

**EVALUATION OF NANO-STRUCTURED SILICON DIOXIDE
FOLIAR FERTILIZER IN LOWLAND
IRRIGATED RICE**

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BIOGRAPHICAL SKETCH

The author was born on the 15th day of July, 1996 at Barangay Curva, Cuyapo Nueva Ecija. She is living now at Barangay Curva, Cuyapo Nueva Ecija. She is the 5th child among the seven children of Mr. Henry R. Lopez and Pacita M. Lopez. Her siblings are Diana, Cindy, Julie Ann, Jenny, Ma. Lyka and Chanda Mae.

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After she graduated in year 2013, she decided to stop studying because of lack of financial support. It is not easy for her mother to support all their needs because her father died in year 2008. Because of the help of Almighty God and her sisters she continued her study. She took an entrance exam at Central Luzon State University in year 2015 and passed. When she was in 3rd year college she got scholar at ESGP-PA. She became member of Soil Science Society and Pi Omicron Fraternity.

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ABSTRACT

LOPEZ, LIELA M., Department of Soil Science, College of Agriculture, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **September 2019, EVALUATION OF NANO-STRUCTURED SILICON DIOXIDE FOLIAR FERTILIZER IN LOWLAND IRRIGATED RICE**

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The study was conducted to evaluate the performance of glutinous rice during wet season of 2018 as affected by Nano-Structured Silicon Dioxide foliar fertilizer. It was tested using Randomized Complete Block Design with three replications. The treatments were T1 Control (No fertilizer), T2 90-40-60 kg N-P₂O₅-K₂O/ha, T3 90-40-60 kg N-P₂O₅-K₂O/ha + 1X NSS (20 DAT), T4 90-40-60 kg N-P₂O₅-K₂O/ha + 2X NSS (20 and 40 DAT), T5 90-40-60 kg N-P₂O₅-K₂O/ha + 3X NSS (20, 40 and 60 DAT). Blanket application of 1000 ppm paclobutrazol was done at tillering stage; prior to stem elongation.

Application of recommended rate of inorganic fertilizer significantly improved the plant height, number of tillers and dry matter yield of glutinous rice over the untreated plants while percent filled grains per panicle, weight of 1000 grains, grains per panicle and yield was unaffected.

Combining nano-structured silicon dioxide foliar fertilizer with the recommended rate of inorganic fertilizer did not improve all the parameters tested. Moreover, spraying frequency of nano-structured silicon dioxide foliar fertilizer did not improve all the parameters. Spraying of nano-structured silicon dioxide foliar fertilizer to glutinous rice is currently not needed as soil silicon may still be sufficient.

Keyword: Nano-structured silicon dioxide; Paclobutrazol; Lodging resistant

LITERATURE CITED

- Agostinho, F. V., Tubana, B. S., Martins, M. S., & Datnoff, L. E. (2017). Effect of Different Silicon Sources on Yield and Silicon Uptake of Rice Grown under Varying Phosphorus Rates. Retrieved from file:///C:/Users/HPmini/Downloads/plants-06-00035%20(3).pdf.
- Atli, A.(2017). Rice 101: Nutrition facts and health effects. Retrieved from <https://www.medicalnewstoday.com/articles/318699.php>.
- Bogdan, K. & Schenk, M. K. (2008). Arsenic in Rice (*Oryza sativa* L.) Related to Dynamics of Arsenic and Silicic Acid in Paddy Soils. Retrieved form https://www.researchgate.net/publication/23495756_Arsenic_in_Rice_Oryza_sativa_L_Related_to_Dynamics_of_Arsenic_and_Silicic_Acid_in_Paddy_Soils/amp.
- Brunings, A. M. Datnoff, J. F. Ma, N. M. Nagamura, B. & Rathinosabapathi, M. K.(2009). Differential gene expression of rice in response to silicon and and rice blast fungus *Magnaporthe oryzae*. *Annals of Applied Biolology*, Vol. 155:161-170.
- Chanthakhone, B. C., Mariafe, C., Rosa Paula, C., Darunee, J., Jirawat, S., & Melissa, F.(2011). Yield and quality of traditional and improved Lao varieties of rice. Retrieved from http://www.scienceasia.org/2011.37.n2/scias37_89.pdf.
- Cortaga, C. C., Duldulao, JB. A., & Perez, L. M. (2014). Grain Quality of some Philippine Traditional Rice Varieties. Retrieved from file:///C:/Users/HPmini/Downloads/GrainqualityofsomePhilippinetraditionalricevarieties.pdf.
- Datnoff, L. E. & Rodrigues, F. A. (2005). The Role of Silicon in Suppressing Rice Deseases. Retrieved from <https://www.apsnet.org/publications/apsnetfeatures/Documents/2005/SiliconRiceDiseases.pdf>.
- Dhewa, T. (2015). Nanotechnology Applications in Agriculture: An Update. Retrieved from http://sciencebeingjournal.com/sites/default/files/10-150316_0302_TPD.pdf.
- Ditta, A. (2012). How helpful is nanotechnology in agriculture? Retrieved from <http://iopscience.iop.org/article/10.1088/2043-6262/3/3/033002/pdf>.
- Dorairaj, D. Ismail, M. R. Sinniah, U. R. & Ban, T. K. (2017). Influence of silicon on growth, yield, and lodging resistance of MR219, a lowland rice of Malaysia. Retrieved from <https://www.tandfonline.com/doi/abs/10.1080/01904167.2016.1264420>

- Fauteux, F. Remus-Borel, W. Menzies, J. G. & Belanger, R. R. (2005). Silicon and plant disease resistance against pathogenic fungi. Retrieved from <https://www.ncbi.nlm.nih.gov/m/pubmed/16006059>
- Grant, B. L. (2012). Types Of Plant Lodging: Treating Plants Affected By Lodging. <https://ipni.net/ipniweb/pnt.nsf/5a4b8be72a35cd46852568d9001a18da/b72f4acd46ccb0885257af40055a808!OpenDocument>.
<https://www.omicsonline.org/nanotechnology-in-agriculture-21577439.1000123.php?aid=3268>.
- Harter, R. D. (2012). Soil Fertility. Retrieved from https://c.ymcdn.com/sites/cchocommunity.site_ym.com/resource/collection/27A14B94-EFE8-4D8A-BB83-36A61F414E3B/TN_57_Soil_FertilityPrinciples_for_Sustainable_Agricultural_Development.pdf
- Kim, S.G. Ki, E. P. & Woo, D. C. (2002). Silicon-induced cell wall fortification of rice leaves: a possible cellular mechanism of enhanced host resistance to blast. *The American Phytopathological Society*, Vol. 92 (10). Retrieved on September 25, 2018.
- Kobayashi, T. E. (2001). Detection of rice panicle blast with multispectral radiometer and the potential of using airborne multispectral scanners. *Phytopathology*. 91:316-323.
- Kordorfer, G.H. & Berthelsen, S. (2011). Silicon analysis in soil, plant and fertilizers. Brazil, GPSi/ICIAG/UFU. Retrieved from <https://www.semanticscholar.org/paper/Methods-for-Silicon-Analysis-in-Soil-%2C-Plant-and-Berthelsen-Kordorfer/984011f3ce446e42a441cdacc462b2ba4db1481e>.
- Ma, J.F. & Takahashi, E. (2002). Soil, Fertilizer and Plant Silicon research in Japan, *Elsevier science*. Retrieved from <https://www.elsevier.com/books/soil-fertilizer-and-plant-silicon-research-in-japan/ma/978-0-444-51166-9>.
- Mactal, A. G. (2011). Paclobutrazol application for lodging resistance and agromorphological modification in traditional rice varieties. PhD, Institute of Graduate Studies, Central Luzon State University, Science City of Munoz, Nueva Ecija. (Unpublished dissertation).
- Maheswari, M. (2013). Growth and Characterizations of SiO₂ Thin Film on Silicon. Retrieved from <http://ethesis.nitrkl.ac.in/5019/1/411PH2100.pdf>.

- Massey, F. P. & Hartley, S. E. (2006). Experimental demonstration of the antiherbivore effects of silica in grasses: impacts on foliage digestibility and vole growth rates. *Proceedings of the Royal Society B. Biological sciences* 273:2299-2304.
- Philippine Rice Research Institute (2002). Integrated Nutrient Management. Retrieved from <http://www.pinoyrice.com/wp-content/uploads/integrated-nutrient-management.pdf>.
- Runkle, E. (2012). Successful Use of Paclobutrazol. Retrieved from <https://gpnmag.com/article/successful-use-paclobutrazol/>.
- Salman, D. (2012). Application of Nitrogen and Silicon Rates on Morphological and Chemical Lodging Related Characteristics in Rice (*Oryza sativa L.*) at North of Iran. Retrieved from <https://pdfs.semanticscholar.org/59bc/3b40a385d4e81831a4093bd78250296397e1.pdf>
- Sato, K. Ozaki, N. Nakanishi, K. Sugahara, Y. Oaki, Y. Salinas, C. Herrera, S. Kisailus, D. & Imai, H. (2017). Effects of nanostructured biosilica on rice plant mechanics. Retrieved from https://www.research.net/publication/314013356_Effects_of_nanostructured_biosilica_on_rice_plant_mechanics.
- Servin, A. D., & White, J. C. (2015). Nanotechnology in agriculture: Next steps for understanding engineered nanoparticle exposure and risk. Retrieved from http://www.ct.gov/caes/lib/caes/documents/usda_center_of_excellence/cenaps/2-servin_and_white_2016.pdf.
- Setter, T. L. Laureles, E. V. & Mazaredo, A. M. (1997). Lodging reduces yield of rice by self-shading and reductions in canopy photosynthesis. *Field Crops Research*, Volume 49, Issues 2-3, February 1997, pp 95-106.
- Shaygany, J. (2011). Increased yield of direct seeded rice (*Oryza sativa L.*) by foliar fertilization through multi-component fertilizers. Retrieved from <https://www.randfonline.com/doi/abs/10.1080/03650340.2011.570336>.
- Srilatha, B. (2011). Nanotechnology in Agriculture. Retrieved from Substrate. Retrieved from <http://ethesis.nitrkl.ac.in/5019/1/411PH2100.pdf>.
- Tubana, B. S. Babu, T. Datnoff, & Lawrence, E. (2016). A Review of Silicon in Soils. Retrieved from https://journals.lww.com/soilsci/fulltext/2016/09000/A_Review_of_Silicon_in_Soils_and_Plants_and_Its.1.aspx

- Wipada, P. (2014). A comparative proteomic study of white and black glutinous riceleaves. Retrieved from <http://www.ejbiotechnology.info/index.php/ejbiotechnology/article/viewFile/2014.11.005/art%2065>.
- Zhong, L. Y. Dong, X.Y. Mei, & Qing-Sen, Z. (2012). Effects of Lodging at Different Filling Stages on Rice Yield And Grain Quality, *Rice Science*, Volume 19, Issue 4, December 2012, Pages 315-319.