

Use of organic fertilizers in the production of *Capsicum annuum* L. in the western mountain range of the Andes

Uso de abonos orgánicos en la producción de *Capsicum annuum* L. en la cordillera occidental de Los Andes

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Published

Edwards Deming Higher Technological Institute. Quito - Ecuador

Periodicity

October - December

Dates of receipt

Received: June 22, 2023

Approved: September 10, 2023

<http://centrosuragraria.com/index.php/revista>
vol. 1. Num. 19. 2023.
pp. 24-37

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Abstract: At present, there is an increasing pressure to reduce the chemical load in plant-based foods, a situation especially driven by European consumers, so it is urgent to develop clean production practices such as the use of organic fertilizers in crop production. The present study aimed to determine the effect of the edaphic dose of earthworm humus and water hyacinth in bell pepper production used as organic fertilizers. The research was carried out at the Experimental Center "La Playita", Technical University of Cotopaxi, La Maná Extension, located at 120 m above sea level. Two organic fertilizers were evaluated in doses of 1.0; 2.5; 3.0; 5.0; 6.0; 7.5 and 8.0 kg-m⁻² established in a randomized block design. The variables evaluated were: plant height (cm), number of fruits and fruit biomass (g), recorded during six years. The result of the 5 and 8 kg-m⁻² dosages allowed a better development and production of the pimiento crop with organic fertilizer, water hyacinth. In conclusion, it is necessary to nourish a soil based on the soil and compost analysis where the exact dosage of organic matter required by a soil can be rescued. in urban-marginal and rural areas of the province of Guayas (Ecuador). By means of an applied study with a qualitative, quantitative, field, descriptive-prospective-analytical-transversal approach, fecal samples of humans and their domestic dogs from the indicated areas will be analyzed, in order to know: The relationship between the environment-helminths-and hosts, prevalence of neglected intestinal helminthiases, zoonotic association, characterization of environmental variables, specification of social determinants of health and generate scientific production.

Keywords: crop; effects; growth indicators; production; treatments.

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Resumen: En la actualidad se ha incrementado la presión de reducir la carga química en los alimentos de origen vegetal, situación especialmente impulsada por los consumidores europeos, por lo que es urgente el desarrollo de prácticas de producción limpia como el uso de abonos orgánicos en la producción de cultivos. El presente estudio pretendió determinar el efecto de la dosis edáfica de humus de lombriz y jacinto de agua en producción de pimiento utilizado como abonos orgánicos. La investigación se llevó a cabo en el Centro Experimental “La Playita”, Universidad Técnica de Cotopaxi, Extensión La Maná, localizado a 120 msnm. Se evaluaron dos abonos orgánicos en dosis de 1,0; 2,5; 3,0; 5,0; 6,0; 7,5 y 8,0 kg·m⁻² establecido en un diseño de bloques al azar. Las variables evaluadas fueron: altura de planta (cm), número de frutos y biomasa del fruto (g), registradas durante seis años. El resultado de las dosificaciones 5 y 8 kg·m⁻² permitió un mejor desarrollo y producción del cultivo de pimiento con abono orgánico, jacinto de agua. En conclusión, es necesario nutrir un suelo basando en el análisis de suelo y abono donde se puede rescatar la dosificación exacta de materia orgánica que requiere un suelo.

desatendidas en zonas urbanomarginales y rurales de la provincia del Guayas (Ecuador). Mediante un estudio aplicado con enfoque cualitativo, cuantitativo, de campo, descriptivo-prospectivo-analítico-transversal, se analizarán muestras fecales de humanos y de sus perros domésticos de las zonas señaladas, con el fin de dar a conocer: La relación entre el medio ambiente-helmintos-y hospederos, prevalencia de las helmintiasis intestinales desatendidas, asociación zoonótica, caracterización de variables ambientales, especificación de determinantes sociales de salud y generar producción científica.

Palabras clave: cultivo; efectos; indicadores de crecimiento; producción; tratamientos.

Introduction

Nowadays, the tension to reduce the burden of chemical agricultural inputs in plant-based foods has increased, so in September 2015, more than 150 world leaders adopted a transformative and globally relevant agenda for sustainable development, and committed to work together for the benefit of today's and tomorrow's generations Food and Agriculture Organization of the United Nations (FAO), (2015). A paradigm shift in vision, approach and ambition to change this reality, because of how detrimental the use of agrochemicals, including insecticides and herbicides, can be, resulting in potential habitat degradation within agricultural areas (Chuquitarco, et al, 2021,p.311).

Before thinking about fertilizer application, all available sources of nutrients should be used, for example cow dung, pig manure, chicken manure, vegetable waste, straw, corn stover and other organic materials (Di Rienzo, et al, 2008). However, these should be composted and

decomposed before application to the soil, in which case the crop response is extraordinary, with yield increases of up to 10 times in some cases. Helping the biological activity and facilitating the root development of the plants. So that (Luna, et al, 2015,p.54) explained that these organic fertilizers have generated as a result healthy and vigorous plants that offer higher total production per vegetable crop area.

The cultivation of peppers is a vegetable of great global consumption that in recent years has experienced a considerable increase in production and export level for many countries, which highlights the importance in the diet of millions of people in the world, planted and cultivated in the provinces of Guayas, Santa Elena, Manabi, Chimborazo, Loja and Imbabura (Brechelt, 2004, p.36). The demand for organically grown vegetables today is becoming more and more demanded; therefore, new alternatives are sought to adjust to the markets and direct consumers, with sustainable methods of healthy production, focused on nourishing the soil, as well as the crops and achieving the highest yields in production (Gavilanes, et al., 2017,p.432).

Based on this background, the objective of this research was to determine the effect of earthworm humus and water hyacinth (organic fertilizers), at different doses, on the growth indicators of the bell pepper crop (*Capsicum annum* L.). The variables analyzed were: plant height, number of fruits and fruit biomass analyzed through different years.

Materials and methods

The research was carried out at the Experimental Center "La Playita", Technical University of Cotopaxi, La Maná Extension; located at an altitude of 120 meters above sea level. It should be noted that the study was carried out during 5 years corresponding to 2012-2016; however, Table 3, 4 and 5 show the disparity of doses of organic fertilizers (worm humus and water hyacinth), used in each year corresponding to the variables analyzed.

Table 1. *Climatic conditions of the canton La Maná province of Cotopaxi Ecuador, recorded through the years 2012-2016.*

Parameters	Averages				
	2012	2013	2014	2015	2016
Temperature (°C)	26,00	25,00	25,47	24,55	24,00
Relative humidity (%)	86,83	82,00	85,84	89,00	88,00
Heliophany (daylight hours-year) ⁻¹	735,70	757,00	898,66	736,60	570,30
Precipitation (mm-yr) ⁻¹	3.029,30	2.000,0	2.223,85	2.854,00	2.761,00

Source: National Institute of Meteorology and Hydrology (INAMHI).

Within the research management, the application of two organic fertilizers, worm humus and water hyacinth, was studied, considering the base dose of application (5.0 kg-m⁻²) according to literary theories, in this framework, low and high levels were tested according to the results obtained. The doses evaluated were 5.0 kg-m⁻² (years 2012-2013), 1.0 and 3.5 kg-m⁻² (year 2014), 2.5; 5.0 and 7.5 kg-m⁻² (year 2015), 6.0 and 8.0 kg-m⁻² (year 2016), applied during soil preparation. The evaluations of the variables were carried out on eight plants of each repetition, analyzed at 65, 80 and 95 days after transplanting, and were: plant height (cm), number of fruits and fruit biomass (g). During the vegetative preparation, a seedbed was made where the seeds were placed 1 cm deep in the coconut fiber substrate, and the trays were covered with plastic, as a greenhouse, so that the seeds could reach a temperature of 15 °C required for germination. Transplanting was carried out after 45 days, when the plants had an average height of 10 cm. During vegetative development until production was reached, a traditional agronomic management required by the bell pepper crop was applied.

Table 2. Soil analysis before planting at La Playita Experimental Center 2012-2016.

Parameters	2012	2013	2014	2015	2016
pH	5.10 acid	5.80 acid	5.70 acid	5.90 acid	7.00 neutral
M.O. (%)	5.00 medium	4.20 average	5.60 high	5.70 high	6.00 high
NH ₄ (ppm)	33.00 average	35.00 half	26.00 average	33.00 average	27.00 average
P (ppm)	73.00 high	25.00 under	74.00 high	31.00 high	79.00 high
K (cmol·kg) ⁻¹	0.70 high	0.60 high	0.31 average	0.41 high	0.31 average
Ca (cmol·kg) ⁻¹	5.50 low	7.00 half	11.00 high	9.00 high	8.00 high
Mg (cmol·kg) ⁻¹	1.40 average	1.10 average	1.30 average	1.50 half	1.20 average
S (ppm)	12.00 half	14.00 half	20,00 high	13.00 half	23,00 high
Zn (ppm)	5.30 medium	1.70 low	4.30 medium	4.50 half	5.30 medium
Cu (ppm)	6.90 high	6.90 high	6.60 high	6.10 high	5, 60 high
Fe (ppm)	78.90 under	108.00 high	114.00 high	153.00 high	132.00 high
Mn (ppm)	3.00 low	4.00 low	4.30 low	3.60 low	5.00 medium
B (ppm)	0.40 low	0.24 low	0.29 low	0.18 low	0.29 low
Texture	Clay loam	Clay loam	Franco Arenoso	Franco Arenoso	Franco

A completely randomized block design (CRBD) and Tukey's multiple range test at 5% probability were used for the comparison of means between treatments. Statistical analyses were performed with the free license program InfoStat 2019.

Result

Table 3 highlighted high averages in plant height with doses of 8 kg·m⁻² with an average of 59.27 cm in water hyacinth and earthworm humus with 50.13 cm in 2016, as for the other doses evaluated, according to

(Márquez, et al, 2013, p.55) organic fertilization in high doses increased plant length and height, as did doses of 9 kg-m⁻². (Hernández, et al, 2013,p.61), showed a probable explanation, since the higher the concentration of organic fertilizer, the greater the activation of microorganisms in the soil, helping the recovery of soil bases, also as mentioned by (Castellanos et al, 2000,p.215) the absorption of nutrients was more efficient, and when evaluating the application of humus in relation to the increase in plant height, the main function of the fertilizers was their action as growth regulators.

Table 3. *Effect of the dose of organic fertilizers on the variable plant height of Capsicum annuum L. in the western cordillera of the Andes, Ecuador, analyzed in different years.*

Plant height (cm)						
Treatments	Dose (kg-m ⁻²)	2012	2013	2014	2015	2016
Earthworm humus	5,00	38,72 ^a	39,99 ^a			
	1,00			35,92 ^a		
	3,00			38,84 ^a		
	5,00			37,30 ^a		
	2,50				42,66 ^b	
	5,00				43,00 ^b	
	7,50				39,58 ^a	
	6,00					44,49 ^b
	8,00					50,13 ^{ab}
Water hyacinth	5,00	34,37 ^a	41,19 ^b			
	1,00			36,71 ^a		
	3,00			37,38 ^a		
	5,00			36,72 ^a		
	2,50				57,03 ^{ab}	

5,00					58,14 ^{ab}
7,50					58,88 ^{ab}
6,00					49,15 ^b
8,00					59,27 ^{ab}
CV (%)	24,98	10,64	9,99	13,42	15,88

^{a,b} Means in the same column with different superscripts represented statistical differences according to Tukey's test ($P < 0.05$).

(Santamaría, et al, 2010,p.337) and Ortega et al. (2016) proved that organic fertilizers raised the cation exchange capacity, had a high content of humic acids, and increased the moisture retention capacity and porosity; also, (Arteaga, et al, 2017,p.66) analyzed that it facilitated soil drainage and growth media, this helping to nourish the soil both to crops. Research conducted by (Lozano-Fernandez et al. 2022) in poor soils and with scarce nutrients recommended that the higher the application dose the greater the result in morphometric variables, corroborated by (Ramos, et al, 2014,p.52) who mentioned that the application of organic matter helped to increase the populations of bacteria, actinomycetes and beneficial fungi in the soil, as well as the physical and chemical properties of the soil; likewise, (Mena, 2021,p.101) concluded on the positive influence that these had on the soil and crops.

In the variable number of fruits, the worm humus (OM) treatment stood out with an average of 8.25 cm; however, water hyacinth showed a lower value with an average of 8.07 cm when using a dose of 8 and 5 kg-m⁻² (table 4). According to (Muñoz et al, 2014, p.27) the organic fertilizers were coadjuvants for the soil, to prove it, before their application, it was necessary to perform a soil analysis with the objective of making the application to improve the soil, according to the macro and micro elements needed, evidenced through the results obtained in crops with greater and better flowering, influencing significantly in a greater production of more accentuated fruits.

According to (Reyes et al, 2009,p.57) when evaluating organic fertilizers, it was found that water hyacinth was the most efficient in terms of the variable number of fruits. Palma (2013) and (Muñoz et al,

2014,p.27) analyzed that the effects of organic fertilizer (water hyacinth) influenced the number of fruits of the crop, due to the nutrients they provided, such as nitrogen, phosphorus, potassium and calcium in the medium and long term, considering that organic fertilizers had residual effect whose duration depended on the speed at which they degraded.

Similar results were presented by (Lution, 2012, p.14) in the production of radish, when applying compost of 5 kg-m⁻², obtained high averages in terms of the number of fruits compared to when doses of 1.2 kg-m⁻² were applied. Fertilab (2021) mentioned that the organic fertilizers used in different doses made variability play an important role in channeling the appropriate dosages depending on soil and agro-climatic factors.

Table 4. *Effect of the dose of organic fertilizers on the variable number of fruits of Capsicum annum L. in the western cordillera of the Andes, Ecuador, analyzed in different years.*

Treatments	Dose (kg-m ⁻²)	Number of fruit				
		2012	2013	2014	2015	2016
Earthworm humus	5,00	1,99 ^a	3,55 ^a			
	1,00			6,33 ^b		
	3,00			6,08 ^b		
	5,00			8,25 ^{ab}		
	2,50				6,03 ^b	
	5,00				6,28 ^b	
	7,50				6,88 ^b	
	6,00					7,67 ^b
	8,00					7,33 ^b
Water hyacinth	5,00	2,19 ^a	3,48 ^a			
	1,00			7,50 ^b		
	3,00			7,17 ^b		
	5,00			6,08 ^b		
	2,50				7,63 ^b	
	5,00				6,91 ^b	
	7,50				7,09 ^b	

	6,00				7,00 ^b
	8,00				8,07 ^{ab}
CV (%)	14,60	17,88	22,51	13,42	34,43

^{a,b} Means in the same column with different superscripts represent statistical differences according to Tukey's test ($P < 0.05$).

As shown in Table 5, the fruit biomass variable presented slightly higher numerical values when applying the water hyacinth treatment with doses of 5 m² and 101.05 g, followed by plants fertilized with earthworm humus with 95.52 g, with doses 5 kg-m⁻², according to Rodríguez and Flóres, (2004) organic fertilizers also acted as plant hormones (phytohormones), which when applied increased the number, quality of roots and vigor of the plant, thus a higher quality in fruit biomasses. (Reyes, et al, 2017, p.57) and (Reyes, et al, 2017, p.88) mentioned that these fertilizers influenced plant development; therefore, the fruit biomass variable depended on the growth process in which the plant was exposed.

Jaramillo (2012) stated that worm humus is a varied organic fertilizer and due to its functionality, it can be used as a source of nutrients to improve the growth and biomass of fruits in crops and it was also used to recover soils with physical degradation problems; compaction, surface sealing and poor drainage.

Soria (2013) in his field work obtained better results with a combination of 50% earthworm humus and 50% water hyacinth, because it helped the initial development of the plant through the biological reactivation of the soil, this allowed the absorption of nutrients through the root system, strengthening the production and quality of the fruit, agreeing with Tenecela (2012) who pointed out that humus and water hyacinth was a very successful combination.

On the other hand, (Hernández, et al, 2013,p.56) indicated that the preparations of organic fertilizers in high concentrations influenced fruit quality, since they increased the content of organic acids and minerals, which accelerated fruit ripening. The results of the present study coincided with those reported by (Amachuy, 2013,p.121) who determined that organic fertilizers at doses of 8 and 6 kg-m⁻² increased the length, number, diameter and fresh biomass of the fruits.

Table 5. Effect of the dose of organic fertilizers on the variable fruit biomass (g) of *Capsicum annuum* L. in the western cordillera of the Andes, Ecuador, analyzed in different years.

Treatments	Dose (kg-m ⁻²)	Fruit biomass (g)				
		2012	2013	2014	2015	2016
Earthworm humus	5,00	95,52 ^b	83,02 ^a			
	1,00			84,82 ^a		
	3,00			82,95 ^a		
	5,00			84,11 ^a		
	2,50				76,60 ^a	
	5,00				78,32 ^a	
	7,50				55,36 ^a	
	6,00					89,33 ^a
	8,00					80,20 ^a
Water hyacinth	5,00	101,05 ^{ab}	78,31 ^a			
	1,00			85,10 ^a		
	3,00			82,10 ^a		
	5,00			86,37 ^a		
	2,50				79,75 ^a	
	5,00				81,74 ^a	
	7,50				83,94 ^a	
	6,00					90,60 ^b
	8,00					92,80 ^b
CV (%)		17,11	15,06	15,38	15,06	24,65

^{a,b} Means in the same column with different superscripts represented statistical differences according to Tukey's test ($P < 0.05$).

Conclusions

The application of organic fertilizers at doses of 5 and 8 kg-m⁻² showed superior results with respect to the rest of the treatments, favorably increasing the physical and chemical properties for the adequate development of the crops. These doses increase the organic matter

content of the soil and therefore the organic carbon content, which leads to an improvement in bulk density and thus total porosity.

The incorporation of water hyacinth (organic fertilizer) presents higher yields according to the established variables, besides maintaining the physical characteristics of the soil, forming aggregates and giving structural stability, joining the clays and forming the exchange complex, favoring the penetration of water and its retention, decreasing erosion and favoring gas exchange. Within the biological characteristics it improves the edaphic fauna in charge of carrying out the existing microbiological activity in the soil, fulfilling an important role in agriculture, besides that they also contribute to the formation of the soil.

The incorporation of different organic fertilizers in different doses has sustainably increased soil organic matter at the end of each crop. The evolution of humic substances as a result of the incorporation of worm humus and water hyacinth is varied and is affected by edaphic and climatic conditions, which are referents of the processes of evolution, structural stability, and degree of humification of OM.

Acknowledgments

The authors would like to thank the Universidad Técnica de Cotopaxi, Extension La Maná, especially the teachers and students of the Agronomy Engineering Career, who significantly supported the research and writing of the manuscript, as well as the students of the Universidad Técnica Estatal de Quevedo for their contributions.

References

- Amachuy Irala, A. (2013). Effect of three doses of earthworm humus from urban organic solid waste on the cultivation of chard (*Beta vulgaris*) in the Mallasa area. Bachelor's thesis. Universidad Mayor de San Andrés. 121 p.
- Arteaga, M., Garcés, N., Guridi, F., Pino, J. A., López, A., Menéndez, J. L. Cartaya, O. (2006). Evaluation of foliar applications of liquid humus in tomato (*Lycopersicon esculentum* Mill.) Var. Amalia under production conditions. *Tropical Crops*, 27(3), 95-101.

- Brechelt, A., 2004. The ecological management of pests and diseases. Agriculture and Environment Foundation (FAMA). 36 p.
- Castellanos, J. Z., Uvalle-Bueno, J. X. and Aguilar-Santelises, A. (2000). Manual de interpretación de análisis de suelos y aguas. 2ª. INCAPA. 215 p.
- Chuquitarco Esmeraldas, V. A., Raura Rodríguez, J. L., Gavilánez Buñay, T. C. and Luna Murillo, R. A. (2021). Productive experiences with bell pepper (*Capsicum annuum* L.) with organic fertilizers in the subtropics of Ecuador. *Ciencia Latina Revista Científica Multidisciplinar*, 5(4), 4311-4321.
- Di Rienzo, J., Casanoves, F., Balzarini, M., Gonzalez, L., Tablada, M. and Robledo, C. (2008). InfoStat Version 2011. InfoStat Group. National University of Córdoba, Argentina.
- Fertilab. (2021). Worm humus. <https://www.fertilab.com.mx/blog/227-el-humus-de-lombriz/>. 4 p.
- Gavilánez-Terán, I., Jara-Samaniego, J., Idrovo-Novillo, J., Bustamante, M. A., Pérez-Murcia, M. D., Pérez-Espinosa, A., López, M. and Paredes, C. (2017). Agroindustrial compost as a peat alternative in the horticultural industry of Ecuador. *Journal Environmental Manage*, 186, 79-87.
- Jaramillo González, C. (2012). Agronomic evaluation of a limestone soil amended with alperujo compost. Master's thesis. National University of Colombia.
- Lozano-Fernández, J., Orozco-Orozco, L. F. and Grisales-Vásquez, N. Y. (2022). Agronomic performance of paprika (*Capsicum annuum* L.) cultivars grown in open field and under protected conditions. *Terra Latinoamericana*, 40, 1-16. e1459. <https://doi.org/10.28940/terra.v40i0.1459>.
- Luna Murillo, R. A., Reyes Pérez, J. J., López Bustamante, R. J., Reyes Bermeo, M., Álava Murillo, A., Velasco Martínez, A., Álvarez Perdomo, G., Castillo Vera, H., Cedeño Troya, D. M. and Macías Pettao, R. (2015). Effects of organic fertilizers on the growth and development of bell pepper (*Capsicum annuum* L.). *Centro Agrícola*, 42(4), 11-18.
- Lution, C. (2012). Sugarcane as a source of energy: composting industrial waste in Colombia. *Tecnicaña*, 28, 13-14.
- Márquez-Hernández, C., Cano-Ríos, P., Figueroa-Viramontes, U., Avila-Diaz, J. A., Rodríguez-Dimas, N. and García-Hernández, J. L. (2013). Tomato yield and quality with organic sources of fertilization in greenhouse. *Phyton*, 82(1), 55-61.
- Márquez-Quiroz, C., López-Espinosa, S. T., Cano-Ríos, P. and Moreno-Reséndez, A. (2013). Organic fertilization: An

- alternative for chile piquín production under protected conditions. *Chapingo Journal. Serie Horticultura*, 19(3), 279-286.
- Mena Ayala, A. (2021). Properties of *Eichhornia crassipes* (Water hyacinth), *Schoenoplectus colifornicus* (Rush), and *Phragmites australis*. *Journal of the Research Institute of the Faculty of Mines, Metallurgy and Geographical Sciences*, 24(47), 101-108.
- Muñoz Villalobos, J. A., Velásquez Valle, M. A., Osuna Ceja, E. S., Macías Rodríguez, H. (2014). The use of organic fertilizers in greenhouse vegetable production. *Revista Chapingo Serie Zonas Áridas*, XIII(1), 27-32.
- Food and Agriculture Organization of the United Nations (FAO). (2015). Healthy soils for healthy lives. International year of soils 2015. <https://www.fao.org/3/at159s/at159s.pdf>.
- Ortega Haas, J. J. (2016). Effect of organic and inorganic fertilizer on the growth of Jipi Palm (*Carludovica palmata* Ruiz & Pavón) in northern Campeche, Mexico. Master's Thesis. El Colegio de la Frontera del Sur. Mexico. 66 p.
- Palma Méndez, K. V. (2013). Agronomic behavior of four fruiting vegetables with three organic fertilizers at the Tecnilandia farm, Quevedo. Bachelor's thesis. State Technical University of Quevedo.
- Ramos Agüero, D. and Terry Alfonso, E. (2014). Generalities of organic fertilizers: importance of Bocashi as a nutritional alternative for soils and plants. *Cultivos Tropicales*, 35(4), 52-59.
- Reyes Pérez, J. J., Guridi Izquierdo, F., Reynaldo Escobar, I.M., Larrinaga Mayoral, J. Á. (2009). Effects of liquid humus on tomato yields in saline soils in the eastern region of Cuba. *Centro Agrícola*, 36(3), 57-61.
- Reyes-Pérez, J. J., Luna-Murillo, R. A., Murillo-Amador, B., Nieto-Garibay, A., Hernández-Montiel, L. G., Rueda-Puente, E. O. and Preciado-Rangel, P. (2017). Use of vermicompost and water hyacinth (*Eichhornia crassipes*) compost in the growth of purple cabbage (*Brassica oleracea*). *Interscience*, 42(9), 610-615.
- Reyes Pérez, J. J., Luna Murillo, R. A., Reyes Bermeo, M. del R., Zambrano Burgos, D. and Vázquez Morán, V. F. (2017). Fertilization with organic fertilizers in bell pepper (*Capsicum*

- annuum L.) and its impact on yield and its components. *Centro Agrícola*, 44(4), 88-94.
- Rodríguez S., M. and Flóres R., V. J. (2004). Essential and beneficial elements. CYTED. Iberoamerican Program of Science and Technology for Development. 25-36. https://core.ac.uk/display/143458034?utm_source=pdf&utm_medium=banner&utm_campaign=pdf-decoration-v1
- Santamaría Romero, S., Ferrera Cerrato, R., Almaraz Suárez, J. J., Galvis Spínola, A. and Barois Boullard, I. (2001). Dynamics and relationships of microorganisms, C-Organic and N-Total during composting and vermicomposting. *Agrociencia*, 35(4), 337-384.
- Soria Proaño, F. A. (2013). Agronomic behavior of chard (*Beta vulgaris*) and broccoli (*Brassica oleracea*) vegetables with two organic fertilizers at the Experimental Center. Licentiate thesis. Technical University of Cotopaxi. Ecuador.
- Tenecela Yuqui, X. (2012). Production of earthworm humus through the use and management of organic wastes. Bachelor's thesis. University of Cuenca.