International Interdisciplinary Congress on Renewable Energies, Industrial Maintenance, Mechatronics and Informatics
Booklets

RENIECYT 1702902 CONAHCYT

RENIECYT - LATINDEX - Research Gate - DULCINEA - CLASE - Sudoc - HISPANA - SHERPA UNIVERSIA - Google Scholar DOI - REDIB - Mendeley - DIALNET - ROAD - ORCID - V|LEX

Title: Silver Nanoparticles as Germination and Growth Promoters of Zucchini (Cucurbita pepo), Corn (Zea mays) and Barley (Hordeum vulgare)

Authors: VARGAS-SOLANO, Zaira, GRANADOS-OLVERA, Jorge Alberto, PÉREZ-LOREDO, María Guadalupe and RANGEL-RUIZ, Karelia Liliana

Editorial label RINOE: 607-8695
VCIERMMI Control Number: 2023-02
VCIERMMI Classification (2023): 261023-0002

Pages: 11
RNA: 03-2010-032610115700-14

Introduction

Studies have shown (Shalaby, 2016) that the presence of Nanomaterials in the Environment generates a response from the elements that make up the ecosystem as well as that particularly in plants exposed to nanoparticles there are variations in their morphological and physiological development depending on the type of particle and exposure levels (Zohra et.al., 2023).

Metal nanoparticles have great potential in different industries (Yokesh et.al., 2014; Boroumand et.al.,2015, Athanassiou et.al.,2018). Its participation in the field of medicine, the generation of broad-spectrum microbicides (Baishya et.al., 2012), in the degradation of pigments, in the production of superconductors, among others, has been successfully and clearly proven.

Research has recently been published that highlights the incorporation of nanostructured materials and products that contain them in agro-industrial applications (Lopez, 2022; Gonzalez y Fuentes, 2010), emphasizing their ability to replace fertilizers, growth promoters and crop enhancers, which have left a long list of harmful effects on the soil, water and even on the producers' health.

The study of the use of Silver Nanoparticles as a promoter of germination and growth of zucchini, corn, and barley, seeks to set a precedent to establish an alternative to replace agrochemicals focused on increasing the yield and productivity of crops of commercial interest at small and large scale, within the area of influence of the Estado de México State and even at national level.

Methodology

Green synthesis of silver nanoparticles

The synthesis of silver nanoparticles is carried out by green synthesis based on silver nitrate as a chemical precursor and the extract of the Mexican Marigold flower (Tagetes erecta) as a reducing agent (Figure 1).

Figure 1 Mexican Marigold flower (*Tagetes erecta*) planted in the facilities of the UPCI.

A solution of silver nitrate AgNO3 at a concentration of 2 mM is added with constant droplets to a volume of Mexican Marigold flower extract (Tagetes erecta) in a 500 ml flask with moderate shaking (Figure 2). Next, the solution is subjected to a sonication process for 40 min in an ultrasonic tank (Figure 3).

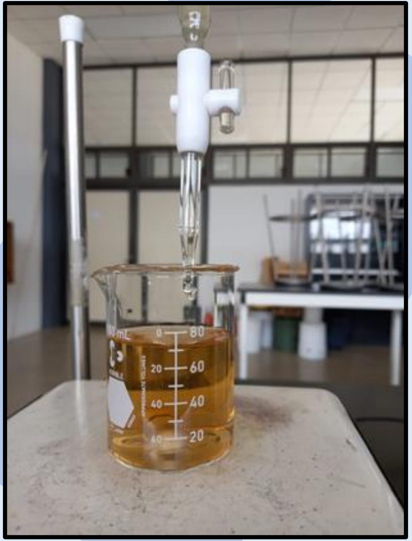

Figure 2 Green Synthesis of Silver Nanoparticles.

Figure 3. Sonication process.

Preparation of solutions of Ag Nanoparticles

Ranges of germination and plant growth promoting solutions were established with solutions of 500 µl - 1000 µl/500ml, which were dispersed in sterile bidistilled water and placed in opaque containers for use in germination and plant growth tests.

Evaluation of the ability to promote germination

The germination of zucchini (Cucurbita pepo), corn (Zea mays) and barley (Hordeum vulgare) seeds was carried out under greenhouse conditions, placing the seeds in a peat moss substrate. Zucchini, corn, and barley seeds were used to evaluate the germination of the plant species.

En cada caja se colocó una capa de algodón (Figura 4a) y sobre ella de 3 a 5 semillas de las especies ya mencionadas, (Figura 4b) se agregan 1.5 mL de agua destilada con una solución de Np's Ag en concentraciones de 500, 750 , 800, 900 y 1000 µl de solución de nanopartículas de plata en 500 ml de agua bidestilada estéril (Figura 4c).

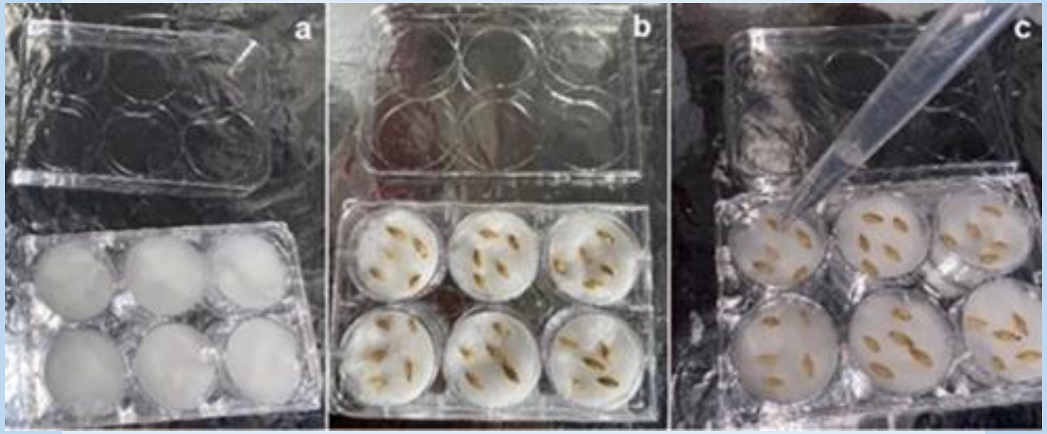

Figure 4 Seed germination tests, a) Cotton placement, b) Seed count in each well, c) Addition of 1.5 mL of water / NP's Ag solution in each group of seeds.

The test was carried out in quintuplicate, the samples must be kept, with a controlled temperature at 25°C for 96 hours.

Results

Adding the light-yellow flower extract to the silver nitrate solution produced the formation of Ag-Np's, Figure 5 shows the UV-Vis spectrum of the silver nanoparticles synthesized by this route, which shows a similar behavior according to that reported by Sally D. Solomon (2007), the absorbance is between 395-430 nm attributable to a particle size between 15-30 nm.

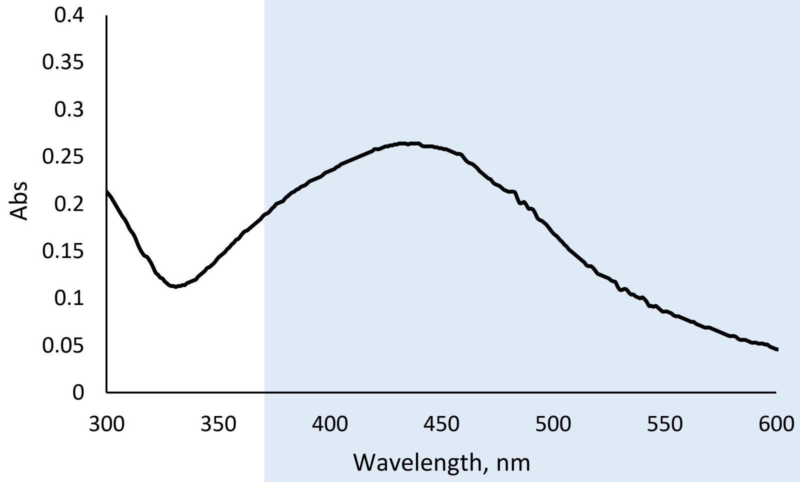

Figure 5 UV-Vis spectrum of the AgNO3-Mexican Marigold flower solution.

Germination evaluation with Np's

The use of Np's as germination and growth promoters of corn (*Zea mayz*), barley (*Hordeum vulgare*) and Zucchini (*Cucurbita pepo*) maximizes germination times and gives a better yield in terms of obtaining the harvest of plants from these seeds. Within the results obtained, it was observed that there is a better germination with respect to the plants that do not contain the silver nanoparticle, although the control seeds that were sown had significant growth, it also had lower root density.

The NPs effect begins to manifest itself from the germination of the seeds, reflecting in a greater emergence and uniformity that is observed in the final germination (Figures 6 and 7), mainly due to the penetration of nanomaterials in the seed, which allow increasing the imbibition of water and micronutrients, accelerating the reserves' degradation, and benefiting the first stages of the germinative process.

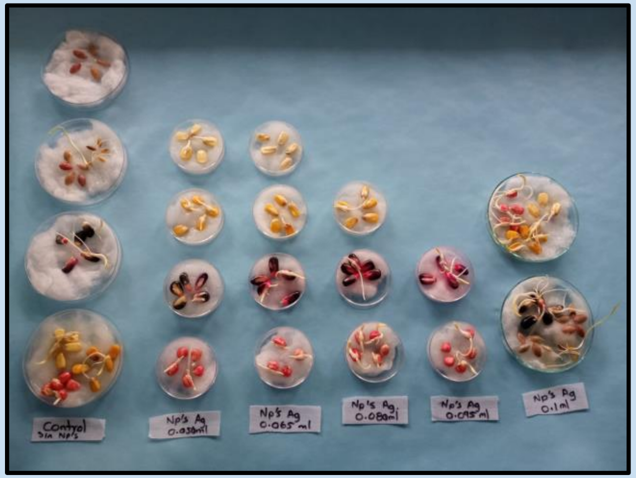

Figure 6 Germination test. Germination of corn (*Zea mays*) variety tuxpeño norteño, zapalote corn, mouse corn and cone corn) in concentrations of 500µl, 650µl, 850µl, 950µl 1000µl /500ml of bidistilled water, plumule growth and mesocotyl nodes.

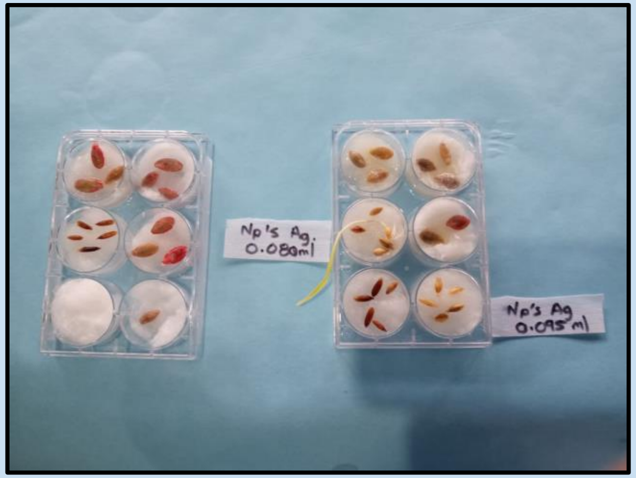

Figure 7 Germination of barley (*Hordeum vulgare*) and zucchini (*Cucurbita pepo*) in concentrations 0.50ml, 0.65 ml, 0.80ml, 0.95ml, 1.0 ml/500ml of bidistilled water.

Conclusions

Based on the obtained results, the UV-vis spectrum confirms the formation of Ag Np's by the methodology proposed by green synthesis using the Mexican Marigold extract.

The concentrations of NP's Ag that are considered germination promoters and/or growth promoters of at least one of the three proposed crops were identified, determining that the concentration of 800□l/500 ml of silver nanoparticles solution and water is the one that carries out more accelerated germination processes in conditions of roots growth and seedlings in accelerated conditions.

Mainly these help the germination process, maximizing the germination times, given the fact that under normal conditions these seeds would take 7-10 days just to germinate.

References

- Athanassiou, C. G., Kavallieratos, N. G., Benelli, G., Losic, D., Rani, P. U., & Desneux, N. (2018). Nanoparticles for pest control: current status and future perspectives. Journal of Pest Science, 91(1), 1-15. https://link.springer.com/article/10.1007/s10340-017-0898-0
- Azmath, P., Baker, S., Rakshith, D., and Satish, S. (2016). Mycosynthesis of silver nanoparticles bearing antibacterial activity. Saudi Pharm. J. 24, 140–146. https://doi.org/10.1016/j.jsps.2015.01.008
- Bahwirth, M. A., Bamsaoud, S. F., & Alnaddaf, L. M. (2023). Nanomaterial impact on plant morphology, physiology and productivity. In Nanomaterial Interactions with Plant Cellular Mechanisms and Macromolecules and Agricultural Implications (pp. 319-340). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-031-20878-2_12
- Baishya, D., Sharma, N., & Bora, R. (2012). Green synthesis of silver nanoparticle using Bryophyllum pinnatum (Lam.) and monitoring their antibacterial activities. Archives of applied science research, 4(5), 2098-2104. https://www.semanticscholar.org/paper/Green-Synthesis-of-Silver-Nanoparticle-using-(Lam.)-Baishya-Sharma/e797f44ea14afa2b0fb03d62cc11917e300bbb1d
- Bhambure, R., Bule, M., Shaligram, N., Kamat, M., & Singhal, R. (2009). Extracellular biosynthesis of gold nanoparticles using Aspergillus niger–its characterization and stability. Chemical Engineering & Technology: Industrial Chemistry-Plant Equipment-Process Engineering-Biotechnology, 32(7), 1036-1041. DOI: 10.1002/ceat.200800647
- Boroumand Moghaddam, A., Namvar, F., Moniri, M., Azizi, S., & Mohamad, R. (2015). Nanoparticles biosynthesized by fungi and yeast: a review of their preparation, properties, and medical applications. Molecules, 20(9), 16540-16565. DOI: 10.3390/molecules200916540

- González, H., & Fuentes, N. (2017). Mecanismo de acción de cinco microorganismos promotores de crecimiento vegetal. Revista de Ciencias Agrícolas, 34(1), 17-31. https://doi.org/10.22267/rcia.173401.61.
- Iravani, S., Korbekandi, H., Mirmohammadi, S. V., and Zolfaghari, B. (2014). Synthesis of silver nanoparticles: chemical, physical and biological methods. Res. Pharm. Sci. 9, 385–406. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4326978/
- López-Rueda, R. M. (2022). Comportamiento geoquímico de las nanopartículas.Tesis doctoral Universidad Jaen. https://ruja.ujaen.es/jspui/handle/10953/711
- Manesh, K. M., Gopalan, A. I., Lee, K. P., & Komathi, S. (2010). Silver nanoparticles distributed into polyaniline bridged silica network: A functional nanocatalyst having synergistic influence for catalysis. Catalysis Communications, 11(10), 913-918. DOI: 10.1016/j.catcom.2010.03.013
- Méndez-Argüello, B., Vera-Reyes, I., Mendoza-Mendoza, E., García-Cerda, L. A., Puente-Urbina, B. A., & Lira-Saldívar, R. H. (2016). Promoción del crecimiento en plantas de Capsicum annuum por nanopartículas de óxido de zinc. Nova scientia, 8(17), 140-156. https://www.scielo.org.mx/scielo.php?script=sci_arttext&pid=S2007-07052016000200140
- Secretaria del Campo del Gobierno del Estado de México SECAMPO (2022) Análisis de Tendencia de la Producción de los Principales Productos Agrícolas, Florícolas y Pecuarios en el Estado de México Junio 2022 disponible en: http://secampo.edomex.gob.mx/sites/secampo.edomex.gob.mx/files/files/Produccion_Campo/Tend_Prod_A_F_P2022.pdf
- Shalaby, T. A., Bayoumi, Y., Abdalla, N., Taha, H., Alshaal, T., Shehata, S., ... & El-Ramady, H. (2016). Nanoparticles, soils, plants and sustainable agriculture. In Nanoscience in Food and Agriculture 1 (pp. 283-312). Springer, Cham. DOI: 10.1007/978-3-319-39303-2_10
- Solomon, S. D., Bahadory, M., Jeyarajasingam, A. V., Rutkowsky, S. A., Boritz, C., & Mulfinger, L. (2007). Synthesis and Study of Silver Nanoparticles W. Journal of Chemical Education, 84(2). https://doi.org/10.1021/ed084p322

MARVID®