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Utilization of zeolite and humic acid in modification of slow-release urea

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Abstract

One effort to reduce nitrogen loss is to make the fertilizer in a form of slow-release. SRF method can be done conventionally based on centrifugal force. Nitrogen release from UZA fertilizers generally decreased during the incubation period. Urea fertilizer in the form of a slow-release combination of zeolite and humic acid is applied to soil media to reduce the rate of nitrate release. In this case, it is necessary to identify the effect of a release ready modifying zeolite and humic acid. Increase in the concentration of humic acid, the nitrogen content in the fertilizer before and after incubation in general decreased.

Keywords: Humic acid; Nitrogen; Slow release; Urea; Zeolite

1. Introduction

Indonesia is not only known as a maritime country but also as an agricultural country because most of the population works as farmers. However, changing times and lifestyles have also led to a decline in agricultural land. The conversion of agricultural land in some areas is caused by residential and industrial land. In Banten Province itself, land conversion from 2018-2019 reached 3,861.09 hectares [1].

The decrease in agricultural land has made farmers begin to switch to using coastal land as agricultural land. Coastal areas are transitional areas in the form of sea and land with a high level of biodiversity such as mangrove forests, coral reefs, seagrass beds The type of soil that is often found in the Anyer area, Serang Banten is regosal soil which has a sufficient composition of phosphorus and potassium nutrients with insufficient nitrogen elements, while the steps that have been taken to overcome the nitrogen deficiency in coastal soils is to use coffee husk compost as a fertilizer and has been shown to improve soil properties [2]. However, during its growth period, it is disturbed by brown ladybugs and grasshoppers, so it is necessary to control the spraying of pesticides with the active ingredient profenofos 1 ml/L [3].

One of the factors so that plants can grow and reproduce optimally is adequate nitrogen in the soil. Nitrogen is the element most needed by plants because it functions for the synthesis of chlorophyll, protein, and amino acids, especially entering the vegetative phase [4]. However, nitrogen that has been *released* in the soil is very easy to lose with its hygroscopic nature. Nitrogen deficiency can cause plants to grow abnormally such as slow and stunted. With the need for nitrogen in plants, one of the efforts made is to add fertilizer. Urea fertilizer is a fertilizer that contains only one type of macro element, namely nitrogen.

The composition of urea fertilizer generally consists of 46% nitrogen and 54% as a carrier. With this composition, urea fertilizer has the highest nitrogen composition compared to other types of nitrogen fertilizers. The biggest problem with

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urea fertilizer which is very hygroscopic, urea can attract moisture from the air and has a humidity of 73% so it is easily soluble in water [5]. Nitrogen in urea will be converted to ammonium ($NH4^+$) in the hydrolysis process with the help of the enzyme urease. When applied to the soil, the hydrolysis process will take place quickly and turn into ammonia vapor. Nitrogen in urea fertilizer which enters in the form of nitrate is a source of water pollution. In the water, the nitrate concentration is quite large, so the growth of microbes, plankton, algae, water hyacinth is inhibited due to the process of enrichment of water by nitrate. In reducing the loss of nitrogen elements, conventional modification is carried out into urea fertilizer with *a* slow-release so that it can slow down the process of hydrolysis of nitrogen in the soil both physically and chemically.

Inorganic nitrogen in the form of nitrate, nitrite, and ammonia that contaminate waters is a source of water pollutants; this can be overcome by efforts to slow the release of urea fertilizer to reduce pollution to the environment. Nitrification has an effect on the environmental ecosystem of nitrate pollution in groundwater by oxidation of NH_4^+ which is converted to NO_3^- which dissolves and causes nitrate pollution in groundwater. With high nitrate in water, it affects biological aspects such as the growth of microbes, algae, plankton, water hyacinth, and other aquatic plants as a result of the process of enrichment of water by nitrate [6].

Slow release urea fertilizer is a urea fertilizer that works from the release of nutrients according to the absorption pattern of plant nutrients on a regular basis. The effect creates barriers with molecular interactions so that the nutrients in the granules of the zeolite are released slowly in the soil medium. The slow release can optimize the absorption and release of nitrogen levels with the specified time and amount required by plants, and can maintain nitrogen in the soil and the amount of fertilizer applied is minimum compared to conventional methods.

2. Material and methods

2.1. Materials

Urea fertelizer was used for nutrient provider was from PT. PUPUK Sriwidjaja, Bayah natural zeolite as an adsorbent, binder, and cation exchanger, Humic acid from Sigma-Aldrich was used for bonding between urea and zeolite in modification, HCl from Merck used for reduce, and remove metal oxides on the surface of the zeolite so that the surface of the contact area is larger and more porous.

2.2. Preparation of slow release urea

Preparation of zeolite samples made of powder by a filtering process until it reaches a size of 80 mesh after chemical activation using acid. For taking soil, it was taken at a depth of 0-20 cm and then ground, sieved, and filtered until the size reached 2 mm. The activated zeolite is then mixed with starch as a fertilizer adhesive while referring to the research conducted by Ciampea (6) by modifying the mixing of urea, zeolite, and humic acid. Urea and zeolite were mixed in a ratio (70:30) and variations in the concentration of humic acid were given with concentrations (1% v/v, 3% v/v, 5% v/v, and 7% v/v).

2.3. Analysis and Characteristics of Urea Release Products

The modified release method of slow-release urea which was applied to coastal soil media, namely Tanjung Tum Beach with an incubation time of 1 week which was tested for nitrogen content using Kjeldahl analysis, obtained nitrogen content by the Kjeldahl method. Characterization of Urea Pellets Using Scanning Electron Microscopy (SEM). Urea pellets were analyzed for morphology using SEM with 300x, 500x, and 2000x magnification.

3. Results and discussion

3.1. Modification of Slow Release Urea

Urea and zeolite were prepared in the form of powder (powder) with a size of 80 mesh. Urea, zeolite was mixed and added with variations in the concentration of humic acid given at concentrations (1%, 3%, 5%, and 7%) then stirred until homogeneous. The material is mixed homogeneously. After that, Slow-release Fertilizer was made using the Urea method and the zeolite was prepared in the form of a powder (powder) with a size of 80 mesh. Urea, zeolite was mixed and added with variations in the concentration of humic acid given at concentrations (1%, 3%, 5%, and 7%) then stirred until homogeneous. The material is mixed homogeneously. After that Slow-release Fertilizer was made by the conventional method using the tray and based on centrifugal force. Here are some photos of the modified slow release which have been enlarged using a microscope, the results show that the product is fused with the appropriate adhesive and does not separate and is slightly white in color from the uneven mixing of zeolite only in small spots on the product.

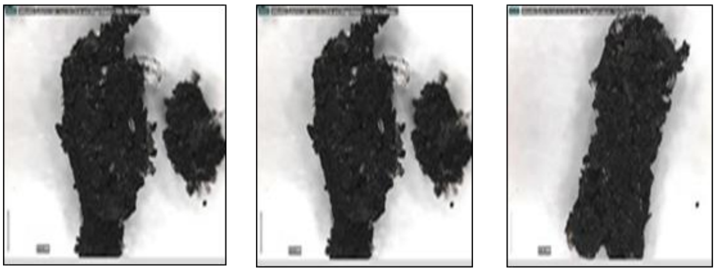


Figure 1 Slow-Release Urea Modified Products

3.2. Nitrogen analysis

Analysis of nitrogen released from slow-release urea fertilizer using the Kjeldahl method resulted as shown in Table 1. Changes in concentration showed different nitrogen concentrations. In this study, nitrogen analysis of slow release urea fertilizer was carried out in the release test before and after incubation in sandy soil. Slow release fertilizer after being tested for release in the soil for 7 days showed a decrease in nitrogen content in slow release fertilizer.

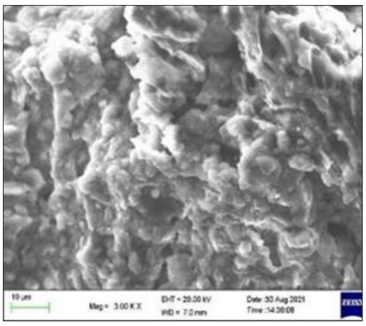
Table 2 Nitrogen concentration in slow release urea fertilizer before and after incubation in sandy soil

Humic Acid Variation	Before Incubation in Coastal Soil Media	After Incubation in Coastal Soil Media
1%	33.23%	0.422%
3%	42.43%	0.512%
5%	39.81%	0.493%
7%	36.81%	0.432 %

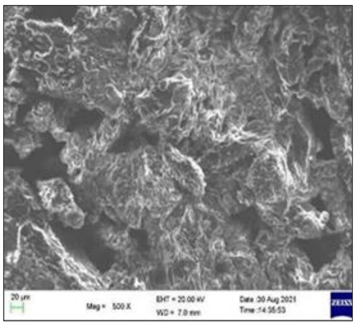
Table 1 also shows an increase in the concentration of humic acid, the nitrogen content in the fertilizer before and after incubation in general decreased. This indicates that the concentration of humic acid is able to bind the Bayah natural zaolite mixture more strongly so that the urea released is lower. Erosion in slow-release fertilizers was slower with high humic acid concentrations than with low humic acid.

3.3. Morphological Analysis of Modified Slow-Release Urea

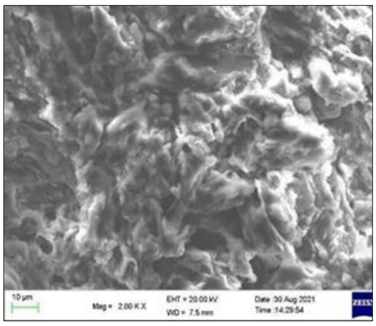
Particles *Electron* Microscopy Scanning (SEM) analysis aims to see the surface of the modified *slow-release* urea with a concentration of 3% humic acid of the total weight with various magnification variations where the results are shown in Figure 3.



a. Magnification 300x



b. Magnification 500x



c. Magnification 2000x

Figure 3 SEM analysis with magnification of 300x, 500x, and 2000x

Modified urea with a magnification of 300X, 500X, and 2000X magnification particles tend to be well dispersed and not agglomerated. Thus, the uniformity of the mixture of the modified *slow-release* urea with zeolite, and humic acid. Zeolite as the absorbent is evenly distributed into the humic acid matrix and can fill the pores in the urea with a coating of starch.

3.4. XRD Analysis of Modified *Slow-Release* Urea

X-ray diffraction data from modified *slow-release* urea using zeolite, humic acid, and starch. It can be seen from the results of this x-ray diffraction test (angle (2θ): 18-90), urea which is shown in blue is very dominant. Another quite dominant phase besides urea is natural zeolite which is red in color on the XRD measurement chart at an angle (2θ) between (18.7506-35.4888).

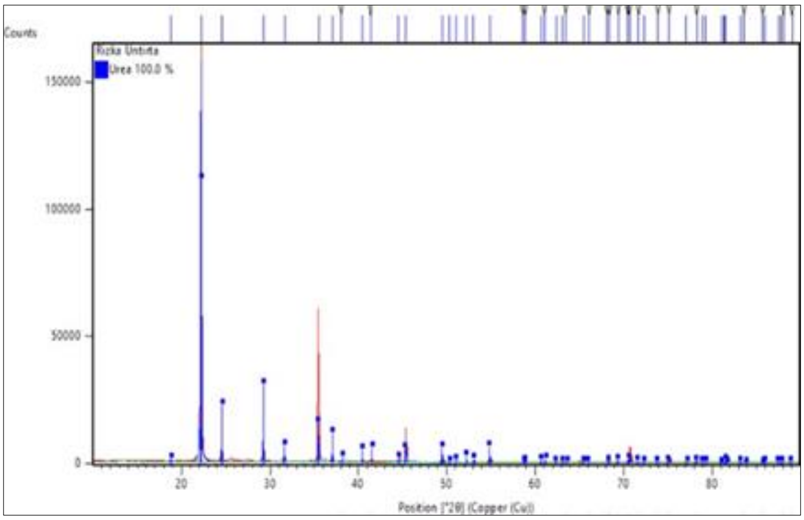


Figure 4 X-ray Graph XRD Test

Meanwhile, zeolite with red color is very dominant and even higher than urea in the position range (37.0408-38.0630): (44.5254-45.36907): and (70.4195-70.6973). For other elements, such as humic acid with a concentration of 3% and cassava starch, it becomes a micro-component and has a wave peak that is almost the same as the results of the diffraction test. From the XRD test of the modification of urea and zeolite with a comparative composition (70:30), the dominant position of the zeolite was only spread in three places with a very small range value, indicating that the modification was successfully mixed evenly with appropriate starch gluing.

3.5. FTIR Analysis of Slow-release Urea

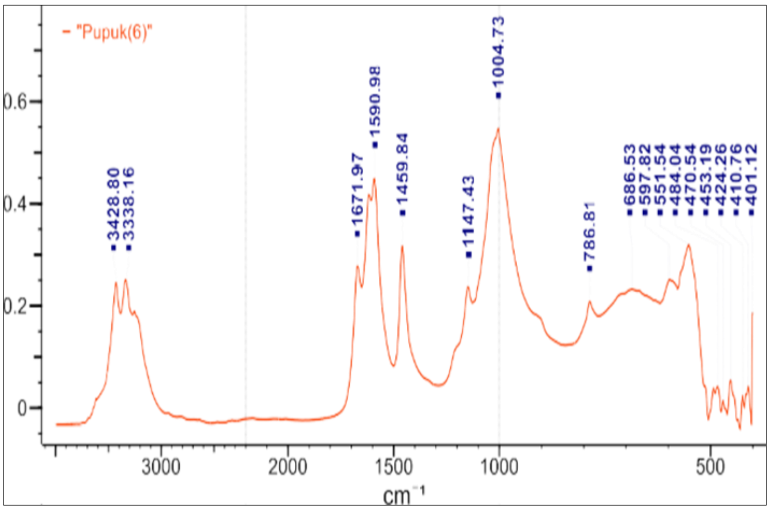


Figure 5 FTIR Spectrum for Urea

FTIR spectroscopic analysis is useful to determine the structural characteristics of chemical compounds and functional groups in the modification of urea.

The results of the FTIR analysis of the modifications are shown in Figure 4.3. shows that the FTIR analysis of urea modification is at peak 3428.8; 1591.0 cm-1 for the NH group and 3338.2 peaks; 1672.0; 1459.8; 11476.4; 1004.7cm-1 for the –OH group. The presence of these groups proves the presence of urea and nitrogen groups in the modification of urea using zeolite and humic acid.

4. Conclusion

In this study, the slow-release urea modification used urea, zeolite, and humic acid methods. Differences in the concentration of humic acid affect the effectiveness in releasing urea. In this study, the nitrogen conditions at the time of release with variations in humic acid 1%, 3%, 5%, and 7% respectively were 0.422%, 0.512%, 0.493%, and 0.432%. Meanwhile, the highest nitrogen condition was at 3% concentration with one-week incubation, which was 0.512% concerning the SNI nitrogen content of at least 0.4%. This shows that the mixed formula of urea, zeolite and humic acid using the SRF method can bind or hold ammonium so that it can slow down the process of changing nitrate slowly, which is why this research is feasible and can be applied to sandy soil.

Compliance with ethical standards

Acknowledgments

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Disclosure of conflict of interest

The authors declare that there is no conflict of interest.

We authorize the full disclosure of the manuscript text and data.

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