

**WATER CONSERVATION USING HYDROGEL AND COCONUT PEAT AS
SOIL AMENDMENTS FOR DIFFERENT SOIL TYPES**

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An Undergraduate Thesis Submitted to the Faculty of the Department of Agricultural and
Biosystems Engineering, College of Engineering, Central Luzon State
University Science City of Muñoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the degree of

**BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS
ENGINEERING
(AB Land and Water Resources Engineering)**

JUNE 2023

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ABSTRACT

ARDENIO, AILEN C. and **DOMINGO, MAYBELYN D.**, Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines, **June 2023**, **WATER CONSERVATION USING HYDROGEL AND COCONUT PEAT AS SOIL AMENDMENTS FOR DIFFERENT SOIL TYPES**

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Hydrogel and coconut peat both have the ability to store large volumes of water and have many applications especially for water conservation. Total available water (TAW) differs depending on soil type or structure, soil that has larger particle size like sandy soil can hold less water thus it has less TAW compared to soil with smaller particle size like clay soil. Hydrogel, coconut peat and mixed treatment (hydrogel and coconut peat with 1:1 ratio) with dosage level 0% (controlled), 0.2%, 0.4% and 0.6% was used as a technique for water conservation. The effects of these treatments to the plant growth and development of radish crop (*Raphanus sativus*) were examined. Seeds of Radish plants were sown in pots of different soil types with different dosage levels of treatments. Results revealed that the application of hydrogel coconut peat and mixed have increased the TAW of all types of soil. Dosage level of 0.6% gained the highest TAW in sandy loam, sandy clay loam and loam soil which is 22.76%, 26.69% and 24.79% respectively. Results also showed that in plant growth and development (plant height, leaf diameter, number of leaves, crop length and fresh weight) of radish was higher in coconut peat treatment followed by the mixed treatment compared to soil amended with pure hydrogel.

Keywords: *Hydrogel; coconut peat; total available water; water holding capacity; radish*

LITERATURE CITED

- A. K. Saini, a. M. Patel, l. H. Saini, & s. H. Malve, "Growth, phenology and yield of summer pearl millet (*Pennisetum glaucum* L.) as affected by varied application of water, nutrients and hydrogel," *International Journal of Ecology and Environmental Sciences*, vol. 2, no. 3, pp. 248–252, 2020.
- Abobatta, W. (2018). Impact of hydrogel polymer in the agricultural sector. *Advances in Agriculture and Environmental Science Open Access (AAEOA)*, 1(2), 59–64. <https://doi.org/10.30881/aaeo.00011>
- Agaba, H.; Bagumaorikiriza, L.J.; Osotoesegu, J.F.; Obua, J.; Kabasa, J.D.; & Hüttermann, A. Effects of hydrogel amendment to different soils on plant available water and survival of trees under drought conditions. *Clean Soil Air Water* 2010, 38, 328–335.
- Agrikrit (2021), *Agricultural Hydrogels: Use of Hydrogels in agriculture*. (2021, January 22). Agrikrit. <https://agrikrit.com/agricultural-hydrogels-how-to-use-and-benefits/>
- Ahmed, E.M. (2015) Hydrogel: Preparation, characterization, and applications: A review. *J. Adv. Res.* 2015, 6, 105–121.
- Akhter, J., Mahmood, K., Malik, K. A., Mardan, A., Ahmad, M., & Iqbal, M. M. (2004). Effects of hydrogel amendment on water storage of sandy loam and loam soils and seedling growth of barley, wheat and chickpea. *Plant, Soil and Environment*, 50(10), 463–469. <https://pse.agriculturejournals.cz/artkey/pse-200410-0006.php>
- Alaboz, P., & Çakmakci, T. (2020, August 1). Kumlütinvekillitintopraktakokopituygulamasınıntarlapasitesivedevamlısolmanok tasüzerineetkisi. *Mediterranean Agricultural Sciences*, 33(2), 285–290. <https://doi.org/10.29136/mediterranean.660207>
- Alagendran Associate Professor In Biochemistry, S., Prakash, V., Kavitha, J., Kamaleshwaran, R., Prabharan, P., & Alagendran, S. (2021). Effect of coir pith compost in agriculture. ~ 106 ~ *Journal of Medicinal Plants Studies*, 9(4), 106–110. www.plantsjournal.com
- Albalasmeh, a. A., Mohawesh, o., Gharaibeh, m. A., Alghamdi, a. G., Alajlouni, m. A., & Alqudah, a. M. (2022). Effect of hydrogel on corn growth, water use efficiency, and soil properties in a semi-arid region. *Journal of the Saudi Society of Agricultural Sciences*, 21(8), 518–524. <https://doi.org/10.1016/j.jssas.2022.03.001>
- Alves Es, Lima Df, Barreto Jas, Santos Dp, & Santos Mal (2017) Determinação do coeficiente de cultivo para a cultura do rabaneteatravés de lisimetria de drenagem. *Irriga* 22(1):194-203. DOI: <http://dx.doi.org/10.15809/irriga.2017v22n1p194-203>

- American Meteorological Society, Soil moisture. (2012). Ametsoc.org. Retrieved November 16, 2022, from https://glossary.ametsoc.org/wiki/Soil_moisture
- Annie. (2022, August 31). *How Much Water do Radishes Need?* Eco Family Life; Annie. <https://ecofamilylife.com/garden/how-much-water-do-radishes-need/>
- Aznar-Sánchez, J. A., Velasco-Muñoz, J. F., López-Felices, B., & Román-Sánchez, I. M. (2020). An analysis of global research trends on greenhouse technology: Towards a sustainable agriculture. *International Journal of Environmental Research and Public Health*, 17(2), 664. <https://doi.org/10.3390/ijerph17020664>
- B.C. Ministry of Agriculture (2005). Soil Water Storage Capacity and Available Soil Moisture. Retrieved January 3, 2023, from https://www.droughtmanagement.info/literature/BC_MA_Soil_Water_Storage_Capacity_2005.pdf
- Batista, R. A., Otoni, C. G., & Espitia, P. J. P. (2019). Fundamentals of chitosan-based hydrogels: elaboration and characterization techniques. In *Materials for Biomedical Engineering* (pp. 61–81). Elsevier
- Bowen, M. W. (2021). *1.6: Particle Size Analysis: The Hydrometer Method*. Geosciences LibreTexts. Retrieved January 4, 2023, from [https://geo.libretexts.org/Bookshelves/Soil_Science/Principles_of_Soil_Science_Exercise_Manual_\(Bowen\)/01%3A_Hands-on_Exercises/1.06%3A_New_Page](https://geo.libretexts.org/Bookshelves/Soil_Science/Principles_of_Soil_Science_Exercise_Manual_(Bowen)/01%3A_Hands-on_Exercises/1.06%3A_New_Page)
- Certified Crop Advisor Study Resources (*Northeast region*). (n.d.). Cornell.edu. Retrieved November 16, 2022, from <https://nrcca.cals.cornell.edu/soil/CA2/CA0212.1-3.php>
- Chaloupková, Veronika & Ivanova, Tatiana & Havrland, Bohumil. (2016). Sieve analysis of biomass: accurate method for determination of particle size distribution. *Water Resources and Rural Development*. 1012-1017.
- Civil, D. (2020, January 16). Oven Drying Method of soil: Lab procedure, observation & calculations. *Dream Civil: Civil Engineering & Construction Informations*. <https://dreamcivil.com/oven-drying-method/>
- Coconut Waste Project (2022). Coco Waste Processing Hub <https://coconutwasteproject.com/coco-waste-processing-hub/>
- Constructionor (2015). Soil classification. Constructionor.com; Admin. <https://constructionor.com/soil-classification/>

- Datta, D., Pramanick, B., Ghosh, S., Saha, R., & Paul Mazumdar, S. (2002). *Coco Peat in Agriculture: Prospects and Innovative Solutions*. Agrinenv.com. Retrieved November 16, 2022, from <https://agrinenv.com/wp-content/uploads/2022/03/v3i3-from-16thy-9-14.pdf>
- Department Of Agriculture Communications Group. (2022). *Dar: Greenhouses enable farmers to produce crops year-round*. Official Portal of the Department of Agriculture; Department of Agriculture. <https://www.da.gov.ph/dar-greenhouses-enable-farmers-to-produce-crops-year-round/>
- Eagle, B., & Eagle, B. (2020, May 21). *Soil Texture: Sand, Silt and Clay*. WordPress.com. <https://thinkingcountry.com/2016/11/30/soil-texture-sand-silt-and-clay/>
- F. Yazdani, I. Allahdadi, & G. A. Akbari, (2007) "Impact of superabsorbent polymer on yield and growth analysis of soybean (*Glycine max L.*) under drought stress condition," *Pakistan Journal of Biological Sciences*, vol. 10, no. 23, pp. 4190–4196, 2007.
- Food And Agricultural Organization *Soil Texture*. (n.d.). Fao.org. Retrieved November 16, 2022, from https://www.fao.org/fishery/docs/CDrom/FAO_Training/FAO_Training/General/x6706e/x6706e06.htm
- Food And Agriculture Organization *Chapter 2 - soil and water*. (n.d.). Fao.org. Retrieved November 16, 2022, from <https://www.fao.org/3/r4082e/r4082e03.htm>
- Galang, M. (2021). *DA-PhilRice urges farmers to conserve water*. Gov.Ph. <https://www.pna.gov.ph/articles/1143292>
- Godawatte, V. N. A. & De Silva, C. S. (2014). Effect of mulch on soil properties, growth and yield of chilli (*Capsicum annum L.*) exposed to temperature stress due to global warming. *Journal of Engineering and Technology of the Open University of Sri Lanka (JET-OU SL)*, 2(2): 2279- 2627.
- Henschel, J. M., & Batista, D. S. (2022). Radish (*Raphanus sativus L.*) responds to exogenous ascorbic acid and irrigation levels. <https://doi.org/10.21203/rs.3.rs-1369767/v1>
- Hindu (2018) Cocopeat for your home garden. Thehindu.com. <https://www.thehindu.com/life-and-style/homes-and-gardens/cocopeat-for-your-home-garden/article23393105.ece>
- Hossain, M. D. S., Islam, M. A., Badhon, F. F., & Imtiaz, T. (2021). Sieve analysis. In *Properties and Behavior of Soil - Online Lab Manual*. Mavs Open Press.

- Kalhature, Aniket & Kumar, Rajeew & Singh, Vijay & Pandey, D.S. (2016). Hydrogels: A Boon for Increasing Agricultural Productivity in Water-Stressed Environment. *Current science*. 111. 1773- 1779. 10.18520/cs/v111/i11/1773-1779.
- Karnani (Ed.). (2017). Hydrogel Agriculture Technology. Vikaspedia. Retrieved November 26, 2022, from <https://vikaspedia.in/agriculture/best-practices/sustainable-agriculture/crop-management/hydrogel-agriculture-technology>
- Mcgill, L. (2018). Effect of Climate Change Conditions on Radish (*Raphanus raphanistrum*) Growth and its Implications on Crop Production. Umich.edu. https://deepblue.lib.umich.edu/bitstream/handle/2027.42/147904/McGill_2018_2.pdf?sequence=1
- Mohammad, A. (2022). How much water does radish need? Vegetable GardenerX | Grow What You Eat; Awais Mohammad. <https://vegetablegardenerx.com/how-much-water-does-radish-need/>
- Montesano, F. F., Parente, A., Santamaria, P., Sannino, A., & Serio, F. (2015). Biodegradable Superabsorbent Hydrogel Increases Water Retention Properties of Growing Media and Plant Growth. *Agriculture and Agricultural Science Procedia*, 4, 451–458. <https://doi.org/10.1016/j.aaspro.2015.03.052>
- Moraes, O., Botrel, T. A. & Dias, C. T. S. (2001). Efeito do uso de polímerohidroretentor no solo sobre o intervalo de irrigação na cultura da alface (*Lactuca sativa*). *Engenharia Rural*, 12, 73-80.
- Mwaikusa, A. (2015, June 30). 7. The importance of Soil moisture or water. GEOGRAPHY POINT - GEOGRAPHY, HISTORY, MAPS AND GIS; mwaikusa. <https://geographypoint.com/2015/06/seven-7-importance-of-soil-moisture-water/>
- Narjary, B., Aggarwal, P., Kumar, S., & Meena, M. (2013). Significance of hydrogel and its application in agriculture. <https://www.semanticscholar.org/paper/e0160616e607d779c7d69ae8fc360feb2e7406d0>
- Nassaj-Bokharai, S., Motesarezede, B., Etesami, H., & Motamedi, E. (2021). Effect of hydrogel composite reinforced with natural char nanoparticles on improvement of soil biological properties and the growth of water deficit-stressed tomato plant. *Ecotoxicology and Environmental Safety*, 223. <https://doi.org/10.1016/j.ecoenv.2021.112576>

- Neethu, T. M., Dubey, P. K., & Kaswala, A. R. (2018). Prospects and Applications of Hydrogel Technology in Agriculture. *International Journal of Current Microbiology and Applied Sciences*, 7(05), 3155–3162. <https://doi.org/10.20546/ijcmas.2018.705.369>
- Noman A, Ali Q, Maqsood J, Iqbal N, Javed Mt, Rasool N, & Naseem J (2018) Deciphering physio-biochemical, yield, and nutritional quality attributes of water-stressed radish (*Raphanus sativus* L.) plants grown from Zn-Lys primed seeds. *Chemosphere* 195(3):175-189. DOI: <http://dx.doi.org/10.1016/j.chemosphere.2017.12.059>
- O’connor, N., & Mehta, K. (2016). Modes of greenhouse water savings. *Procedia Engineering*, 159, 259–266. <https://doi.org/10.1016/j.proeng.2016.08.172>
- Oladosu, Y., Rafii, M. Y., Arolu, F., Chukwu, S. C., Salisu, M. A., Fagbohun, I. K., ...Haliru, B. S. (2022). Superabsorbent Polymer Hydrogels for Sustainable Agriculture: A Review. In *Horticulturae* (Vol. 8, Issue 7). MDPI. <https://doi.org/10.3390/horticulturae8070605>
- Orikiriza, L. J. B., Agaba, H., Eilu, G., Kabasa, J. D., Worbes, M., & Hüttermann, A. (2013). Effects of hydrogels on tree seedling performance in temperate soils before and after water stress. *Journal of Environmental Protection*, 04(07), 713–721. <https://doi.org/10.4236/jep.2013.47082>
- Pamela (2012). Radish Seed Production Guide. Gov.Ph. Retrieved November 16, 2022, from <https://library.buplant.da.gov.ph/images/1641882970Radish%20Seed%20Production%20Guide.pdf>
- Philippine Agriculture (2018), *Agriculture Saddled By Poor Irrigation Systems*. (2018, February 12). Agriculture Monthly. Retrieved December 21, 2022, from <https://www.agriculture.com.ph/2018/02/12/philippine-agriculture-saddled-by-poor-irrigation-systems/>
- Philippine Council for Agriculture, Forestry, Natural Resources Research, Development, & Banos, L. (2007). Radish production in hilly upland areas. *PCARRD Highlights (Philippines)*. <https://agris.fao.org/agris-search/search.do?recordID=PH2008001325>
- Prakash, V., Kavitha, J. R., Kamaleshwaran, R., Prabharan, P., & Alagendran, S. (2021). *Effect of coir pith compost in agriculture*. Plantsjournal.com. Retrieved November 16, 2022, from <https://www.plantsjournal.com/archives/2021/vol9issue4/PartB/9-4-15->

451.pdf?fbclid=IwAR323EMha7UHw-7h-J55_irXez0bp61--tHJrynXEj-
ie0Xnw5UEk7GTnhw

- Rosales, J. (2017). *WATER CONSERVATION AND MANAGEMENT*. Arcler Press LCC.
- Ross, R. P., & Muthulingam, M. (2014). CBSE-2014 [2 nd and 3 rd April 2014] Challenges in Biochemical Engineering and Biotechnology for Sustainable Environment Studies on the Moisture Retention Capacity of Coir Pith, as a Function of Time. *In the International Journal of ChemTech Research CODEN* (Vol. 6, Issue 12). www.sphinxesai.com
- Sahay, A. (2021, July 20). *Conservation of water: Methods, ways, facts, uses*. Embibe Exams. <https://www.embibe.com/exams/conservation-of-water/>
- Sharma, V. (2019). *Soil moisture sensors for irrigation scheduling*. UMN Extension. Retrieved January 6, 2023, from <https://extension.umn.edu/irrigation/soil-moisture-sensors-irrigation-scheduling>
- Sikora, F. (2014, January). *Soil Test Methods from the Southeastern United States*. AESL. Retrieved January 4, 2023, from <http://aesl.ces.uga.edu/sera6/PUB/MethodsManualFinalSERA6.pdf#page=188>
- Silva Rt, Souza Aat, Oliveira Fa, Targino Iso, Silva Mln (2012) Tolerância do rabanete ao encharcamento do solo. *Revista Verde de Agroecologia e Desenvolvimento Sustentável* 7(1):25-33.
- Starbuck, C. (2012). Factors Affecting Root Growth in the Landscape // Missouri Environment and Garden News Article // Integrated Pest Management, University of Missouri. <https://ipm.missouri.edu/MEG/2012/1/Factors-Affecting-Root-Growth-in-the-Landscape/index.cfm#:~:text=Roots%20are%20dynamic%20and%20their,and%20Non%20toxic%20soil%20chemistry.>
- Stivers, J. (2017). *Oklahoma Cooperative Extension Service*. <http://osufacts.okstate.edu>
- Sudeshika, W. A. A., Pradheeban, L., Nishanthan, K. & Sivachandiran, S. (2018). Effect of different rooting media on growth and yield performances of carrot (*Daucus carota*). *International Journal of Agronomy and Agricultural Research*, 12: 31-38.
- Tomášková, I., Svatoš, M., Macků, J., Vanická, H., Resnerová, K., Čepl, J., Holuša, J., Hosseini, S. M., & Dohrenbusch, A. (2020). Effect of different soil treatments with hydrogel on the performance of drought-sensitive and tolerant tree species in a semi-arid region. *Forests*, 11(2). <https://doi.org/10.3390/f11020211>

- Ugao, (2017). How to make coco peat at home and where to use it? Ugacoco.com. Retrieved November 16, 2022, from <http://ugacoco.com/coco-peat/>
- Venturoli, F. & Venturoli, S. (2011). Recuperação florestal em uma área degradada pela exploração de areia no Distrito Federal. *Ateliê Geográfico*, 5, 183-195. <https://doi.org/10.5216/ag.v5i1.13831>.
- White, J. M., & Strandberg, J. O. (1979, May). Physical Factors Affecting Carrot Root Growth: Water Saturation of Soil. *Journal of the American Society for Horticultural Science*, 104(3), 414–416. <https://doi.org/10.21273/jashs.104.3.414>
- Xu, H., Yeum, K.-J., Yoon, Y.-H., & Ju, J.-H. (2019). Effect of Hydrogels in Three Substrates on Growth and Ornamental Quality of Apple Mint (*Mentha suaveolens*) in Unirrigated Green Roofs. *Journal of Horticulture Research Article 1 J Horttic*, 6, 260. <https://doi.org/10.35248/2376-0354.19.06.260>
- Zonta, J. H., Braun, H., Reis, E. F., Paulucio, D. & Zonta, J. B. (2009). Influência de diferentes turnos de rega e doses de hidroabsorvente no desenvolvimento inicial da cultura do café conilon (*Coffea canephora* Pierre). *IDESIA*, 27(3), 29-34