fruit diameter, number (productivity), and weight of the tomatoes were compared within the treatments.

2.3 Chlorophyll, beta-carotene, and lycopene quantitation

According to Mackinney's and Kimura's methods, spectrophotometric analysis was used to determine the amounts of lycopene, β-carotene and chlorophyll. Lycopene, β-carotene, chlorophyll a, b, and total chlorophyll content were measured in as mg/100 ml.

2.4 Elements of Fruit Quality

Using the preceding 7 fruit samples, the fruit quality attributes were evaluated. Fruits were cut into small fragments. A juice extractor was used to get tomato juice out of each of the 7 fruit. Clear juice was used to test the quality. After removing the seeds, peels, and flesh, the juice volume was measured using a graduated cylinder.

2.4.1 PH

The pH of tomato fruit juice was determined by combining 10 g of fruit flesh tissue with 100 mL of distilled water in 50 ml of filtrate juice [5].

2.4.2 Titratable acidity (TA)

After diluting 10 g of homogenized tomato juice sample with 50 mL of distilled water and titrating it with a 0.1% NaOH solution at a pH of 8.17 [6], the acidity was calculated as g/L.

2.4.3 Ascorbic acid (AA)

Treatment of tomatoes ascorbic acid content were quantified using Method Tareen et al. (2012) [7]. The technique consisted of homogenizing 5 g of fruit puree with 5 mL of 0.1% HCl (w/v) and centrifuging for 10 minutes at 10,000 rpm. Then, the supernatant was collected. The absorbance of the supernatant solution was then determined utilizing a spectrophotometer set to 243 nm.

2.5 Statistical evaluation

All the experiments were performed in triplicate. In the report, both the samples mean and the standard error are included. The data are analyzed for variance utilizing SPSS software (versin 23), first with a one- way analysis of variance (ANOVA).

3 Results and Discussion

The (Table 1) presents a review of the nutritional physicochemical qualities of a variety of vermicompost (A, B, and C) and compost (D) samples that were generated from paper mill sludge, sugar mill press mud. Vermicompost B, which was made with the most earthworms, had the most improved nutritional, physical, and chemical properties compared to vermicompost C, A, and compost. This is a result of the vermicompost carring adequate quantities of growth hormones (such as ethylene, auxins, and gibberellins) and enzymes (such as cellulase, nitrogenase, and phosphatase, amongst others) [7].

Table 1. The Physicochemical characteristics of vermicompost and control compost

	Control compost	Vermicompost A	Vermicompost B	Vermicompost C
p^H	7.82±0.51	7.05±0.05	7.13±0.14	7.22±0.10
Nitrogen	2.21±0.08	4.21±0.43	3.68±0.16	3.97±0.21
Phosphorus	1.98±0.05	2.98±0.15	2.58±0.12	2.73±0.15
Potassium	0.57±0.02	1.02±0.5	0.85±0.02	0.96±0.04
Organic carbon	41.12±1.05	40.20±1.02	37.24±0.98	36.61±0.92
C:N ratio	18.60±1.21	9.54±0.51	10.11±1.02	9.22±0.97
Moisture content (%)	75.23±0.15	75.10±0.31	74.86±0.23	74.59±0.47

3.1 Impact of vermicompost on mean plant height

The average height of the plants in the treatments with vermicompost changes was significantly higher than in the control group, as shown in (Table 2). The average plant height increased by 76.15 cm for treatment T6, followed by T7 with a 69.92 cm, T5 with a 68.45 cm, T4 with a 67.64 cm, T3 with a 66.25 cm, T2 with a 61.71 cm and T1 with a 58.38 cm. The information in the aforementioned part fits with what has been found in the current body of literature. In the study, Awadhpersad et al. (2021) [8] found that tomato plants grew taller and had more branches after being treated with vermicompost and vermiwash, compared to the control group. The study of Arancon et al., [9], they used vermicompost water extract, showed that it made stem cuttings of sugarcane and mint plants grow longer and bigger overall. Innovative Vermicomposting process may produces many useful substances, such as macro- and micronutrients, hormones, growth boosters, regulators, and enzymes like lipases, chitinases, amylases, proteases, and cellulases. These substances are very important for turning industrial waste into forms that plants can use easily. Because vermicompost contains the above mentioned plant development elements, it is possible that these plants will grow more rapidly in it.

Table 2. Total yield parameters of tomato plants

Experimental treatment	Plant height at 90 days (cm)	Fruit diameter (cm)	Fruit weight (g)	No. of fruits/plant	Total yield (Kg/plant)
T1 -	58.38 ± 1.26	2.61 ± 0.18	88.15 ± 0.85	60.37± 3.86	5.32±1.52
T2 -	61.71 ± 0.98	2.82 ± 0.27	88.54 ± 1.15	70.14± 3.55	6.21±0.96
T3 -	66.25 ± 1.52	3.79 ± 0.59	89.03 ± 0.92	70.53 ±4.04	6.33 ± 1.36
T4	67.64 ± 1.81	3.88 ± 0.36	89.12 ± 1.23	71.10 ±4.16	6.33 ± 2.04
T5	68.45 ± 1.20	3.74 ± 0.27	89.70 ± 1.28	74.48 ±3.75	6.68 ± 2.18
T6	76.15 ± 1.57	4.14 ± 0.57	91.35± 1.03	90.38 ±4.21	8.25± 1.02
T7	69.92 ± 1.08	3.98 ± 0.20	90.5 ± 0.96	82.15 ±3.96	7.43 ± 1.97

3.2 Effect of vermicompost on mean tomato yield, weight and diameter

The average tomato yield result is highest for T6 and lowest for T1 (Table 2). The average number of tomatoes grew 8.25 kg in T6, followed by T7 (7.43), T5 (6.68), T4 (6.33), T3 (6.33), T2 (6.21) and T1 (5.32). It has been discovered that the stock density of earthworms during vermicomposting is a critical component in influencing how productive tomato plants grow. Staffen et al. (2019)[(10)] also showed that vermicompost plus mineral fertilizer boosted tomato fresh mass and yield per plant compared to the control.

On average, T6 tomatoes weigh and diameter the most, while T1 tomatoes weigh and diameter the least. This (Table 2) shows that the chemical fertilizer functioned better in T2 than in T3 and T1. T6 (6.25%) raises the average weight of tomatoes the most, followed by T7 (5.92%), T5 (4.69%), T4 (3.15%), and T3 (2.08%). People claim that the macronutrients in vermicompost help plants produce more chlorophyll, improve their enzyme system, increase normal fruit weight, and accelerate growth also in this process earthworms are produce humus through organic processes that boost plant nutrient absorption and metabolic rate. In this way changing the microorganisms in the rhizosphere and eliminating plant diseases, vermicompost enhances plant development[(11)].

3.3 Effect of vermicompost on leaf chlorophyll content

The effect of varied vermicompost rates on the amount of chlorophyll in leaf tissue was statistically significant, as shown in (Table 3). The experiment's results demonstrate Chlorophylls a concentrations ranged from 0.258 to 0.176 mg/100 ml, whereas chlorophyll b concentrations ranged from 0.296 to 0.092 mg/100 ml. The leaf chlorophyll a, chlorophyll b, and total chlorophyll content were highest in T6 plants and lowest in T1 plants. There were no significant differences in chlorophyll content between T5 and T4 plants, even though they also had higher chlorophyll content than T1 plants. The T6 type had the best effects on chlorophyll levels because it was the best source of N (Table 1). This could be because adding vermicompost B to the soil made it contain more N. While the amount of N available for plant growth in growing medium is often tied to chlorophyll content[(12)].

Table 3. Analysis of fruit pigments Chlorophyll, Lycopene and β-Carotene

Experimental treatment	Chlorophyll a (mg/100 ml)	Chlorophyll b (mg/100 ml)	Total Chlorophyll (mg/100 ml)	Lycopene (mg/100 ml)	β-Carotene (mg/100 ml)
T1 -	0.176	0.092	0.269	0.472	0.147
T2 -	0.182	0.105	0.287	0.521	0.173
T3 -	0.133	0.153	0.264	0.538	0.205
T4	0.150	0.143	0.305	0.563	0.249
T5	0.183	0.227	0.338	0.571	0.271
T6	0.258	0.296	0.556	0.589	0.297
T7	0.213	0.248	0.462	0.576	0.289

The (Table 3) shows the results of figuring which pigments are in tomato fruit. The results showed that T6 (0.589 mg/100 ml), T7 (0.576 mg/100 ml), T5 (0.571 mg/100 ml), T4 (0.563 mg/100 ml), T3 (0.538 mg/100 ml), and T2 (0.521 mg/100 ml) had the most lycopene, while T1 (0.472 mg/100 ml) had the least. High levels of beta-carotene were found in T6 (0.297 mg/100 ml), T7 (0.289 mg/100 ml), T5 (0.271 mg/100 ml), T4 (0.249 mg/100 ml), T3 (0.205 mg/100 ml), T2 (0.173 mg/100 ml), and the reference T1 (0.147 mg/100 ml). The amounts of lycopene and beta-carotene were found to be very different. Beta-carotene is an antioxidant that is known to help the nervous system. Sabry et al. (2021)[13] have shown that there is a link between beta-carotene and better reproductive function.

3.4 Aspects of Fruit Quality

The results presented in (Figure 2) shows that ascorbic acid (AA), titratable acidity (TA), pH of tomato were also influenced by different combinations of vermicomposts and compost. Tomato fruit quality of T6 treatment had the highest significant AA content than any other treatments. The vitamin C content ranged from 20.13 to 30.15 mg per 100 grams. Improvement of tomato fruit quality under T6 treatment attributed to the better growth of plants (Figure 2), which might have favored the production of quality fruits. However, Control T1 exhibited higher values of TA and pH of fruit juice in comparison with all the other vermicomposts amended with different rates of sugar mill press mud and paper mill sludge. Fruit pH is an important factor for fresh consumption tomato; low pH improves taste and flavor of the fruit. All compost types had pH values ranging from 4.11 to 4.86. These values are relatively similar to those reported by various researchers in previously conducted studies Aurora et al. (2019)[14]. In this investigation, the TA values ranged from 2.03 to 3.15 (g/L). The maximum TA value (3.15(g/L) was found in the T1 compost, while the lowest TA value (2.03(g/L) was found in the T6 compost. The result of Zoltan Felfoldi et al. (2022)[15] support our result that using nutritional quality parameters of the fresh red tomato varieties cultivated in organic system.

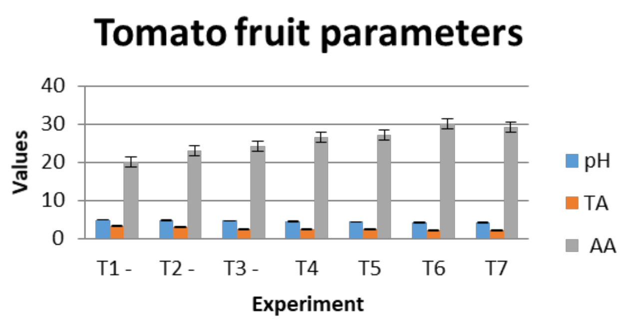

Fig 2. Tomato fruit parameters

4 Conclusion

While the tomato plant was treated with vermicompost (B) produced with the highest earthworm stock density, it showed the best growth and yield enhancement. The use of vermicompost made from press mud resulted in a noticeable increase in the overall height of tomato plants, despite the fact that there was no statistically significant impact on total output. According to the findings, earthworms have a significant impact on increasing the physicochemical properties of vermicompost, resulting in improved growth metrics and yield. The results revealed a statistically significant ($p < 0.05$) difference between all of the treatments and the control group. The data imply that vermicomposting is a viable option for the environmentally responsible treatment of paper mill sludge and sugar mill press mud. When vermicompost was applied to tomato plants, it had a good effect on their growth and yield. It is probable that the creation of vermicompost would be suggested as a suitable soil supplement for increasing the growth and production of various crops, taking into account the individual nutrient requirements of each crop. The use of vermicomposting as a feasible alternative for the sustainable management of paper mill sludge and sugar mill press mud and environmental preservation has been highlighted.

5 Acknowledgement

The authors thank Dr. D.Senthil Kumar, Head, Department of Zoology, Kandasamy Kandar's College, Namakkal, Tamil Nadu and also thank the Administrative authorities of Kandasamy Kandar College for imparting infrastructure.

References

1) Ganguly RK, Chakraborty SK. Paper Pulp Mill Wastes: A Curse or Boon – Modern Approach of Recycling. In: Handbook of Environmental Materials Management. Springer International Publishing. 2020;p. 1–15. Available from: https://doi.org/10.1007/978-3-319-58538-3_216-1.
2) Ganguly RK, Chakraborty SK. Eco-management of Industrial Organic Wastes Through the Modified Innovative Vermicomposting Process: A Sustainable Approach in Tropical Countries. In: Earthworm Assisted Remediation of Effluents and Wastes. Springer, Singapore. 2020;p. 161–177. Available from: https://doi.org/10.1007/978-981-15-4522-1_10.
3) Nithya S, Raman S. Microbial diversity of vermicompost in different concentration od paper mill waste with cow dung and sugar mill press mud mixture of Perionyx excavatus and Eudrilus eugeniae. *JJM*. 2022;15(1):5020–5030. Available from: http://www.jjmicrobiol.com/index.php/jjm/index.
4) Mohan A, Kumar D, Jayachandran R, Yuvaraj A, Thangaraj R. Biogeneration and physico-chemical properties of panchagavya fortified chicken feather vermicompost. 2021. Available from: https://doi.org/10.21203/rs.3.rs-922574/v1.
5) Polat E, Demir H, Erler F. Yield and quality criteria in organically and conventionally grown tomatoes in Turkey. *Scientia Agricola*. 2010;67(4):424–429. Available from: https://doi.org/10.1590/S0103-90162010000400008.
6) Thakur BR, Singh RK, Nelson PE. Quality attributes of processed tomato products: A review. *Food Reviews International*. 1996;12(3):375–401. Available from: https://doi.org/10.1080/87559129609541085.
7) Tareen MJ, Abbasi NA, Hafiz IA. Effect of salicylic acid treatments on storage life of peach fruit Cv. "Flordaking". *Pakistan Journal of Botany*. 2012;44(1):119–124. Available from: https://www.researchgate.net/publication/287587669_Effect_of_salicylic_acid_treatments_on_storage_life_of_peach_fruits_CV_'Flordaking'.
8) Awadhpersad VRR, Ori L, Ansari AA. Production and effect of vermiwash and vermicompost on plant growth parameters of tomato (Lycopersicon esculentum Mill.) in Suriname. *International Journal of Recycling of Organic Waste in Agriculture*. 2021;10:397–413. Available from: https://doi.org/10.30486/ijrowa.2021.1911898.1148.
9) Arancon N, Van Cleave J, Hamasaki R, Nagata K, Felts J. The influence of vermicompost water extracts on growth of plants propagated by cuttings. *Journal of Plant Nutrition*. 2020;43(2):176–185. Available from: https://doi.org/10.1080/01904167.2019.1659355.
10) Steffen GPK, Maldaner J, de Morais RM, Saldanha CW, Missio EL, Steffen RB, et al. The vermicompost anticipates flowering and increases tomato productivity. *Agrociencia Uruguay*. 2019;23(1):1–7. Available from: https://agrocienciauruguay.uy/index.php/agrociencia/article/view/54/29.
11) Munoz-Ucros J, Panke-Buisse K, Robe J. Bacterial community composition of vermicompost-treated tomato rhizospheres. *PLOS ONE*. 2020;15(4):1–12. Available from: https://doi.org/10.1371/journal.pone.0230577.
12) Bednarczyk D, Aviv-Sharon E, Savidor A, Levin Y, Charuvi D. Influence of short-term exposure to high light on photosynthesis and proteins involved in photo-protective processes in tomato leaves. *Environmental and Experimental Botany*. 2020;179:104198. Available from: https://doi.org/10.1016/j.envexpbot.2020.104198.
13) Sabry MM, Elnour RA, Monem MA, Fotouh GIA. The Possible Effect of β -carotene on Nicotine Withdrawal in Testicular Tissue of Adult Male Albino Rats. Histological and Immunohistochemical Study. *Egyptian Journal of Histology*. 2021;44(3):687–699. Available from: https://doi.org/10.21608/ejh.2020.38061.1342.
14) Dobrin A, Nedelus A, Bujor O, Mot A, Zugravu M, Badulescu L. Nutritional quality parameters of the fresh red tomato varieties cultivated in organic system. *Scientific Papers Series B, Horticulture*. 2019;LXIII(1):439–443. Available from: https://orgprints.org/id/eprint/36786/1/NUTRITIONAL%20QUALITY%20PARAMETERS%20OF%20THE%20FRESH%20RED%20TOMATO%20VARIETIES%20CULTIVATED%20IN%20ORGANIC%20SYSTEM.pdf.
15) Felföldi Z, Ranga F, Roman IA, Sestras AF, Vodnar DC, Prohens J, et al. Analysis of Physico-Chemical and Organoleptic Fruit Parameters Relevant for Tomato Quality. *Agronomy 2022*. 2022;12(5):1–22. Available from: https://doi.org/10.3390/agronomy12051232.