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Enhancing sweet potato crop irrigation sustainability through repurposed treated urban wastewater

Mejora de la sostenibilidad del riego de cultivos de batata mediante aguas residuales urbanas tratadas y reutilizadas

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Abstract

Introduction: This study, situated at Morón City's stabilization pond in Cuba's Ciego de Avila province. **Objective:** the viability of utilizing treated urban wastewater for sweet potato crop irrigation. **Method:** throgh the traditional furrow irrigation technique and the evaluation of the effects on the soil and the crop. **Results:** the research conducted 17 irrigation events, where 14 used effluents and 3 sourced groundwater. Additionally, five rainfall events complemented the irrigation sessions. Throughout the crop's growth cycle, it received a cumulative 5,906.91 m^3 of water from the effluent application, supplemented by 2,109.61 m^3 from groundwater and 2,272.50

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m^3 from effective precipitation. Remarkably, the commercial agricultural yield achieved an impressive 24.17 t·ha^{-1}, well within the potential yield range for this clone. Assessment of the applied effluent revealed an electrical conductivity of 952.0 μS·cm^{-1} and a pH of 5.6, falling within permissible levels for agricultural crop development. Wastewater irrigation substantially augmented soil nutrient content, boosting P_2O_5 by 2.67 mg·100g^{-1}, K_2O by 15.05 mg·100g^{-1}, and organic matter by 1.88 %. This corresponded to a significant nutrient influx, introducing 242.36 kg of P_2O_5 and 1,366.13 kg of K_2O into the soil. **Conclusion:** This study unequivocally demonstrates the affirmative impacts of employing urban wastewater on soil quality and crop productivity. Not only did it elevate agricultural yield, but it also enriched the soil with vital nutrients while circumventing phytosanitary issues. By exemplifying sustainable water management and urban hydrology principles in agricultural practices, this research underlines their potential in fostering sustainable agriculture.

Keywords: agricultural yield; effluent application; soil nutrients; wastewater repurposing

Resumen

Introdución: La investigación se llevó a cabo en la laguna de estabilización de la ciudad de Morón, en la provincia de Ciego de Ávila, Cuba. **Objectivo:** la reutilizar las aguas residuales urbanas depuradas en dicha laguna para el riego del cultivo del boniato. **Método**: la aplicación de los efluentes se realizó mediante el riego por surcos, con una lámina bruta de 28,13 mm. **Resultados:** se aplicaron un total de 17 riegos, de los cuales 14 fueron con efluentes y 3 con agua subterránea. Además, hubo cinco precipitaciones que reemplazaron eventos de riego. Durante el ciclo vegetativo del cultivo, recibió un volumen de agua de 5906,91 m^3 debido a la aplicación del efluente, 2109,61 m^3 debido al agua subterránea y 2272,50 m^3 debido a las precipitaciones efectivas. El rendimiento agrícola comercial fue de 24,17 t ha^{-1}, aceptable según el rendimiento potencial de este clon. El efluente aplicado tenía una conductividad eléctrica de 952,0 μS cm^{-1} y un pH de 5,6 unidades, valores dentro del rango permisible y adecuado para el desarrollo de cultivos agrícolas. El riego con agua residual produjo un incremento del suelo de 2,67 mg 100g^{-1} de P2O5, 15,05 mg 100g^{-1} de K2O y 1,88 %

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de MO, lo que representa una ganancia en nutrientes de 242,36 kg de P2O5 y 1 366,13 kg de K2O. **Conclusiones:** la investigación demostró que la aplicación de aguas residuales urbanas tuvo efectos positivos en el suelo y el cultivo, mejorando el rendimiento agrícola y aportando nutrientes al suelo sin causar problemas fitosanitarios.

Palabras clave: aplicación de efluentes; nutrientes del suelo; rendimiento agrícola; reutilización de aguas residuales

Introduction

Sweet potato (*Ipomoea batatas*) stands as a fundamental crop in global human nutrition, with its widespread cultivation across all regions of Cuba attributed to its early maturation, high yield, drought resistance, texture, short cooking times, and significant nutritional value. Despite these advantages, agricultural yields remain below the potential of the employed clones, primarily due to various factors such as inadequate irrigation and fertilizer application (Acosta *et al.,* 2024).

One promising strategy to enhance water resource availability for sweet potato cultivation is the utilization of treated urban wastewater. Such wastewater represents a valuable supplementary source for fulfilling water demands and offers substantial benefits soils while mitigating environmental impacts (García *et al.,* 2020).

Therefore, the adoption of wastewater applications necessitates the exploration of rational alternatives rooted in environmental, social, and economic criteria (Castillo *et al.,* 2020).

According to the Food and Agriculture Organization (FAO, 2017) of the United Nations, the utilization of treated wastewater for agricultural irrigation can present a sustainable solution for water resource management and crop fertilization. This is attributed to the presence of organic matter (OM), nitrogen, and phosphorus in wastewater, which not only provide essential nutrients but also reduce the need for mineral fertilizers. Nevertheless, the World Health Organization (WHO) cautions that the presence of contaminants, including heavy metals and pathogens, may impose limitations on wastewater usage, requiring additional treatment and monitoring measures to ensure crop and environmental safety (WHO, 2019).

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The contribution of organic carbon to soil through wastewater applications is contingent upon the quality of the wastewater. Generally, wastewater contains OM that, when introduced to the soil, has the potential to augment its organic carbon content. González *et al.* (2022) emphasize that organic soil carbon is a pivotal component governing all essential soil functions, underscoring the significance of its study. Globally, there is an alarming trend of declining organic carbon in soils as they undergo exploitation, yet its presence is vital for bolstering soil fertility and enhancing its capacity to retain water and air.

In the context of Cuba, the reutilization of treated wastewater finds practical application primarily in the tourism sector. Here, treated wastewater sourced from select hotels is used for the irrigation of green spaces and golf courses. Nonetheless, its adoption within the agricultural sector remains marginalized due to the inadequacy of infrastructure, technological solutions, regulatory frameworks, and strategies aimed at promoting the reuse in Cuban agriculture (Díaz, 2018).

This study's primary objective is to investigate the reuse of purified urban wastewater from the Morón city stabilization pond for sweet potato (*I. batatas*) irrigation. We will employ the traditional furrow irrigation technique and assess its impact on both the soil and the crop.

Materials and Methods

The research was conducted at the stabilization pond in the city of Morón, located in the Ciego de Ávila province of Cuba. The pond is situated at coordinates 22° 06′ 39″ North latitude and 78° 37′ 40″ West longitude, with an altitude of 7.00 m above sea level. The agricultural area where the research took place covers an area of 15,000 m^2 (150 m x 100 m) and is characterized by a Typical Leached Reddish Yellow Quartzitic Ferralic soil with the following hydrophysical properties: soil density (ρ) of 1.33 $g \cdot cm^{-3}$, field capacity (*Fc*) of 33.00 %, and wilting point (*Lp*) of 28.05 %, at a depth of 0.30 m.

The crop under evaluation was sweet potato (*I. batatas*), specifically the INIVIT B2-2005 clone. It was planted with a spacing of 0.90 m between rows and 0.30 m

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between individual plants, with a planting depth of 10 cm. The selected evaluative area covered 900 m^2 (9 m x 100 m), corresponding to 10 rows spaced at 0.90 m apart.

Hydraulic Evaluation of the Furrow Irrigation System: The treated wastewater, sourced from the Moron stabilization pond, is channeled through an outlet structure into a canal with a length of 200 m, a surface width of 2 m, a base width of 0.60 m, and a depth of 0.40 m. From there, it is directed to the irrigation trench, where furrows are established to distribute the flow within the irrigation plot.

The furrow irrigation technique, a traditional surface method, was employed for the application of flow to the plot, and the applied flow rate was measured using the volumetric method (García *et al.,* 2020).

To mitigate the adverse effects of continuous effluent application to the soil, groundwater irrigation was employed at a ratio of four effluent irrigations to one groundwater irrigation. The volume of groundwater used was determined as (Figure 1):

Figure 1

Formula for the volume of groundwater applied in irrigation

$$V_{sub} = \frac{q_{sub} \cdot T_L \cdot N_s \cdot N_R \cdot 60}{1000}$$

Where V_{sub} is the volume of groundwater applied in irrigation (m^3), and q_{sub} is the groundwater flow rate through the irrigation ditch, T_L is the time taken for the flow to reach the furrow's far end (min), Ns is the total number of furrows in the irrigation area , and N_R is the number of irrigations applied during the crop cycle.

Rainfall utilization during the sweet potato's growth and development period was assessed based on the water input from precipitation that was substituted for irrigation events and facilitated the dilution of potential excess substances introduced into the soil by the effluent. The volume of rainfall was determined from systematic records on the CA-869 (Tele-Patria) pluviometric equipment during the period 2021 – 2023.

The vegetative assessment was conducted at 60 days after planting and involved the measurement of the following variables: number of branches per plant (Nr/p), branch length (Lr) in cm, stem diameter (Dt) in mm, number of leaves per plant (Nh/p),

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number of marketable tubers per plant (Nt/p), and tuber mass per plant (Mt/p) in g. Three plants were selected from each evaluable furrow, totaling 30 plants.

Agricultural yield was determined at 90 days after planting, once the crop had reached adequate development. The evaluable area was divided into five replicates (each composed of two furrows with a length of 20 m), and the tuberous roots were weighed using a 500 kg scale. The achieved yield was expressed in metric tons per hectare.

The agrochemical evaluation of the soil and the phyto sanitary assessment of the crop was carried out at the provincial Soil and Plant Health laboratory in the Ciego de Avila province. The agrochemical analysis was performed using soil samples with and without effluent application. The determined parameters included electrical conductivity (conducted by the conductometric method), pH in KCl (determined using the potentiometric method with a soil solution ratio of 1:2.5), extractable P_2O_5 and K_2O (extracted using a $(NH_4)_2CO_3$ solution with pH 9), organic carbon, and OM (analyzed through the colorimetric Walkley-Black method).

The phyto sanitary assessment of the crop was conducted through entomological and mycological trials using whole plant samples, employing the methods of visual observation and a stereoscopic microscope.

The analysis of the quantity of nutrients applied to the soil through effluent was based on the results of the Figure 2, Figure 3, Figure 4 y Figure 5:

Figure 2

Formula for the quantity of nutrients in the soil with the effluent application

$$CANT_{C\_apl} = \frac{CN_{C\_apl} \cdot Msh}{10^5}$$

Figure 3

Formula for the quantity of nutrients in the soil without effluent application

$$CANT_{S\_apl} = \frac{CN_{S\_apl} \cdot Msh}{10^5}$$

Figure 4

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Formula for the nutrient gain in the soil due to effluent application

$$G_{nut} = CANT_{C\_apl} - CANT_{S\_apl}$$

Figure 5

Formula for the financial gain from currency savings by not purchasing fertilizers

$$G_{financ} = P_{fert} \cdot G_{nut}$$

Where: $CANT_{C\_apl}$ is the quantity of nutrients in the soil with the effluent application (kg), $CANT_{S\_apl}$ is the quantity of nutrients in the soil without effluent application (kg), CN_{C_apl} is the concentration of nutrients in the soil with effluent application (mg·100g^{-1}), CN_{S_apl} is the concentration of nutrients in the soil without effluent application (mg·100g^{-1}), M_{sh} is the mass of moist soil (kg) which depends on the soil density (kg·m^3), volume of moist soil (m^3), plot's area (m^2), depth of moist soil (m). Besides G_{nut} is the nutrient gain in the soil due to effluent application (kg), G_{financ} is the financial gain from currency savings by not purchasing fertilizers (USD), P_{fert} is the price of fertilizer in the international market (USD/kg).

Results and discussions

Analysis of the Surface Irrigation System

The diagnosis conducted on the components of the surface irrigation system used in the research revealed that this system consists of the main canal, the ditch, and the furrows. The geometric parameters of the ditch are as follows: the surface width (T_z) is 1.20 m, the bottom width of the ditch (b_z) is 0.45 m, the flow circulation depth (y_z) is 0.34 m, the hydraulic area (A_z) is 0.22 m^2, and the slope coefficient (m) is 0.54. A flow of 17.88 L·s^{-1} with a velocity of 0.08 m·s^{-1} flows through this ditch.

In the area used for sweet potato cultivation, there are a total of 214 furrows with a surface width (Ts) of 0.56 m, a bottom width of the furrow (bs) of 0.21 m, and a flow circulation depth (y_s) of 0.15 m. Each furrow carries a flow rate of 2.65 L s^{-1}, which takes 12.40 min to reach the furrow's far end (T_L). In this system, six furrows are irrigated simultaneously, requiring 35 changes to complete the irrigation of the plot.

Analysis of the number of irrigations applied to the crop

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Table 1 shows the average number of irrigations applied with effluents (N_R) and the number of rainfall events that replaced groundwater irrigations (N_{LL}) over the three years evaluated. On average, a total of 19 irrigations were applied, with 14 using effluents and 5 using groundwater.

Table 1

Number of Irrigations Applied to the Crop.

Year	N_R		N_{LL}	Total
	(with effluent)	(with groundwater)		
2021	12	3	7	15
2022	16	6	3	22
2023	14	5	5	19
Mean	14	5	5	19

Note. Where N_R is the number of irrigations applied during the crop cycle), and N_{LL} is the number of rainfall events during the vegetative cycle.

Analysis of Irrigation Depths

The net irrigation depth (L_N) recommended for a Typical Leached Yellow-Reddish Quartzitic Ferralitic soil is 19.75 mm. However, the applied volume (V_{apl}) was 5,906.91 m^3, resulting in a gross depth (L_b) of 28.13 mm and a total depth (L_T) of 393.79 mm. These results yielded a parcel-level system efficiency (E_f) of 70.22 %, which is deemed acceptable for this irrigation technique. It highlights the experience and tradition of local farmers in the sustainable use of effluents in agricultural production.

Analysis of water volumes supplied to the crop

Throughout the crop's vegetative cycle, it received water volumes from the stabilization pond effluents, groundwater, and rainfall. The volume of water from effluent application amounted to 5,906.91 m^3 (63%), while the volume of groundwater used for irrigation was 1,265.77 m^3 (13 %). Rainfall, stemming from effective precipitation of 30.30 mm, and five rainfall events substituting for irrigation sessions, contributed 2,272.50 m^3 (24 %). It is worth noting that 87 % of the irrigation, comprising water from effluent and rainfall, is gravity-fed, requiring no electrical energy consumption and carrying positive economic, social, and environmental implications.

Analysis of Vegetative Variables and Crop Yield

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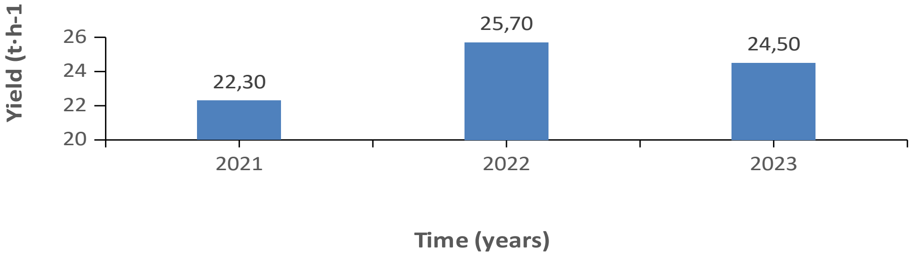
The analysis of vegetative variables 60 days after planting revealed the following results: 7.5 for the number of branches per plant, 191 cm for the length of the branch, 5.6 mm for the stem diameter (*Dt*), 576 for the number of leaves per plant, 3 for the number of marketable tubers per plant, and 580 g for the tuber mass per plant. These results show significant variability compared to other clones. However, they are consistent with what was reported by Hernández *et al.* (2018) for the INIVIT B2-2005 clone, especially in terms of branch length and stem diameter, which remain stable after 80 days of planting (Figure 6). The number of leaves per plant varies significantly among different clones (Rodríguez *et al.,* 2017).

Figure 6

Crop Yiel



Note. Own elaboration (2024).

As for commercial agricultural yield, an average value of 24.17 t·ha^{-1} was achieved, which is considered acceptable compared to the potential yield of this clone. In this study, the yield obtained for groundwater irrigation is 17.25 t·ha^{-1}, slightly lower than the national average of 19.60 t·ha^{-1}. Hernández *et al*. 2018, achieved yields of 13.92 t·ha^{-1} with a 15 % reduction due to sweet potato weevil pest. The *Cylas formicarius* Fab. is a common scientific name for the sweet potato weevil, a significant pest that infests sweet potatoes and other related plants, and can cause substantial damage to sweet potato crops by infesting tubers and stems. However, Casanovas *et al.* (2022) achieved higher yields of 11.0 t·ha^{-1} during the spring season.

Analysis of the Chemical Characteristics of Effluent and Soil

The average electrical conductivity of the effluent used in the research was 952.0 µS·cm^{-1}, significantly lower than the permissible limit for effluent discharge into receiving bodies of water, which is less than 4,000 µS·cm^{-1}. Studies conducted by

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Aguilar and Cubas in 2021 found electrical conductivity values in wastewater effluents ranging from 389-1005 $\mu S \cdot cm^{-1}$, emphasizing the importance of this parameter for using treated wastewater in crop production.

The average pH value in the effluent was 5.6 units, classifying it as slightly acidic and considered suitable for agricultural crop development. The optimal range, according to the Food and Agriculture Organization (FAO, 2017) is between 5.5 and 6.5 units. This pH value was found to be suitable for sweet potato cultivation; however, systematic monitoring is recommended to maintain values within the recommended range. This is important because the use of wastewater in agriculture can affect soil pH due to the presence of compounds like carbonates and bicarbonates in wastewater, which can lead to pH increases from 7.1 to 7.7 (Humanante *et al.,* 2022).

Table 2 displays the concentrations of P_2O_5 and K_2O in $mg \cdot 100g^{-1}$ and the percentage of OM in the soil without effluent application and with effluent applications. In all cases, irrigation with wastewater from the Morón stabilization pond led to an increase in these components, contributing 2.67 $mg \cdot 100g^{-1}$ (89 %), 15.05 $mg \cdot 100g^{-1}$ (186 %), and 1.88 % (94 %), respectively.

Table 2

Concentration and Nutrient Contributions in the Soil.

Evaluation	**P_2O_5 (mg $100g^{-1}$)**	**K_2O (mg $100g^{-1}$)**	**OM (%)**
Soil without effluent application	3.00	8,10	1,99
Soil without effluent application	5,67	23,15	3,87
Contribution	2,67	15,05	1,88
Contribution (%).	89	186	94

Note. Where OM is organic matter.

The application of effluents to the soil resulted in a nutrient gain (G_{nut}) of approximately 242.36 kg of P_2O_5 and 1,366.13 kg of K_2O. Therefore, considering a market price of 0.424 and 77.50 USD per kg for $(NH_4)_2HPO_4$ and Soluble K_2HPO_4 fertilizers respectively, a financial gain (G_{fin}) of 102.76 and 105,874.77 USD was achieved by not having to allocate financial resources to purchase phosphorus-based and potassium-based fertilizers.

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Studies conducted by Espinosa *et al.* (2015) on the availability of phosphorus and potassium in soil and their relation to sweet potato cultivation demonstrated the importance of monitoring and strict management of the levels of both elements for soil fertility management and crop production. This enables farmers and soil experts to make decisions regarding soil nutrient management.

The level of OM in soil irrigated with urban wastewater also represented a significant contribution to soil improvement. In this regard, a study conducted in India by García *et al.* (2020) found soil OM levels in urban wastewater-irrigated soil at 1.52 %, a value lower than those attained in this research. It is evident that these values can vary significantly based on wastewater quality, soil type, and the irrigation technique employed.

Phytosanitary Evaluation of the Crop

The phytosanitary evaluation of the crop did not find symptoms of harmful insects in the harvest; although very few symptoms of sweet potato weevil (*Cylas formicarius*) were observed at the base of the stem. The results of the mycology analysis provided neg-ative results for fungal pathogens.

Conclusions

The application of treated effluents from the Morón stabilization pond for sweet potato irrigation is carried out using furrow irrigation with a gross depth of 28.1 mm and a parcel-level efficiency of 70.22 %. An average of 17 irrigations were applied, with 14 using effluents and three using groundwater. Additionally, five precipitations occurred that replaced the same number of irrigation events. The volumes of water received by the crop during its vegetative cycle were 5,906.91 m^3 (63 %) from effluent application, 1,265.77 m^3 (13 %) from groundwater application, and 2,272.50 $m^3 \cdot ha^{-1}$ (24 %) from effective precipitation. The commercial agricultural yield of the crop reached an average value of 24.17 $t \cdot ha^{-1}$, which is considered acceptable concerning the potential yield of this clone. The applied effluent exhibits an electrical conductivity of 952.0 $\mu S \cdot cm^{-1}$ and a pH of 5.6 units; both values fall within the permissible range and are considered suitable for agricultural crop development. Wastewater irrigation from the Morón stabilization pond led to an increase in soil content of 2.67 $mg \cdot 100g^{-1}$ of P_2O_5,

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15.05 mg·100g^{-1} of K_2O, and 1.88% of OM, representing a nutrient gain of approximately 242.36 kg of P_2O_5 and 1,366.13 kg of K_2O. Effluent application did not cause phytosanitary, entomological, or mycological issues in the crop.

Bibliographical References

Acosta, Z., Arechabala, M., Borroto, E., Díaz, R., Hernández, L., Mansur, A., Melero, N., Pell, I., Rodríguez, B. yTorres, O. (2024). Central history and heritage of Cuba. Digital CSIC Open Science. https://digital.csic.es/handle/10261/341859

Aguilar, J. y Cubas, N. (2021). Soil contamination due to the use of wastewater. *Journal of Research in Agricultural Sciences and Veterinary Medicine, 5*(14), 132-144. https://doi.org/10.33996/revistaalfa.v5i14.104

Casanovas, C., Villar, A., Alvares, A. y Avilleira, I. (2022). Assessment of Cuban food security based on the agricultural surface area exploited and agricultural yields. *J ournal of University and Society*, *14*(5), 304-314. http://scielo.sld.cu/scielo.pdp?script=sci-arttext&pid=S2218-86202022000500304&lng=es&tlng=pt

Castillo, J. G., Balarezo, L. D. y Vinces, M. B. (2020). Alternatives for stabilizing sludge from wastewater treatment plants. *Journal of RIEMAT, 5*(1), 1-4. https://revistas.utm.edu.ec/index.php/Riemat/article/view/2499

Díaz, J. A. (2018). Water in Cuba: a challenge to sustainability. *Journal of Hydraulic and Environmental Engineering, 39*(2), 46-59. https://scielo.sld.cu/scielo.php?script=sci-arttext&pid=S1680-03382018000200004&lng=pt

Espinosa, A., Ruiz, L., Rivera, R. y Espinosa, E. (2015). Effect of Nitrogen and arbuscular mycorrhizal fungi on two commercial clones of sweet potato on a carbonated loose brown soil. *Journal of Agricultural Center, 42*(2), 39-46. https://www.researchgate.net/profile/Ramon-Rivera-6/publication/279516461

Food and Agriculture Organization of the United Nations [FAO]. (2017). Water reuse for agriculture in Latin America and the Caribbean. States, principles and needs. https://www.fao/3/a-i7748s

García, M., Luna, J., Gallegos, M., Preciado, P., Cervantes, M. y González, U. (2020). Impact of wastewater on some properties and accumulation of heavy metals in

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URL: https://revistas.unica.cu/index.php/uciencia/article/view/8674
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the soil. *Journal of Terra Latinamerican,* *38*(4), 907-916. https://doi.org/10.28940/terra.v38i4.556

González, L., Carrillo, F., Acosta, M., Baéz, A., Espitia, E., Etchevers, J. y Paz, F. (2022). Mexican experience in the implementation of the Roth C-26.3 model of soil organic carbon dynamics: scope and limitations. *Journal of Terra Latinamerican*, 40, 1-23. https://doi.org/10.28940/terra.v40i0.1386

Hernández, L., Santana, Y., Carrodeguas, S., Del Busto, A., Dovales, A., Lugo, B., Pita, A. y Hernández, R. (2018). Agronomic response of sweet potato clones and damage by sweet potato weed in Pinar del Río. *Journal of Agricultural Center, 45* (4), 91-94. http://scielo.sld.cu/scielo.pdp?script=sci-arttext&pid=S0253-57852018000400091&lng=es&tlng=en

Humanante, J. J., Moreno, L. C., Grijalva, A., Saldoya, R. W. y Suarez, J. A. (2022). Removal efficiency and impact of the wastewater treatment system in the urban and rural sectors of the Province of Santa Elena. *Journal of Manglar 19*(2): 177-187. http://doi.org/10.17268/manglar.2022.022

Rodríguez, D., Morales, A. L., Morales, A., Herrera, J. A. y Díaz, A. (2017). Morpho-agronomic and physiological evaluation of six improved genotypes of sweet potato (Ipomoea batatas (L.) Lam.). *Journal of Tropical Agriculture, 3*(1), 20-30. http://ojs.inivit.cu/index.php?journal=inivit&page=rt&op=printerFriendly&path%5B%5D=63&path%5B%5D=0

World Health Organization [WHO]. (2019). Water for human consumption. https://www.who.int/es/news-room/fact-sheets/detail/drinking-water

Conflict of interest

The authors declare no conflicts of interest.

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