Environmental Research and Ecotoxicity. 2025; 4:154
doi: 10.56294/ere2025154

ORIGINAL

Evaluation of vermicompost leachate in the organic fertilization of the chili pepper crop

Evaluación del lixiviado de vermicompost en la fertilización orgánica del cultivo de ají (Capsicum chinensis)

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Cite as: Arellano Molina M, Guillén Durán A, González García H, Pineda Ochoa CL. Evaluation of vermicompost leachate in the organic fertilization of the chili pepper crop. Environmental Research and Ecotoxicity. 2025; 4:154. https://doi.org/10.56294/ere2025154

Submitted: 20-04-2024 **Revised:** 05-09-2024 **Accepted:** 14-01-2025 **Published:** 15-01-2025

Editor: Prof. Dr. William Castillo-González

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ABSTRACT

The use of vermicompost leachate has a biostimulant effect, due to its high biological quality, as well as being an alternative to increase the nutritional status of plants, which favors the promotion of growth and development in crops. Therefore, the general objective of this research was to evaluate the leachate of vermicompost in the organic fertilization of the chili pepper crop. In this way, the research was framed from a positivist paradigm with a quantitative approach, a level of explanatory research and a methodological design of experimental field. The statistical design was completely randomized which was contemplated by 4 treatments and 12 plants per treatment, these were the following: T0: without fertilization; T1: application of vermicompost leachate at a 25 % dilution; T2: application of vermicompost leachate at 50 % dilution; T3: application of vermicompost leachate at 75 % dilution; the measured variables were: seedling emergency capacity, plant height, number of leaves, leaf diameter, stem diameter and root length. The results showed no statistical differences between the treatments applied for the variables of emergency capacity, growth and development the chili pepper crop; however, an increase of T3 is observed in the variables evaluated compared to the other dosages used.

Keywords: Organic Fertilization; Vermicompost Leachate; Chili Pepper Crop.

RESUMEN

El uso del lixiviado del vermicompost ejerce un efecto bioestimulante, por su alta calidad biológica además de ser una alternativa para incrementar el estado nutricional de las plantas, lo cual favorece la promoción del crecimiento y desarrollo en cultivos. Por ello, el objetivo general de esta investigación fue evaluar el lixiviado de vermicompost en la fertilización orgánica del cultivo de ají. De esta manera, la investigación estuvo enmarcada desde un paradigma positivista con un enfoque cuantitativo, un nivel de investigación explicativa y un diseño metodológico de campo experimental. El diseño estadístico fue completamente aleatorizado el cual estuvo contemplado por 4 tratamientos y 12 plantas por tratamiento, estos fueron los siguientes: T0: sin fertilización; T1: aplicación del lixiviado de vermicompost en una dilución del 25 %; T2: aplicación del lixiviado de vermicompost en una dilución del 50 %; T3: aplicación del lixiviado de

vermicompost en una dilución del 75 %; las variables medidas fueron: capacidad de emergencia de plántulas, altura de la planta, número de hojas, diámetro de la hoja, diámetro del tallo y longitud de raíz. En los resultados no se observaron diferencias estadísticas entre los tratamientos aplicados para las variables de capacidad de emergencia, crecimiento y desarrollo del cultivo de ají; sin embargo, se observa un aumento del T3 en las variables evaluadas respecto a las otras dosificaciones utilizadas.

Palabras clave: Fertilización Orgánica; Lixiviado de Vermicompost; Cultivo de Ají.

INTRODUCTION

Due to its high biological quality, vermicompost leachate has been considered to have a biostimulant effect. It is also an alternative for improving the nutritional status of plants, promoting the growth and development of healthy and functional roots, and providing countless benefits in relation to plant health.[1,2,3,4,5,6,7]

Among vegetable crops, chili peppers are one of Venezuela's most important agricultural products. They are annual plants that adapt well to temperate climates and tolerate high temperatures. However, when these exceed 32 °C, the number of flowers and their fertilization may be affected.[2,8,9,10,11,12]

It is important to note that in the early stages of the chili pepper life cycle, optimal conditions must be provided to ensure the vigor of the seedlings before they are taken to the field so that the crop achieves optimal yield. Therefore, the nutritional level that can be provided should play a fundamental role in their growth and development to achieve the appropriate parameters in terms of height, stem diameter, and number of leaflets, among others, in a shorter time.[13,14,15,16,17,18,19,20]

For this reason, this research was based on the organic fertilization of chili pepper seedlings. In this study, a completely randomized experimental design with three (3) replicates was proposed, consisting of ten (10) experimental units and four (4) treatments, including the control. The trial was established under semi-controlled conditions at the La Guajira farm in the Caña Brava sector, Rómulo.

Betancourt parish, Mérida state, to evaluate germination, growth, and development variables.

Will using vermicompost leachate have a phytotoxic effect on the emergence capacity of chili pepper seedlings?

Objective

Evaluate vermicompost leachate in organic fertilization of chili pepper (Capsicum chinensis) cultivation).

METHOD

Due to the nature of the study, it was conducted from a positivist paradigm using a quantitative approach. Similarly, Palella and Martins[17] define positivism as perceiving science as a systematized body of information that includes principles, theories, and norms, which turns the researcher's work into action to discover and add facts to the existing body of knowledge. Science uses measurements, specifies observation conditions, and pursues generalization to fulfill its purposes.

About the quantitative approach, Rosario and Camacho[3] refer to the quantification of natural and social phenomena, using statistics to analyze the facts to be investigated and assuming a preference for experimentation to obtain knowledge.

Type and design of the research

This study was framed within explanatory research, which seeks to find the reasons behind facts through cause-effect relationships. In this sense, explanatory studies can deal with both the determination of causes (post facto research) and effects (experimental research) through hypothesis testing.[5,27,28]

Similarly, the research design was experimental field research, in which the researcher approaches the source of study to intentionally manipulate variables (cause) to observe their influence on other variables (effect). Different statistical tests were used for the analysis.[3,29,30]

For this purpose, a completely random or completely randomized experimental design or statistical design was considered since the treatments were tested under homogeneous conditions of the experimental material (experimental units/plants), and the assignment of treatments to the experimental units was carried out randomly (unrestricted randomization).[5] Thus, there were forty-eight (48) experimental units distributed in four (4) treatments, twelve (12) plants per treatment, namely:

- T0: No fertilization.
- T1: Application of vermicompost leachate in a 25 % dilution.
- T2: Application of vermicompost leachate in a 50 % dilution.
- T3: Application of vermicompost leachate in a 75 % dilution.

Materials and Methods

The experiment was conducted under semi-controlled conditions during the nursery phase. For sowing, topsoil and sand were collected as substrate (60 % topsoil and 40 % sand), which was then passed through a sieve to sift it. It was immediately placed in 500-gram nursery bags, which were watered for three (3) or four (4) days without sowing to eliminate spontaneous vegetation. Three seeds were placed in each bag after four (4) or five (5) days. Once they emerged, they were thinned to select the most vigorous seedlings. Similarly, each experimental unit was fertilized monthly according to the treatments described above, with 60 ml of dilution per plant. Irrigation was applied every other day to field capacity, and weed control was carried out manually once a week if necessary.

Seeds. Seeds were selected from fruit using traditional methods, with a predominance of the Chirel variety, based on characteristics such as size, color, and physical condition, ensuring that the seeds were free of perforations and/or deformities. In addition, a selection was made by placing the seeds in a container with water; those that floated were discarded, as they were considered unsuitable for germination.

Seed imbibition. Once the seeds were selected, they were immersed in water for 24 hours to prevent seed dormancy; organic fertilizer was applied.

Obtaining the leachate: To get the leachate, the liquid resulting from the vermicomposting process was collected for one month, using fruit and vegetable scraps and cow manure to feed the worms. The collected liquid was subjected to maturation by adding one part molasses for every ten (10) parts of leachate and then oxygenated with a fish tank pump for seventy-two (72) hours.

Materials used: The study used the following materials: substrate, seeds, 500-gram nursery bags, watering can, hand sprayer, vernier caliper, scale, ruler, and camera.

Methods:

- Emergence test. This indicator was determined by a weekly count of the emerged seedlings, which identified the degree of phytotoxicity based on the method implemented by Graves et al.[6,31,32,33]
- Height. From the emergence of the seedlings, height data was collected weekly until optimal conditions for transplanting were reached (approximately twelve (12) to fifteen (15) centimeters in height, with a stem thickness of five (5) to seven (7) millimeters and four (4) or five (5) leaflets, Mundarain et al.[7,34,35,36] The measurement was taken using a graduated ruler placed vertically on the soil surface, bringing the value that coincided with the apical bud of the central stem as data.
- Number of leaves. This variable was measured from the emergence of the first genuine leaf, every week until the seedling reached an approximate height of twelve (12) to fifteen (15) centimeters, with a stem thickness of five (5) to seven (7) millimeters and four (4) or five (5) leaflets. Mundarain et al.[7,37,38,39]
- Stem diameter. This was measured with a vernier caliper at the midpoint of the seedling's height every week until the seedling reached an approximate height of twelve (12) to fifteen (15) centimeters, with a stem thickness of five (5) to seven (7) millimeters and four (4) or five (5) leaflets Mundarain et al.[7,40,41,42]
- Leaf diameter. This was measured with a graduated ruler every week.
- Root length. This was determined from the emergence of the first genuine leaf, measured with a graduated ruler from the base of the stem to the root cap. This variable was evaluated weekly, taking two seedlings per week.

Data collection techniques and instruments

For the study, direct observation was used as a technique, understood as the visual recording of what happens in a real situation, classifying and recording the data according to a pre-established scheme and by the problem being studied. According to Yuni and Urbano[8,43,44,45] direct observation means that we can assign and/or determine the properties and attributes of phenomena using our senses directly and, in some cases, rely on specific measuring instruments that offer universal measurement systems.

The data were collected and then entered into record sheets (charts 1 and 2), which allowed us to compile all the information measured in the field during the experimental phase.

Chart 1. Data recording sheet for the variables: emerged seedlings, seedling height, and root length of chili pepper (Capsicum chinensis) seedlings in four dilutions of vermicompost leachate

Treatment	Repetition	Emerged seedlings	Seedling height (cm)	Root length (cm)

https://doi.org/10.56294/ere2025154

Chart 2. Data recording sheet for the variables: number of leaves, leaf diameter, and stem diameter of chili pepper seedlings (Capsicum chinensis) in four dilutions of vermicompost leachate

Treatment	Repetition	Number of sheets	Blade diameter (cm))	Stem diameter (mm)

Data processing and analysis techniques

Once the field results were obtained, descriptive data exploration methods were used to perform a univariate statistical analysis of the growth and development variables of chili seedlings, in which standard statistical parameters were determined, such as the mean and standard error, as well as a comparison of means using the Tukey test with a probability (<0,05 %) using the Statistics version 8.0 program.

RESULTS

The following table shows that despite no statistical differences between the treatments evaluated, the treatment that had absolute seedling emergence capacity in each of the replicates or experimental units studied was the dilution with 75 % vermicompost leachate, i.e., treatment 3. Similarly, treatments 0, 1, and 2 did not show total emergence in the replicates considered for this study, with 3, 2, and 1 experimental units or plants not emerging for each treatment, respectively.

For his part, Solórzano[9] states that applications of humic acids produce a higher percentage of seedling emergence, 90 %, and statistical differences with the rest of the treatments applied (chitosan and mycorrhizae, 86,67 % and 83,33 %, respectively), which are also higher than the control, which recorded an emergence of 70 %.

At the same time, López Baltazar et al.[10] stated that the highest germination percentage was observed in plants where peat was applied (T1: 86,5 %), the intermediate statistical groups consisted of vermicompost together with mezcal agave bagasse compost (T3: 81 %) and mezcal agave bagasse compost (T4: 79,3 %), with no differences between the latter two but significant differences between these three treatments (T1, T3, and T4) compared to vermicompost (T2: 64,2 %). Monge[11] indicates that a high germination rate (>90 %) is essential for obtaining economic returns.

Table 1. Emergency capacity of chili pepper seedlings subjected to different concentrations of vermicompost leachate at the La Guajira farm located in the Caña Brava sector, Rómulo Betancourt parish, El Vigía, Mérida state

Treatments	Emergency capacity of chili pepper seedlings Emerged seedlings
T0	0,75±0,45[a]
T1	0,83±0,38[a]
T2	0,91±0,28[a]
T3	1,00**±0,00**[a]
C.V	37,88
Probability	>0,05

In relation to the vegetative growth of the seedlings, statistically insignificant differences (p>0.05) were observed between the treatments evaluated for plant height and root length variables. However, a favorable trend was observed in absolute terms for both variables for treatment three compared to the other dilutions used (table 2). The results for the plant height variable were similar to those reported by Santiago et al.[12] applying twelve treatments with earthworm leachate dosages in the cultivation of habanero chili peppers (Capsicum chinense Jacq) 50 to 60 days after germination.

Contrary to the results obtained by Zambrano[13] which indicate statistical differences between the treatments applied for the plant height variable, showing an increase in applications of 180 g/plant of bovine manure vermicompost (T4: VEB 3 t.ha-1), the lowest dose used about the other treatments (T2: VEB 7 t.ha-1, 420 g/plant; T3: VEB 5 t.ha-1, 300 g/plant). Similarly, Jiménez, 2010 showed better results (19,18 cm) in seedlings treated with a nutrient solution compared to the control (9,07 cm); he also obtained between 8 and 15 cm in height in seedlings where worm liquid was applied in varieties of Capsicum annuum L.

Similarly, Moreno et al.[15] indicated that the control treatment (T5) exceeded the values obtained in the treatments incorporating VC (T1 to T4) for the plant height variable.

Trevisan et al.[16] report that the use of humic substances has been widely studied and reported to increase stem length, root length, leaf length, fresh and dry mass, fruit size and quality, and crop yields.

https://doi.org/10.56294/ere2025154

Table 2. Vegetative growth of chili pepper seedlings with the use of vermicompost leachate at the La Guajira farm located in the Caña Brava sector, Rómulo Betancourt parish, El Vigía, Mérida state

Treatments	Vegetative growth of chili pepper seedlings	
	Plant height (cm)	Root length (cm)
T0	7,39±0,41[a]	10,71±0,21[a]
T1	6,93±0,46[a]	8,29±0,20[a]
T2	5,99±0,42[a]	8,66±0,32[a]
T3	7,14±0,39[a]	10,21±0,25[a]
C.V	61,21	27,03
Probability	>0,05	>0,05

In the case of seedling development, no statistically significant differences (p>0,05) were obtained between the treatments applied for each of the variables studied (table 3). However, the number of leaves and leaf diameter tended to be better in T3, as in T0 with the rest of the treatments. Stem diameter also increased with applications of 75 % vermicompost leachate dilutions. This contrasts with the findings of López-Baltazar et al.[10] where the highest number of leaves was obtained in plants with vermicompost substrate in chili 'onza' (Capsicum annuum L.) and nutrient solution.[14]

Similar results were reported by López-Baltazar et al.[10] for the stem diameter variable, where there were no significant differences, and the three alternative substrates presented higher values in absolute terms (11-16 %) compared to the conventional substrate (peat). In contrast, Zambrano[13] found significant differences in stem diameter at 15, 30, 45, and 60 days after transplanting between the treatments evaluated (soil and different doses per plant of bovine manure vermicompost) compared to chemical fertilization (NPK, 10 g/plant).

Table 3. Development of chili pepper seedlings fertilized with vermicompost leachate at the La Guajira farm located in the Caña Brava sector, Rómulo Betancourt parish, El Vigía, Mérida state

Treatments	Development of chili pepper seedlings		
	Number of sheets	Blade diameter (cm)	Stem diameter (mm)
T0	8,03±0,44[a]	34,66±0,68[a]	2,82±1,66[a]
T1	6,70±0,46[a]	25,92±0,72[a]	2,54±1,81[a]
T2	6,03±0,43[a]	26,01±0,69[a]	2,26±1,66[a]
T3	7,03±0,39[a]	32,66±0,65[a]	2,84±1,61[a]
C.V	63,01	60,48	64,54
Probability	>0,05	>0,05	>0,05

CONCLUSIONS

Of the different concentrations of leachate applied to chili pepper crops, treatment three (75 % dilution) favored the emergence of chili pepper seedlings, with all replicates used in the trial emerging.

Treatment three (75 % dilution) increased the vegetative growth of chili pepper seedlings compared to the other concentrations used in this study.

For chili pepper seedling development, we could indicate the favorable effect of treatment three (75 % dilution) on the variables studied, as in unfertilized plants.

RECOMMENDATIONS

Use treatment three on chili pepper seedlings, as it is considered the most complete and effective dilution for seedling emergence, growth, and development of chili pepper crops.

We suggest using different doses and mixtures with other organic fertilizers on chili pepper seedlings in future research.

Extend the evaluations to crop yield with these doses and expand the concentrations and use of this fertilizer with others that can be combined at the field level in chili pepper cultivation.

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FUNDING

None.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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