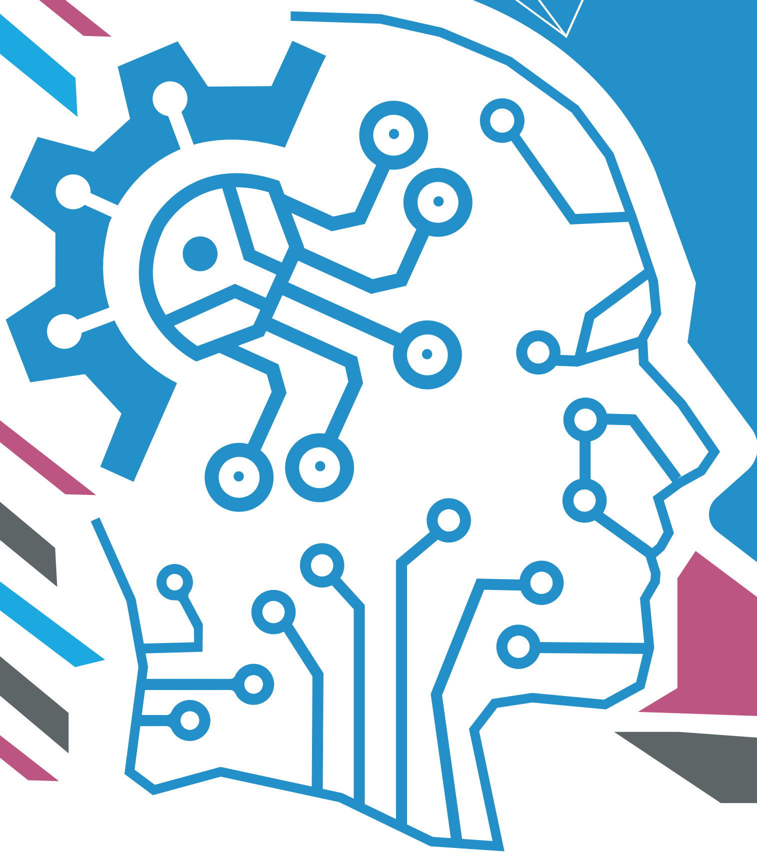
E-BOOK OF EXTENDED ABSTRACT

THE 14TH INTERNATIONAL INVENTION, INNOVATION & DESIGN COMPETITION 2025



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HYDROLIT: WATER RETENTION FERTILIZER IN DRY SOIL FROM SEAWEED ALGINATE, BIOCHAR, AND ZEOLITE

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ABSTRACT

Climate change has an impact on the instability of rainfall patterns and soil degradation, especially on lateritic soils that have low water retention capacity and fertility. This affects plant infertility in lateritic soils. This research aims to improve water retention and fertility of lateritic soils through water storage media based on seaweed alginate (Gracilaria verrucosa), rice husk biochar, and zeolite as a sustainable agricultural solution. Alginate functions as a water binder, biochar increases soil porosity and provides organic carbon that supports soil microbial activity, while zeolite absorbs and releases water and nutrients gradually. The research methods included zeolite preparation and activation, seaweed processing, and rice husk pyrolysis. Water storage media were prepared by mixing laterite soil, biochar, seaweed, and zeolite in a certain ratio. Water absorption and storage capacity tests were conducted gravimetrically and analyzed by Duncan's test at the 95% confidence level. The results showed that the combination of seaweed alginate, biochar, and zeolite significantly increased the water retention capacity and fertility of the laterite soil. Thus, this innovation not only increases water availability in the soil but also improves laterite soil fertility, making it an adaptation strategy to the impacts of climate change while supporting sustainable agriculture in drylands.

Keywords: seaweed alginate, rice husk biochar, water resistance, laterite soil, zeolite.

1. INTRODUCTION

Changing rainfall patterns and increasing global temperatures are major factors affecting the sustainability of agroecosystems (Solissa et al., 2024). Impacts such as soil degradation, decreased water availability, and stress on soil microorganisms increasingly threaten agricultural productivity (Supardi et al., 2023; Meisuri et al., 2023). Lateritic soils that have low water retention are increasingly vulnerable to drought, while the inefficient use of chemical fertilizers worsens soil conditions and inhibits nutrient absorption (Setiawan et al., 2022). Therefore, soil amendments that can improve fertility and water retention are needed.

One solution that has been experimented by Haryanti et al. (2008) is the mixing of organic fertilizer and water storage using seaweed because it has hydrocolloid properties that can absorb and retain soil moisture longer even in the dry season of seaweed. However, the water storage capacity decreased at a 1 cm cut size after 45 minutes, from 927.3% to 776.7%. Therefore, other natural material-based innovations are needed as additions that can increase the soil's capacity to store water and sustainably retain the nutrients.

One of the innovative solutions is the use of rice husk biochar and zeolite-based fertilizers that offers a holistic approach to increase agricultural resilience to climate change. Rice husk biochar has a high porosity structure that allows biochar to absorb and store water, thereby increasing water availability for plants and reducing the rate of evaporation in the soil (Meisuri et al., 2023). Thus, zeolite as a natural adsorbent plays a role in regulating the release of nutrients and storing water, thereby increasing fertilizer efficiency and supporting plant growth in drought conditions (Mardikawati et al., 2023).

Based on this, researchers combined the three ingredients to create an innovative fertilizer that not only increases soil fertility, but also improves water storage capacity. This fertilizer also reduces evaporation, and increases crop resistance to environmental stress. By utilizing these three biological resources, this innovation is a concrete step towards a more adaptive and sustainable agricultural system (Mahmudi et al., 2023; Marlin et al., 2023).

2. METHODOLOGY

2.1 Tools and Materials

i. Pyrolysis tools:grinder, 5-liter plastic container, oven, 100 mesh sieve, knife, homogenization mixer, digital balance, cutting board, small shovel, bucket.

ii. Materials: Gracilaria verrucosa seaweed, rice husk, zeolite stone, polybag, water and citric acid.

2.2 Manufacturing Process

i. Preparation of zeolite: Zeolite is pulverized then sieved to pass 100 mesh, then zeolite is soaked with distilled water for 24 hours, then filtered and dried using an oven at 120 ° C for 3 hours.

ii. Seaweed preparation: Seaweed soaked in water for approximately 3 days. The purpose of this soaking is so that the seaweed becomes soft and fresh again, the seaweed is cut at a size of 1 cm pieces and oven baking is done at 75 °C.

iii. Preparation of biochar: As much as 17 kg of leaves (leaves, twigs, flowers, dried fruits) and then dried using an oven at 105 °C for 2 hours. Pyrolysis was carried out at 400°C at a heating rate of 20°C/minute for 1 hour.

iv. Making water storage media: Put laterite soil in polybags, added biochar, seaweed, zeolite and laterite soil in a ratio of 2:1:1:1:2.

2.3 Data Analysis

Analysis of water absorption and storage capacity using the formula:

$$Ka = \frac{B1 - B2}{B2} \times 100\%$$

Description:

Ka = Water absorption or storage capacity

B1 = Weight after treatment (g)

B2 = Weight before treatment (g)

The data obtained were then analyzed to determine the capacity of water absorption and storage, and continued with the Duncan test at the 95% confidence level.

3. FINDINGS

Lateritic soils have low fertility due to high mineral leaching and low organic matter content, especially in tropical areas with high rainfall. The loss of essential nutrients such as calcium, magnesium and potassium further reduces their productivity. In addition, low cation exchange capacity (CEC) as well as dense soil structure and limited water retention make lateritic soils less favorable for plant growth (Gifaricandrabayu et al., 2023). Therefore, soil improvers that can improve fertility and water retention are needed to address these problems..

Seaweed alginate serves as an alternative to water absorption in high laterite soils. A research conducted by Haryanti(2008) states that the highest water storage capacity in seaweed is found in the size of 1 cm pieces because the larger surface area increases water absorption. Water absorption in Gracilaria verrucosa occurs through osmosis, which is the diffusion of water molecules from high to low concentration areas, influenced by pressure that encourages the spread of molecules through the pores. Water uptake increased every 45 minutes, while water storage capacity decreased slightly due to transpiration after exposure to open air. Larger pieces have a smaller surface area, so the transpiration rate is lower, allowing water to be stored for longer.

On the other hand, zeolite contains klipnotilolit which functions as a water retainer, with research showing that its addition can increase plant water content up to 13.70% and water porosity up to 60.7% (Suwandi, 2009). In addition, zeolites are able to exchange cations quickly, bind and store water, and retain essential nutrients such as potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}) that are important for plant growth (Nursanti & Kemala, 2024). This ability helps reduce nutrient losses from the root zone, making nutrients available longer. As a slow release agent, zeolite regulates the gradual availability of water and nutrients, increases fertilizer efficiency, and maintains soil moisture in dry environmental conditions (Suwardi, 2009).

In addition, biochar also plays a role in improving soil structure by absorbing and storing water in its pores, maintaining soil moisture, and supporting microbial activity. Biochar made from grasses with a particle size of (1.00 - 2.00) mm has the highest field capacity moisture content of 43.42% (Liescahyani, et al., 2015). The porous structure of biochar can retain water in micro and macro crevices, regulate water flow, and reduce water loss through percolation. With the combination of seaweed, biochar and zeolite on laterite soil, it can optimize water absorption for more productive and sustainable agriculture.

4. CONCLUSION

Based on previous research, biochar plays a role in increasing soil porosity and improving aeration, while seaweed provides growth regulators that support plant growth and improve soil structure. Zeolite, with its ability to absorb and release water and nutrients gradually, helps maintain soil fertility in the long term. It is hoped that our research of integrating these three materials will provide an innovative solution to increase agricultural productivity, especially in the face of the increasingly complex challenges of climate change and environmental degradation.

REFERENCES

Amalina, A. D., Yulianti, P. D., Putra, E. R., Ni'mah, R. I., Azizah, L,. (2024). Peran Biochar dalam Meningkatkan Kesuburan Tanah dan Retensi Air. *Jurnal Pertanian, Peternakan, Perikanan,* 2(2), 239-251. https://ejournal.warunayama.org/index.php/hibrida/article/view/6216/5735

Basmal, J. (2009). Prospek Pemanfaatan Rumput Laut sebagai Bahan Pupuk Organik. *Squalen,* 4(1), 1-7.https://www.bbp4b.litbang.kkp.go.id/squalen-bulletin/index.php/squalen/article/viewFile/141/110

Gifaricandrabayu, M., Trianda, O., Rizqi, A. H. F,. (2023). Karakteristik Endapan Nikel Laterit Pada Daerah X, Kabupaten Kolaka Utara, Provinsi Sulawesi Tenggara. *Rekaya Teknologi Industri dan Informasi, https://journal.itny.ac.id/index.php/ReTII/article/view/4552/1751*

Haryanti, A. M., Darmanti, S., Izzati, M. (2008). Kapasitas Penyerapan dan Penyimpanan Air pada Berbagai Ukuran Potongan Rumput Laut Gracilaria Verrucosa sebagai Bahan Dasar Pupuk Organik. 10(1), 1-6. https://www.researchgate.net/publication/330671245_Kapasitas_Penyerapan_dan_Penyimpanan_Air_pada_Berbagai_Ukuran_Potongan_Rumput_Laut_Gracilaria_verrucosa_sebagai_Bahan_Dasar_Pupuk_Organik

Kamakaula, Y. (2024). Pengaruh Perubahan Iklim terhadap Keanekaragaman Hayati dalam Agroekosistem Pertanian Berkelanjutan. *Jurnal Review Pendidikan dan Pengajaran,* 7(1), 2280-2285. https://journal.universitaspahlawan.ac.id/index.php/jrpp/article/view/26460/18375

Liescahyani, I., Djatmiko, H., Sulistyaningsih, N,. (2015). Pengaruh Kombinasi Bahan Baku dan Ukuran Partikel Biochar Terhadap Perubahan Sifat Fisika pada Tanah Pasira, 1(1). 1-6. repository.unej.ac.id/handle/123456789/69322?show=full

Mahmudi, A. A., Fionasari, R., Mardikawati, B., Judijanto, L,. (2023). Integration of Artificial Intelligence Technology in Distance Learning in Higher Education. *Journal of Social Science Utilizing Technology,* 1(4), 111-190. https://journal.ypidathu.or.id/index.php/jssut/article/view/661/390

Mardikawati, B., Diharjo, N. N., Saifullah,. Widyatiningtyas, R., Gandariani, T., Widarman, A., (2023). Pemanfaatan Artificial Intelligence dan Mendeley untuk Penyusunan Karya Ilmiah: Pelatihan Interaktif Berbasis Teknologi. *Community Development Journal,* 4(6), 11453–11462. https://journal.universitaspahlawan.ac.id/index.php/cdj/article/view/22460/15784

Marlin, K., Tantrisna, E., Mardikawati, B., Anggriani, R., Susilawati, E,. (2023). Manfaat dan Tantangan Penggunaan Artificial Intelligences (AI) Chat GPT terhadap Proses Pendidikan Etika dan Kompetensi Mahasiswa di Perguruan Tinggi. Innovative: *Journal Of Social Science Research,* 3(6), 5192–5201. https://j-innovative.org/index.php/Innovative/article/view/7119/4839

Meisuri, M., Nuswantoro, P., Mardikawati, B., Judijanto, L,. (2023). Technology Revolution in Learning: Building the Future of Education. *Journal of Social Science Utilizing Technology,* 1(4), 214-226. https://journal.ypidathu.or.id/index.php/jssut/article/view/660/392

Nasibah, M., Krisdiyanto, D., Artsanti, P. (2022). Preprasi dan Karakteristik Tanah Laterit Menggunakan Aktivator Asam Fluorida. *Integrated Lab Journal*, 10(2), 61-62. https://ejournal.uin-suka.ac.id/pusat/integratedlab/article/view/2957

Nisak, S, K., & Supriyadi, S. (2019). Biochar Sekam Padi Meningkatkan Pertumbuhan dan Hasil Tanaman Kedelai di Tanah Salin. *Jurnal Pertanian Presisi*, Vol 3(2), 168-171. https://doi.org/10.35760/jpp.2019.v3i2.2345

Radiarta, I, N., Erlania, Rusman. (2013). Pengaruh Iklim terhadap Musim Tanam Rumput Laut, Kappaphycus alvarezii di Teluk Gerupuk Kabupaten Lombok Tengah, Nusa Tenggara Barat. *Jurnal Riset Akuakultur,* 8(3), 454-462. http://dx.doi.org/10.15578/jra.8.3.2013.453-464

Sabilu, Y. (2016). Aplikasi Zeolit Meningkatkan Hasil Tanaman pada Tanah Ultisol. *Biowallacea,* 3(2), 396-400. link 2456.

Setiawan, B., Fika, R., Trisna, M., Yanti, N,. (2022). Evaluation of the Rationality of OTC (Over The Counter) Drug Self-Medication and Patients in Pasaman Barat District Pharmacy. *Science Midwifery,* 10(5), 4168–4177. https://midwifery.iocspublisher.org/index.php/midwifery/article/view/1023/880

Solissa, E. M., Hayati, A. A., Rukhmana, T., Muharam, S., Mardikawakti, B., Irmawati,. (2024). Mengembangkan Pendidikan Karakter Berbasis Budaya Menuju Society 5.0. *Journal on Education,* 6(2), 11327-11333. https://jonedu.org/index.php/joe/article/view/4928/3874

Sutono, S., Nurida, N, L,. (2012). Kemampuan Biochar Memegang Air pada Tanah Bertekstur Pasir. *Buana Sains*, 12(1), 45-52. https://download.garuda.kemdikbud.go.id/article.php?article=960724&val=14764&title=KEMAMPUAN%20BIOCHAR%20MEMEGANG%20AIR%20PADA%20TANAH%20BERTEKSTUR%20PASIR

Suwardi. (2009). Teknik Aplikasi Zeolit di Bidang Pertanian sebagai Bahan Pembenah Tanah. *Jurnal Zeolit Indonesia,* 8(1), 1-4. https://media.neliti.com/media/publications/219453-none.pdf

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