High School Students for Agricultural Science Research

Volume 10

July 2021

Index

Editorial: Ten years gone 1-3

Bioinformatic analysis of specific groups of prokaryotic reverse-transcriptases
A. Nidame-Rodríguez, M. Hernández-Guerrero, J. Gutiérrez-Huertas, P.M. Blázquez-Fernández, R. Limane, M. Roldán-Ramírez, C. Ontiveros-Castro, D. Bernal, F. Martínez-Abarca 4-20

Growing plants in saline worlds: Earth vs. Mars
M. Carrascosa Sánchez, A. Ortíz Minaeva, P. Duro Muñoz, A.D. Zamora Toro, E. Rodríguez Comerón, A. Ruiz Fernández, E. Martínez de Haro, N. Gutiérrez Martín, S. Molina Lemos, A. Villoslada Calvo, M. Mansour, J. Martínez Barranco, V. Manzano Guerrero, L.M. Reyes Borges, N. Barroso Vacas, M. Espinosa-Urgel, A. Quesada Ramos 21-42

Liquid organic fertilizers prepared from bio-waste can promote common bean growth and development
M.J. Robles López, L.F. Carbajal Ramírez, S. Martínez Carrasco, Y. Motos Torrente, M. Pérez Avilés, S. Robles Martínez, M. Ruíz Cifuentes, J.A. Torrente Sánchez, L. Carrasco Blázquez, G. Tortosa Muñoz 43-50

Analysis of vitamin C content of fruits from five pepper varieties showing different pungency levels and antimicrobial potentiality of capsaicin
P. Entrena-Aranda, M. Roldán-Martín, I. Mengíbar-López, L. Rodríguez-López, A.Y. Moreno-Duperón, E. De la Torre-Amat, J.S. Vida-Lara, A. Quesada, C. Ruiz, M.J. Campos, J.M. Palma 51-65

Pepper fruits: healthy properties and consumption in Spain. A survey in a high school environment
L. Otero Galadí, F.J. Maqueda Garrido, J.D. Martín Payán, F.J. Martínez Domingo, A. Quesada, C. Ruiz, M.J. Campos, J.M. Palma 66-77

A close view to local horticultural seeds from the region of Murcia (Spain)
A. Martínez, O. Alcolea, D. Díaz, R.A. Faller, J.A. García, A. Gladkykh, J.F. Maquilón, L. Moreno, F. Palet, S. Romaní, C. de la Fuente Sáez, J.D. Alché 78-90

Liquid organic fertilizers prepared from bio-waste can promote common bean growth and development

María José Robles López[1], Leonardo Flavio Carbajal Ramírez[1], Sergio Martínez Carrasco[1], Ylenia Motos Torrente[1], María Pérez Avilés[1], Sergio Robles Martínez[1], Manuel Ruíz Cifuentes[1], Juan Andrés Torrente Sánchez[1], Lucía Carrasco Blázquez[1], Germán Tortosa Muñoz[2#]

[1]*IES José Marín. C/ Dolores Rodríguez Sopeña, 1, 04820, Vélez-Rubio, Almería, Spain.*

[2]*Department of Soil Microbiology and Symbiotic Systems. Estación Experimental del Zaidín. CSIC. Profesor Albareda 1, 18008 Granada, Spain.*

#Corresponding author: german.tortosa@eez.csic.es

Summary

Soil is a vital resource for life on our planet due to it regulates terrestrial ecosystems and has an essential role in food production. However, soil is a scarce and non-renewable resource, which is threatened by various factors such as Climate Change and desertification. Organic matter is one of the limiting factors of soil fertility, and organic waste such as bio-waste can be used as a valuable source of organic matter and plant nutrients. In this project, two liquid organic fertilizers (LOFs) were prepared from food bio-waste and were applied in common bean plant in order to test their feasibility as fertilisers. LOFs were obtained by using different combinations of boiling water of rice, eggs and banana peels as carbon (C), nitrogen (N) and potassium (K) sources, respectively. Plants were watered twice per week, and three treatments were assayed: Control (only tap water), LOF + N (with C, K and N sources), and LOF – N (with only C and K sources). After 42 days of plant growing, results showed that LOFs treatments promoted plant biomass (shoot and root dry weight) and yield (wet fruits weight/ number of fruits) compared to control plants. That demonstrated that the application of the liquid organic matter obtained from food bio-waste can be properly used for common bean cultivation under greenhouse conditions.

Keywords: Organic matter, plant nutrients, food scraps, bannana peels, boling water of food, *Phaseolus vulgaris*.

INTRODUCTION

Organic matter is one of the limiting factors of soil fertility [1]. It is known that it improves its physical, chemical and biological properties, by favouring the germination of seeds, the recycling of nutrients or the retention of water, among many other factors. Organic matter is also a key factor in their fertility and is essential for the development of plants.

On the other hand, soil is a vital resource for life on our planet [2]. It regulates terrestrial ecosystems and has an essential role in food production. However, soil is a scarce and non-renewable resource, and is threatened by various factors such as Climate Change. In Andalucía (Spain), soils are under serious pressure of desertification, so increasing their organic matter content can be an useful and effective strategy to mitigate this impact. But how can we do it?

There are many organic waste that can be used as a source of organic matter and plant nutrients for soils. By recycling them, two problems can be solved: desertification and waste generation [3]. This is one of the main principles of the Circular Economy [4]. An example of an organic waste is bio-waste, which is defined as the biodegradable fraction of the waste produced at domestic, commercial or local levels [5]. Some food scraps such as banana peels, or the boiling water of food such as rice or eggs are a potential source of plant nutrients like carbon (C), nitrogen (N) or potassium (K), among others.

Taking all these issues into account, the aim of this project was to study the feasibility of using bio-waste to prepare organic fertilisers and to evaluate their agricultural effectiveness in plant cultivation, concretely in common bean growth.

MATERIAL AND METHODS

1. Liquid Organic Fertilisers (LOFs) preparation.

The LOFs used in this experiment were obtained by using different combinations of biowaste water extracts as C, N and K sources, which were prepared as follows:

- C source. 200 g of rice and an olive-oil spoon were added to 1 L of tap water and boiled for 10 min. No salt was added. After that, the water extract was filtered and stored in a plastic bottle until using.
- N source. Two eggs and an olive-oil spoon were added to 1 L of tap water and boiled for 10 min. No salt was added. After that, the water extract was filtered and stored in a plastic bottle until using.
- K source. Banana peels, which were chopped with a scissors, was added to 0.5 L of tap water and boiled for 10 min. No salt was added. After that, the water extract was filtered and stored in a plastic bottle until using.

2. Plant experiment

Common bean (*Phaseolus vulgaris* cv. Contender) seeds were germinated in Petri dishes containing 25 mL of 1 % (weight to volume) agar in darkness at 30 ºC during 3 days. After that, one germinated seed was transplanted into 1 L plastic pot filled with an agricultural soil collected from an organic olive orchard located in Moclín (Granada, Spain). Plants were watered twice per week (100 mL) according to LOFs treatments (Figure 1) described in Table 1:

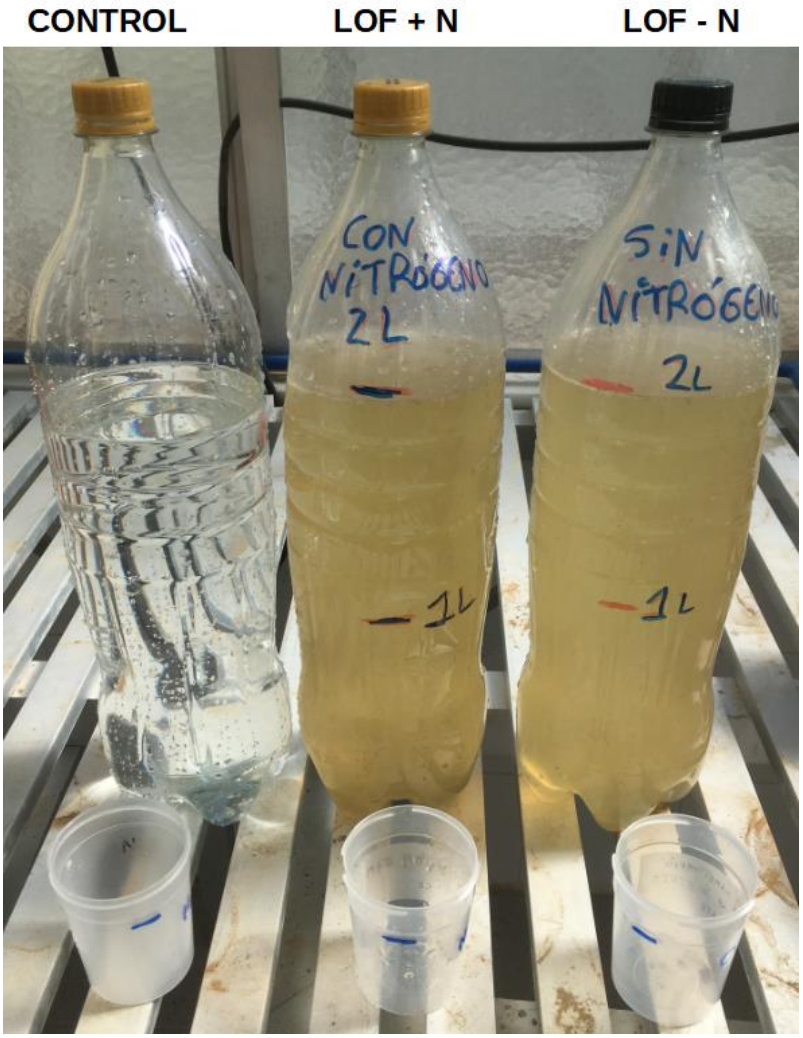

Figure 1. Liquid organic fertilisers (LOFs) treatments used in the plant experiment.

Table 1. Liquid organic fertilisers (LOFs) recipes used in the plant experiment.

Components	Treatments		
	Control	LOF + N	LOF - N
C source		100 mL	100 mL
N source		100 mL	
K source		100 mL	100 mL
Tap water	2000 mL	1700 mL	1800 mL

A total of 25 pots (five per treatment) were used in this experiment. Plants were grown during 42 days (from March to April 2021) at the Greenhouse and Growth Chamber Service facilities of the Estación Experimental del Zaidín (EEZ-CSIC). After harvesting, shoot (SDW) and root dry weight (RDW) were determined by using an air-dried oven after 3 days. Also, wet fruits weight (WFW) and the number of fruits (NF) were registered for each plant. Finally, yield of each treatment was calculated as the arithmetic mean of WFW/NF ratio of all plant.

RESULTS

Figure 2 showed an overview of the plant experiment just before harvesting. According to that, the application of both LOFs (LOF+N and LOF-N) enhanced common bean growth and flowering compared to Control treatment plants, which were watered only with tap water.

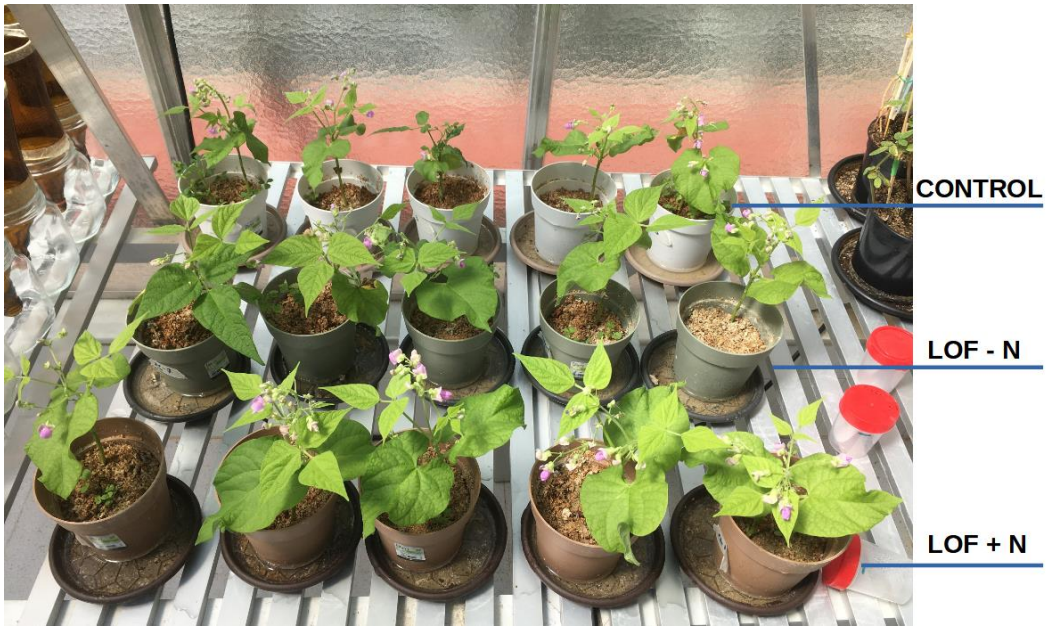

Figure 2. Common bean plants (*Phaseolus vulgaris*) growth with tap water (Control), liquid organic fertilisers with (LOF + N) and without (LOF – N) nitrogen source. Five pots per treatment were used in this experiment.

Despite the relative error of the data, the organic matter and plant nutrients applied with LOFs produced an increase in the plant biomass at the end of the experiment. LOFs treatments (LOF + N and LOF - N) showed a 10 to 20 % higher SDW than the control treatment (Figure 3A). This behavior was also found in RDW (Figure 3B), which reached final values of 0.26, 0.30 and 0.36 g in Control, LOF + N and LOF – N treatments, respectively. Finally, the aqueous organic fertilizers used in these experiments enhanced the common bean yield, which was 1,5 times higher with the addition of LOFs compared to tap water (Figure 3C).

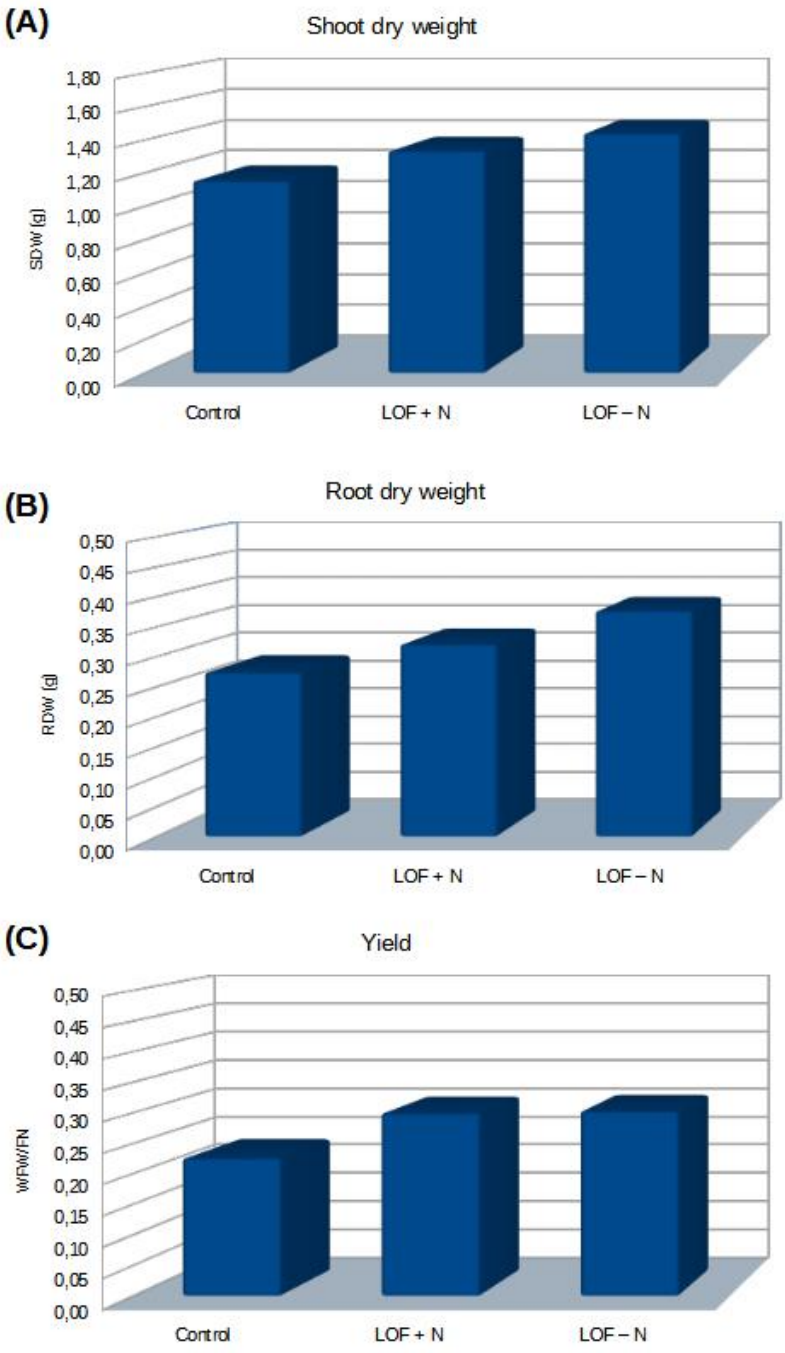

Figure 3. Shoot (SDW) (A) and root dry weight (RDW) (B), and common bean yield (C), expressed as the ratio of wet fruits weight (WFW) and number of fruits (NF) (WFW/NF), of common bean plants (*Phaseolus vulgaris*) growth with tap water (Control) and liquid organic fertilizers with (LOF + N) and without (LOF – N) nitrogen source.

DISCUSSION

Biowastes can be an interesting source of organic matter and plant nutrients [6]. Some of the main nutrients that plants need to grow are C, N, P and K. Although plants assimilate C through photosynthesis, they also assimilate it through the roots through organic matter in the soil. N is one of the most limiting for agriculture. Although it is the main component of the atmosphere (78%), it is in a form that is not very available to plants. Phosphorus (P) is usually presented in our soils in large proportions, although in poorly soluble forms. K is another essential nutrient and plants like banana trees demand a lot of K. Other nutrients are also very important such as iron (Fe), magnesium (Mg), calcium (Ca), etc.

The soil organic matter has a biological component, formed by numerous organisms (macro and micro) that intervene in the transformation of nutrients. Many of them form beneficial symbiosis with plants, such as rhizobia that help legumes to fix atmospheric nitrogen (Figure 4).

Figure 4. Formation of root nodules in common bean (*Phaseolus vulgaris*) plants growth in this experiment.

In agriculture there are many materials that can be used as a source of plant nutrients. Some of them are food waste (bio-waste), which can be used just before transforming them into compost or vermicompost [7].

According to our results, LOFs treatments promoted common bean biomass and yield compared to control plants. This demonstrated that bio-waste is a valuable source of organic matter and plant nutrients, which can be properly used in agriculture.

REFERENCES

[1] The importance of soil organic matter. Key to drought-resistant soil and sustained food production. Alexandra Bot and José Benites. FAO Soils Bulletin, N.º 80, ISBN 92-5-105366-9. Available in: http://www.fao.org/3/a0100e/a0100e.pdf

[2] Orgiazzi A, Bardgett RD, Barrios E, Behan-Pelletier V, Briones MJI, Chotte J-L, De Deyn GB, Eggleton P, Fierer N, Fraser T, Hedlund K, Jeffery S, Johnson NC, Jones A, Kandeler E, Kaneko N, Lavelle P, Lemanceau P, Miko L, Montanarella L, Moreira FMS, Ramirez KS, Scheu S, Singh BK, Six J, van der Putten WH, Wall DH. (Eds.). 2016. Global Soil Biodiversity Atlas. European Commission, Publications Office of the European Union, Luxembourg. 176 pp. Available in: https://esdac.jrc.ec.europa.eu/content/global-soil-biodiversity-atlas.

[3] Díaz Arco A, Molina Muñoz M, Navarro García E, Ortega Fernández C, Palma Pérez L, Sarmiento Vega MC, Castellano Hinojosa A, Tortosa Muñoz G, Bedmar EJ. 2016. Biofertilisers with olive-oil taste: isolation of plant growth-promoting rhizobacteria (PGPR) from "alperujo" compost. High School Students for Agricultural Science Research. Vol. 5, Estación Experimental del Zaidín (EEZ-CSIC), ISSN: 2340-9746. Availbale in: https://www.ucc.eez.csic.es

[4] de Man R, Friedge H. 2016. Circular economy: European policy on shaky ground. Waste Manag. Res. 34, 93–95. DOI: 10.1177/0734242X15626015.

[5] Definition of Biodegradable Waste. European Commission. (last access: 21/06/2021). https://ec.europa.eu/environment/waste/compost/index.htm

[6] Recycling bio-waste by small-scale composting. C. Roldán Segura, C. Walkley, G. Tortosa. 2018. High School Students for Agricultural Science Research. Vol. 7, Estación Experimental del Zaidín (EEZ-CSIC), ISSN: 2340-9746. Availbale in: https://www.ucc.eez.csic.es

[7] Biological insights of Estación Experimental del Zaidín (EEZ) bio-waste composting J.M. Díaz, C. Moro, Y. Coletti, A. de la Torre, J. de la Torre, A. Rolland, D. Ledesma, E.J. Bedmar, G. Tortosa. 2020. High School Students for Agricultural Science Research. Vol. 9, Estación Experimental del Zaidín (EEZ-CSIC), ISSN: 2340-9746. Availbale in: https://www.ucc.eez.csic.es

MY OWN IDEAS

María José Robles López

Que se pueden aprovechar los restos vegetales que no utilicemos para que las plantas tengan más vigor, que tengan mejor fruto, que sean más resistentes a las plagas, etc. Los abonos ayudan a que crezcan más rápido las plantas y así ayudamos al medio ambiente contaminando menos.

Sergio Martínez Carrasco

Mi opinión sobre el proyecto, es que me ha parecido muy interesante, ya que con cosas que consumimos diariamente y a menudo, podemos ayudar a nuestras plantas y suelo. La verdad que he aprendido bastante y me ha sorprendido que con restos vegetales, podemos contribuir a reducir el abonado químico, y hace un abonado orgánico y cero productos químicos.

Ylenia Motos Torrente

Me pareció un proyecto increíble de principio a fin. Nos ha enseñado que con muy poquito esfuerzo y con residuos que normalmente tiramos a la basura podemos crear un abono bastante beneficioso y donde hemos podido comprobar que la combinación de estos hace un gran cambio a la planta. También es un proyecto que te enseña a reciclar y ver el valor que tiene hacerlo. Es una bonita forma de poner nuestro granito de arena. Y destacar la sencillez que tiene hacerlo y como se puede adaptar a todas a las edades. Gracias por hacerme parte de este increíble proyecto.

María Pérez Avilés

Me ha gustado mucho este experimento ya que siempre hemos hablado de la gran diferencia que puede haber de un producto a otro debido a cómo se ha cuidado su proceso con productos fitosanitarios, pero no me imaginaba que algo tan simple como nuestras fórmulas harían que las plantas se diferenciaran unas de otras.

Sergio Robles Martínez

Mi opinión es que hay que reciclar los restos vegetales que no utilicemos para darle otras funciones como el abono orgánico que es natural y no hay ningún producto químico por lo tanto beneficiará a la planta que tenga mayor vigor, fruto y sistema radícular, el suelo también se beneficiara la tierra más esponjosa, nos beneficiará también a nosotros al no llevar productos químicos y ser todo natural, el abono orgánico hace resistente a la planta para librarla de plagas y enfermedades.


eez
estación experimental del Zaidín