Utilization of Compost and Zeolite as Ameliorant on Quartz Sand Planting Media for Caisim (Brassica Juncea) Plant Growth

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Abstract. This study aims to determine the effect of zeolite, compost and its combination on some of the chemical properties of soil sand and the growth of caisim plants. The experiment used Completely Randomized Design (CRD) with 12 treatments and 3 replications, where the treatment consisted of various level of zeolite (Z0 = without treatment (control), Z1=1.25 gr polybag\(^{-1}\), Z2=2.50 gr polybag\(^{-1}\), Z3=3.75 gr polybag\(^{-1}\), various level of compost (K0=0 gr polybag\(^{-1}\), K1=10 gr polybag\(^{-1}\), K2=20 gr polybag\(^{-1}\), K3=30 gr polybag\(^{-1}\), and a combination of zeolite and compost level (ZK0=0 gr polybag\(^{-1}\), ZK1=1.25 gr zeolite+10 gr compost polybag\(^{-1}\), ZK2=2.50 gr zeolite+20 gr compost polybag\(^{-1}\), ZK3=3.75 gr zeolite+30 gr compost polybag\(^{-1}\)). Observation parameters consist of plant height and number of leaves, as well as chemical analysis parameters of planting media consisting of pH, CEC, organic C, and P-available. The results showed that the use of ameliorant material in the form of zeolite, compost and a combination of compost and zeolite could improve the chemical properties of the planting medium in the form of quartz sand, and affect the growth of caisim.

1. Introduction
The country of Indonesia is an agrarian country with the majority of its population earning a living as farmers. The community's perspective on agriculture has turned into an industry because of the progress of science and technology so that agricultural land becomes narrow. The increasing population also influences the condition of the community itself. The increase in population which was not followed by the expansion of the area resulted in many agricultural areas being converted into residential areas. To overcome the increasingly narrowing of agricultural land and increasing food needs, a solution is needed to overcome these problems.

Coastal sand can’t be used optimally by the people around the coast for agricultural activities, because so far the beach and is considered unfit as a planting medium and has limitations and its management is more difficult than dry land or paddy fields. The nature of porous sand and has a very low water holding capacity is one of the obstacles to the use of soils with high sand content. In addition, and also tends to have a low cation exchange capacity, so that nutrients present in sandy soils are lost and washed faster. Because it has large pores (macropores), the sand becomes easily wet and dries quickly by the evaporation process. Cohesion and consistency (resistance to separation processes) of sand is so small that it is easily eroded by water or wind. Thus, the sand media requires more intensive irrigation and fertilization. This causes sand to be rarely used as a single planting medium.

Problems in the utilization of materials that are expected to be able to improve soil properties (soil ameliorant) and increase the production of a plant are the selection of species and the determination of...
the right amount of material. The provision of soil ameliorant is carried out by selecting sources of material that are relatively easy to obtain, for example, zeolite and compost. Compost is an organic compound that has undergone a decomposition process of microorganisms so that it changes the C/N ratio which approaches the C/N ratio of the soil. Compost does not only contain nutrients but also contains organic compounds that are useful for improving soil structure, especially in tropical soil conditions [1, 2]. Compost can also increase the capacity to store good water from the soil. While zeolite, in addition to improving soil chemical properties, can also increase soil aggregation so that the soil becomes stable.

A zeolite is a group of compounds of various types of mineral alumino silicate hydrated with cations which are mainly alkaline and alkaline earth. Zeolites have functions such as returning soil nutrients that are lost, storing and binding elements that are needed for both macro and micronutrients so that they remain available, soothe the soil, because zeolite has large pores so that the circulation of oxygen is good for plant roots, saving usage fertilizer (not wasted), because it is bound by zeolite, absorbs heavy metals [3] and elements that interfere with plant growth. This is supported by [4–7], that giving zeolite to the soil can increase nutrient content in the soil.

The plants used as indicators in seeing the effect of compost combination with zeolite on sand are Caisim plants. Caisim (Brassica juncea) is a vegetable plant with a sub-tropical climate but is able to adapt well to tropical climates. Caisim is generally planted in lowland areas, but can also be in high altitudes. Caisim is classified as a plant that is tolerant of high temperatures (heat). At present, the need for caisim is increasingly increasing along with the increase in human population and the benefits of consuming for health. [8] stated that Caisim had a high economic value after crop cabbage, flower, cabbage and broccoli.

Thus, it is necessary to use Zeolite and Compost in improving soil properties, because it is known that some Zeolite and compost properties are as a negative charge enhancer, high water absorption, high CEC, and high surface area. Besides that, it can add some nutrients, so that it is expected to improve the efficiency of the use of water sources, it can also improve the quality and quality of results while reducing soil and environmental pollution. Zeolite and Compost can also stabilize aggregate so that it can increase the water holding capacity by the soil. In addition to seeing the combination of compost and zeolite, a comparison of the growth of the use of each type of amelioration is also carried out, which is the result of zeolite growth and compost.

In view of the foregoing, the purpose of this study was to determine the effect of zeolite, compost and its combination of several chemical properties of sandy soil and caisim plant growth. So that it is expected that in the future farming techniques in coastal sand can be processed into the productive agricultural land.

2. Research Method

The experiment used Completely Randomized Design (CRD) with 12 treatments and 3 replications, where treatment consisted of various level of zeolite (Z0=without treatment (control), Z1=1.25 gr polybag$^{-1}$, Z2=2.50 gr polybag$^{-1}$, Z3=3.75 gr polybag$^{-1}$), level of compost (K0=0 gr polybag$^{-1}$, K1=10 gr polybag$^{-1}$, K2=20 gr polybag$^{-1}$, K3=30 gr polybag$^{-1}$), and a combination of zeolite and compost level (ZK0 = 0 gr polybag$^{-1}$, ZK1=1.25 gr of zeolite+10 gr of compost polybag$^{-1}$, ZK2=2.50 gr zeolite+20 gr of compost polybag$^{-1}$, ZK3=3.75 gr of zeolite+30 gr of compost polybag$^{-1}$). To determine the effect of each gift, observations of plants and soil were carried out. The parameters observed in plants were planted height and number of leaves carried out at weeks 0, 1, 2, 3, and 4 after planting (seed age 2 weeks). While the parameters observed in the planting medium are pH, CEC, organic-C, and available-P which is done after the crop is harvested.

The research implementation phase consisted of planting media preparation, where the quartz sand used was cleaned and sieved first, then the sand was put into polybags as much as 2 kg and mixed with ameliorant material according to the dosage in each treatment. Then the stages of nursery and caisim planting. Nurseries are carried out on plastic tubs with soil + compost growing media. Seedlings are moved at the age of two weeks or when the seedlings have 4 leaves. Each polybag is planted with 2 plants and 1 plant is maintained until harvest. The maintenance stage includes daily watering, fertilization, pest control, and plant diseases and refining. Harvesting stage is done when the plant is 45
weeks after planting by carefully pulling it out so that the roots of the plant do not break. The roots of the plant are washed with water to clean the remaining soil that is still attached. Then the plant weighed the wet biomass of the roots and leaves. Then dried in an oven at 60 oC for 24 hours or until the weight stabilizes. After drying the sample is weighed to find out the dry weight of the plant. Furthermore, the preparation phase of soil analysis, where the planting medium in the form of quartz sand in composite per treatment, was taken as much as + 500 grams and dried air winds. After drying the soil is crushed and sieved using a 0.5 mm and 2 mm sieve. Soil passed 2 mm sieve is used to determine water content and pH, while those that pass the 0.5 mm filter are used for the determination of organic-C, soil CEC, and P analysis.

Statistical analysis of the data was done using Analysis of Variance (ANOVA) at (α =) 0.05 level of significance, and when a significant difference between treatments was observed, further statistical verification was carried out with Duncan Multiple Range Test (DMRT), also at α = 0.05 level.

3. Result and discussion

3.1. Caisim plant height (Brassica juncea)

The effect of addition ameliorant material on the growth of caisim plants (Brassica juncea) can be seen in Figure 1.

Figure 1. Shows that the growth of caisim plant height began to look significant since the 1st week and continued to increase until the 4th week, where among all treatments given ZK 3 treatment showed higher significant growth compared to other treatments. Based on the results of research using zeolite, the growth of caisim plants is optimal. The growth of this plant is influenced by various factors, including the physical and chemical properties of the media and the environmental conditions. The properties of plant growing media in the form of sand are also known in addition to the difficulty of maintaining water, sand also has sufficient absorption of heat from the above results does not affect plant height. With the high absorption of heat will indirectly affect the growth of plant roots, because watering is carried out every day on a regular basis.

The plants treated with compost showed that the administration of compost with different doses did not significantly affect the height of caisim plants from the results of statistical tests, but in plant height parameters there was a tendency for higher doses of compost to be given, higher plant growth. The highest plant height is found in compost with a level of 30 gr polybag\(^{-1}\) (30.00 cm). Visually the plants in the field show that giving compost with a lower level, the plant has a longer stem (petiole) with a small stem diameter. Whereas with plants that are given a higher dose of compost that has a shorter stem (petiole) with a larger diameter.

While the combination of compost and zeolite treatment, in general, does not significantly affect plant height at week 0 and 1, it is suspected that in these weeks the nutrient needs are still not much needed by plants so that it is still sufficient from the inventory in the soil. In the third week, the treatment
effect began to appear, namely by showing the height of the plants from all treatments had a real influence. In those weeks the need for nutrients is increasing so that it is no longer able to be filled with nutrients from the soil. But at the third and fourth weeks, the combination of compost and zeolite treatment again gave an effect that was not statistically significant. However, when viewed from the number trend that appears, the treatment of ZK 0 (treatment without the combination of compost and zeolite) from week to week shows the difference in the increase in plant height which is relatively small when compared to other treatments given combination treatment of compost and zeolite with various level. Of the three combination treatments (ZK1, ZK 2, and ZK 3), the highest plant growth rate was ZK 3 with a plant height of about 31.33 cm. Based on these results, the higher the treatment dose given into the soil will increase the amount of plant height.

3.2. Number of leaves of caisim plants (Brassica juncea)

The effect of giving ameliorant material to the number of leaves of caisim plants (Brassica juncea) can be seen in Figure 2.

![Figure 2](image)

**Figure 2** The average growth of the number of leaves of caisim plants (strands) every week

Figure 2 shows that the number of leaves of the caisim plant began to appear significant since the 1st week and continued to increase until the 4th week. Of all treatments given, the treatment that showed the most significant results was in ZK treatment 3. The increase in the number of leaves was closely related to the height of the plant. The number of leaves shown in zeolite treatment showed that although each week increased but statistically the number of leaves was not affected by zeolite administration, this was allegedly due to the low dose of zeolite and the quality and type of zeolite used because each type of zeolite was mainly zeolite. nature has different physical and chemical properties [9].

Although the results of statistical analysis generally show that treatment is not significantly different from plant height, the combination of compost and zeolite treatment has an effect on increasing the number of leaves. This shows that with almost the same plant height there are different numbers of leaves because there are international differences in the caisim stem. A short internode allows for more leaves. Analysis of variance showed that the combination of compost and zeolite treatment had a significant effect on increasing the number of caisim leaves in weeks one, three and four after planting and had no significant effect on week 0 and week 2 after planting.

3.3. Chemical properties of quartz sand planting media

The results of the analysis of soil chemical properties in zeolite treatment, compost, and the combination of compost and zeolite are presented in Table 1 below. From the results of pH H₂O analysis with zeolite treatment, it can be seen that the treatment of zeolite ameliorant administration can increase the pH, where the increase which tends to be higher occurs in the treatment of zeolite application with higher doses even though not significantly. The same thing happened in the treatment of a zeolite combination with compost. The use of zeolite can increase soil pH, total N content, available P₂O₅, CEC,
the number of cations that can be exchanged and alkaline saturation, as well as reducing $\text{Al}^{3+}$ levels can be exchanged. With the nature of the zeolite which can exchange cations, it is possible to also absorb $\text{H}^+$ ions which are a source of acidity so that the pH tends to increase [10].

Table 1 Results of Analysis of Soil Sand Media from Different Types Treatment of combination of compost and zeolite.

| Treatment | pH$_{\text{H2O}}$ | CEC (me 100 gr$^{-1}$) | Organic-C (%) | Available-P (ppm) |
|-----------|------------------|------------------------|----------------|------------------|
| Z0        | 5.57             | 3.6                    | 0.12           | 119              |
| Z1        | 6.03             | 4.8                    | 0.33           | 160              |
| Z2        | 6.11             | 5.4                    | 0.32           | 142              |
| Z3        | 5.92             | 5.7                    | 0.32           | 140              |
| K0        | 5.01             | 2.1                    | 0.19           | 0.19             |
| K1        | 5.05             | 2.5                    | 0.24           | 0.24             |
| K2        | 5.74             | 4.2                    | 0.45           | 0.45             |
| K3        | 5.96             | 6.7                    | 0.68           | 0.68             |
| ZK0       | 5.58             | 3.3                    | 0.16           | 178              |
| ZK1       | 6.40             | 3.7                    | 0.27           | 182              |
| ZK2       | 6.20             | 3.6                    | 0.51           | 204              |
| ZK3       | 6.70             | 4.3                    | 0.69           | 140              |

Administration of zeolite was known to increase CEC because the content of K, Ca and Mg in the previously absorbed media becomes available. This is in accordance with [11], that the zeolite application can increase soil CEC along with the increase in zeolite dose. The increase in the content of K, Ca and Mg in the growing medium is thought to be proportional to the increase in zeolite given. The content of K, Ca, and Mg of growing media is higher with the higher doses of zeolite given. Zeolites can increase soil CEC, in line with what was stated by [12] that organic matter plays a role in increasing CEC and soil KB. According to [13], ameliorant material has been shown to increase acid soil fertility by increasing soil properties such as pH, CEC and water holding capacity.

Based on the results of organic-C analysis and available-P zeolite treatment, it can be seen that the treatment of zeolite ameliorant administration tends to increase. This is also in accordance with [14] that the addition of ameliorant material is significant to increasing available-P in the soil. Increased organic-C content can be obtained from organic matter in the form of compost added during nursery and also the occurrence of root decomposition resulting in increased organic-C. Humic materials play an active role in fixation and release of organic-C. The higher addition of humic material from compost is thought to contribute more organic matter, and the amount of organic matter was shown by the percentage of organic carbon content [15]. In addition, applications with the addition of compost to accelerate biological activity and increase the biomass of microbiology of larger soils simultaneously open the way to increase the organic-C content [16, 17]. Whereas the available-P as stated above that zeolite is able to increase CEC so that the assumed Ca-P can be released and P can be available to plants and the impact of this will increase P even though it is not significant.

The effect of compost application, in general, does not show a significant effect on soil chemical properties. But the pattern shows that giving a higher level of compost (K3) at a dose of 30 gr polybag$^{-1}$ tends to increase pH, although the increase is not significant. Whereas according to [12] organic matter plays a role in buffering soil pH. In addition, organic matter can also contribute functional groups such as carboxyl (COOH-) and phenolic (OH-) groups derived from organic matter humus. From the functional group indirectly with the presence of OH ions, the pH will increase while pH decreases when there are more H$^+$ ions.
The effect of compost and zeolite application (Table 1) generally does not show a significant effect on soil chemical properties. But the pattern shows that giving higher doses of compost (ZK 3) with zeolite combined tends to increase soil pH, organic-C and P [18], although the increase is not significant. While the combination of compost and zeolite treatment has no effect on land CEC. This is presumably because when the addition of zeolite and compost there is cation saturation donated from compost to zeolite, where the cations from organic matter (compost) have filled the zeolite, so that when the CEC measurement/analysis becomes low.

4. Conclusion
Based on the results of research that has been done, it can be concluded that: (1) The use of ameliorant material in the form of zeolite, compost and a combination of compost and zeolite can improve the properties of sand soil such as pH, organic-C, available-P and CEC, where the combination of compost and zeolite treatment as ameliorant material can improve soil chemical properties of sand with an increase in soil pH, organic-C, and P even though the increase was not significant, while there was no significant effect on land CEC; (2) Treatment with zeolite, compost and a combination of compost and zeolite affect the growth of caisim plants. Where treatment using zeolite, compost and compost and zeolite interactions tend to give better results in the treatment with the highest dose, with the consecutive level of Z3=3.75 gr polybag−1, K3 = 30 gr polybag−1 and ZK3=30 gr compost+3.75 gr zeolite polybag−1)

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