Effect of zeolite particle size and levels of phosphate concentration in phosphate absorption and growth of *Sorghum bicolor* (L.) Moench

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Abstract. Medium particle size plays an important role in plant growth and absorption of nutrients. Pore types affect root development and infiltration. In addition, zeolite can increase the efficiency of nutrient use by increasing the availability of phosphate rock and exchange cation without structural changes. The experimental to determine the optimal particle size of zeolite in absorbing phosphate with design a complete random block. Media composition consists of coarse zeolite (ZK) and fine zeolite (ZH) with ratio of 50% ZK + 50% ZH (A1), 25% ZK + 75% ZH (A2) and 75% ZK + 25% ZH (A3). ZK and ZH distribution by mixing it in the tray. The result show that the percentage of survival is A3 which has 78%, A2 and A1 having 33%. Respectively, medium 75% ZK + 25% ZH (A3) was tested for phosphate absorption test, using 5 different levels namely 0 mM phosphate levels (A31), 0.3 mM (A32), 1 mM (A33), 3 mM (A34), and 10 mM (A35). Experimental results that addition of 10 mM phosphate (A35) increased plant length by 51.35%, leaf width 42.50%, wet and dry weight by 156.52% and 195.54%, weight wet root 53.46% and phosphate content 195.58%. It can be concluded that A3 support the phosphate absorption to sorghum growth.

1. Introduction

Planting media helps plant growth because it provides nutrients for plants that grow on it. The right planting media can increase plant growth. Sorghum (*Sorghum bicolor* L. Moech) usually grows in dry tropical regions. Studies issued by Netondo et al. [1] showed that sorghum plants were relatively very tolerant of drought. Zeolite can be used as a medium for planting models for sorghum because it has a stable structure and is not easily changed due to air collisions during watering [2]. Zeolites have various particle sizes with the pores formed in the media. Media consisting of large particles can not withstand air (fast infiltration). Plants cannot hold water out of water and easily wither. Media with large size allows movement in absorbing air and air. Whereas small media can accommodate better air by providing plant water needs [3].

The finer particles of the media feed will increase the capacity of exchange (CEC). The importance of cationic absorption capability in soils by zeolites which can increase plant nutrient uptake and cations in zeolite cavities are not tightly bound in zeolite crystalline frameworks [4]. Zeolites are able to increase cation exchange capacity, among others, the length of phosphate (P) [5]. The element P is very necessary for young plants. The element P is needed by young plants, especially in the formation of meristematic tissue [6]. Absorption of P and air can also be increased by the addition of Arbuscular Mycorrhiza Fungi (AMF) which can increase stiffness [7]. Therefore, it is necessary to test the...
composition of coarse and fine zeolite media with the addition of mycorrhizae to increase P uptake and sorghum growth.

2. Methods and Materials
Experiments were carried out in July 2018 at the Laboratory of Microbiology, Indonesian Center for Biology and Sciences, Indonesia Institute of Sciences (LIPI). Experiments using a completely randomized design (CRD) with 3 replication. The media used is coarse zeolite (ZK) and fine zeolite (ZH) of 235 grams. Composite first it is inserted into the tray with a media composition combination of 50% ZK + 50% ZH (A11), 25% ZK + 75% ZH (A21) and 75% ZK + 25% ZH (A31). Planting by punching holes in the middle of the media as deep as 3 cm then placed 3 seeds and closed again. Phosphate fertilization treatment derived from KH2PO4 was given through fertigation at 1 week after planting (WAP) with a concentration gradient of 0 mM (A31), 0.3 mM (A32), 1 mM (A33), 3 mM (A34), and 10 mM (A35). In addition, fertilizer is also urea to support plant growth of 5 grams per liter. Observations lasted for 5 MST included percentage of growth, length of plant, number of leaves, width of leaf weight of stover and root weight. Laboratory tests carried out were phosphate levels in plant roots using spectrophotometers and mycorrhizal infections using aniline blue.

3. Results and Discussion
3.1. Percentage grow of sorghum
Results show the combination of zeolite particles is very important to a growing percentage of sorghum. The combination zeolite particle size of 75% and 25% (A31) up to 5 weeks after transplanting (WAP) gave a yield of 78%, different growth not significant to A11 and A21. This proves the media with a combination of zeolite particle size in (Table 1) can still provide a good contribution, but A3 media can better support growth without the need for more maintenance. Whereas media A1 and A2 up to week 5 MST have a percentage of 33%. This shows that the composition of the media is less suitable with sorghum, even though there is still sorghum which is able to grow and optimize on A1 and A2 media. The requirements for planting media include sterile, mild porous, easy to obtain and cheap. Sorghum has a spreading root system and is more tolerant than other cereal plants that are planted in shallow hard layers. Zeolites are highly porous minerals with Ph 6.2 [8]. According to Aidha [9] and Rahman and Hartono [10], sorghum is tolerant of water shortages that have the opportunity to be developed on land that is drought in the dry season.

| Treatment of | 1 WAP | 2 WAP | 3 WAP | 4 WAP | 5 WAP |
|--------------|-------|-------|-------|-------|-------|
| A11          | 33    | 33    | 33    | 33    | 33    |
| A21          | 33    | 33    | 33    | 33    | 33    |
| A31          | 78    | 78    | 78    | 78    | 78    |

Notes: WAP = week after planting, A11 = 50% Coarse Zeolite + 50% Fine Zeolite, A21 = 25% Coarse Zeolite + 75% Fine Zeolite, A31= 75% Coarse Zeolite + 25% Zeolite Fine.

Data in (Table 1) weeks 1, 2, 3, 4 and 5 have the same percentage. This shows that zeolites are able to maintain the consistency and stability of the zeolite structure. The zeolite crystal structure remains stable even though it is heated to 650 °C, stable under alkaline conditions up to pH 10, and stable in acidic conditions to pH 3.0 [8]. In addition, the use of zeolite media in sorghum with a combination of particle size can produce macro and micro which is more likely to develop and streamline nutrients and air [6].
3.2. Phosphate absorption
Zeolite media can increase P uptake and plant growth because zeolites are able to increase P available. Phosphate uptake produced by A35 treatment with an increase of 195.58%, an increase in A34 increased by 4, 76% and maintenance of A33 increased by 20.93% compared to controls. While the A32 pH treatment is no more than control (Figure 1).

![Figure 1. The result of content phosphate 5 weeks after planting of sorghum](image)

Zeolite mechanism can increase P because Ca in binding P zeolite in soil bound by dawn by Fe and Al. Ca in zeolites is easily released in a casiable form that is interchangeable, so P bound Ca becomes available [11]. The zeolite pores have a very large total area, one gram of zeolite surface area of the pores is equivalent to 40 square meters. These pores cause zeolites to have the ability to absorb molecules [8]. The shape and size of the zeolite pore controls the molecules that can pass through it. Several types of molecules can pass through the zeolite pores, other molecules will be trapped in the pores, and larger molecules will be inhibited. The addition of zeolites to the soil increases the size of cation exchange capacity, which comes from fertilizers which are adsorbed by negatively charged particles can reduce leaching loss [12]. Zeolites are able to streamline nutrition by increasing the Company, reducing loss of cation exchange capacity. Zeolites are able to make controlled-release fertilizers and non-micro release [13][14][15].

3.3. Variable of plant growth
Experimental continued by adding phosphate gradient using A31 media which had the best performance. Provision of phosphate is very real to the length of the plant (see Figure 2). At 3 MST the heating of A35 increased by 40.64% of the control (A31). The length of A35 massage sorghum at 4 MST increased by 45.06% differing very significantly from the treatment of A31, A32 and A33. Whereas the treatment of phosphate A35 at 5 MST increased by 51.35% from the control (A31), the results were different from all treatments as in Table 3. This shows that in addition to the A35 treatment that can be used for old work 75% Coarse Zeolite + 25% Fine Zeolite. The greater the age of phosphate plants absorbed the greater. P that is in the soil that can be absorbed by plants is characterized by the volume and size of plants, with high measurements with length plants. Phosphorus greatly affects the growth and development of plants in the young phase, phosphorus is abundant in cells in the form of nucleotide units, nucleotides as constituents of RNA and DNA used in plant cell development [16]. This proves that zeolite media helps to efficiently provide phosphate fertilizer.
Increased plant growth is also seen from the width of sorghum leaves. Phosphate administration in A35 treatment on sorghum leaf width with an increase of 42.50% of the control (Figure 3). Whereas treatments A34, A33, A32 and cannot be used. Planting media as a place to grow plant roots. The particle size on A3 media has a variety of macro and micro that can be used well. After being absorbed by the roots, phosphate is distributed to all parts of the leaf-specific plant. Leaves are the main organ where photosynthesis takes place. Therefore the highest leaf width allows more even distribution of light between leaves. Light distribution that is interconnected between mutual shelter between leaves [17]. The more packages will produce more better, and more optimal absorption. Appropriate functions in supporting the process and producing optimal results also increase plant growth through inorganic changes into organic compounds [18].
concentration given which produces high and the amount of plant leaves. Even affects the weight of sorghum biomass.

![Figure 4](image.png)

**Figure 4.** Average of weight of biomass and root sorghum during 5 weeks after planting (WAP) contains 5 treatment

According to [19] states that if there is no soil in the soil increases the amount that can be absorbed by plants will also increase, the formation of plant tissues. Increased levels of P in combination shows that zeolite can increase the P uptake value of plants and sorghum plant growth in each zeolite treatment.

### 4. Conclusion

Based on experimental data for 5 week after planting (WAP), it can be concluded that there is an influence of media size on the percentage of adults grown and optimization of phosphate absorption. The higher phosphate is a given higher level of phosphate in plants. It can be concluded that the media composition of 75% Coarse Zeolite + 25% Zeolite Fine (A31) is able to absorb the optimal P at the maximum phosphate concentration.

### 5. References

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