The application of amendments for growth and nutrient absorption of medicinal plant *Petiveria aleaceae* on entisol soils type

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**Abstract.** COVID-19 encouraged the efforts to find its prevention and treatment. Indonesia possesses myriads of plant diversity, many of which have anti-microbial effects. Singawalang plant (*Petiveria aleaceae*) has been used as an alternative treatment for tuberculosis, malaria, and other diseases in Indonesia and other countries. Active ingredients of Singawalang are flavonoids and various types of amino acids found in the leaves and roots. The purpose of this study was to investigate the role of dolomite, zeolite, and NPK fertilizers in increasing nutrient absorption and Singawalang growth in entisol soils. *P. aleaceae* were planted in polybags using entisol soils medium by using a Completely Randomized Design (CRD). Zeolite, dolomite (2.5 tons/ha), and NPK Fertilizer (15:15:15) at a dose of 0; 1.5; 3; 4.5 g/plant were applied. The results showed that the amendment application had a significant effect on the number of leaves but did not significantly affect other growth parameters and nutrient absorption of NPK. In general, zeolites can increase the growth and absorption of nutrients higher than dolomite.

1. Introduction
Entisol soil is not significantly favorable for plant growth. In general, entisol has a loamy sand texture; its nutrient content and CEC (Cation Exchange Cation) are low, requiring amendment and fertilization [1]. Zeolite and dolomite are soil amendments, proven in several studies to increase plant growth and yield [2]; Zeolite also plays a role in maintaining soil moisture [3]. Dolomite application helps N and P availability in reducing soil acidity [4]. In addition, dolomite also increases CEC [5].

Singawalang (*Petiveria aleaceae*) is a medicinal plant with active ingredients containing flavonoids and several amino acids found in the leaves and roots. The Singawalang has been used as an alternative treatment for tuberculosis, malaria, and other diseases in Indonesia and other countries. Extracted roots and leaves can be used as anti-rheumatic, anti-inflammatory, and also anti-tumor [6]. In addition, Singawalang contains a compound of Dibencyl Tri Sulphide (DTS), which functions as an anti-fungal, insecticide, and insect repellent [7].

The availability and sustainability of raw materials used in medicinal plants on a national or international scale is a major problem. This research aimed to investigate the role of dolomite, zeolite, and NPK fertilizers in increasing nutrient absorption and the growth of Singawalang in entisol soils.
2. Materials and methods
The research was carried out from April to October 2018 in Kenayan Village, Widomartani, Sleman, Yogyakarta. Entisol soils were from Experiment Field, Gadjah Mada University, Banguntapan, Kalitirto, Yogyakarta. The preparation of planting media consisted of manure and entisol with a ratio of 1:2:1 put into a 5 kg polybag. This research was arranged in a Completely Randomized Design (CRD). Treatment was amendments: Dolomite and Zeolite 2.5 t/ha for 3 weeks incubation helped increase the soil acidity to 7.0.

Amendments: Dolomite and Zeolite 2.5 t/ha, respectively.

NPK fertilizer (15:15:15), with a dose of 0; 1.5; 3.0; and 4.5 g/plant. Amendments were applied at the beginning of the study and incubated during 3 weeks.

The observation parameters on plant growth and nutrient (NPK) uptake were carried out in the research area when the plant was just 3 months old. The parameter variables include plant height, number of leaves, leaf area, root volume, root dry weight, nutrient uptake of Nitrogen (N), Phosphorus (P), and Potassium (K).

3. Results and discussion
3.1. Growth component
The nutrients availability in entisol was low. The initial analysis of entisol soils indicated an acidity rate of 6.96; Carbon (C) organic of 0.68%; total Nitrogen (N) of 0.32; Phosphate (P) of 10.5 ppm; Potassium (K) of 9.65 mmg/100 g; CEC 4 me/100 g. The application of Dolomite or Zeolite amendments of 2.5 t/ha for 3 weeks incubation helped increase the soil acidity to 7.37 and 7.3, and CEC 6.4 and 7.7, respectively. However, the value of organic matter and CEC was low.

| Amendment | NPK g/plant | PH (cm) | NL | LA (mm²) | RV (cm³) | DRW (g) |
|-----------|-------------|--------|----|----------|----------|---------|
| Dolomite  |             |        |    |          |          |         |
| P1 (0.0)  | 54.83 a     | 100.33 a | 2742.00 a | 23.67 a | 9.64 a |
| P2 (1.5)  | 72.50 a     | 148.67 ab | 3563.66 a | 35.00 a | 12.78 a |
| P3 (3.0)  | 71.67 a     | 178.00 b  | 3900.42 a | 45.33 a | 16.18 a |
| P4 (4.5)  | 58.83 a     | 130.67 ab | 2247.04 a | 28.00 a | 11.22 a |
| Zeolite   |             |        |    |          |          |         |
| P1 (0.0)  | 62.33 a     | 98.33 b  | 2206.34 a | 27.67 a | 10.48 a |
| P2 (1.5)  | 68.17 a     | 157.00 p | 3059.34 a | 36.33 a | 12.65 a |
| P3 (3.0)  | 56.67 a     | 174.00 p | 3817.24 a | 52.00 a | 17.11 a |
| P4 (4.5)  | 63.17 a     | 182.67 q | 3510.12 a | 44.67 a | 16.58 a |

Notes: PH= Plant height; NL= Number of leaves; LA= Leaf area; RV= Root volume; RDW= Root dry weight. The value with the same notation on each column was not significantly different

The provision of amendments increased the cation exchange capacity; according to [8], the provision of amendments increased the negative charge or soil colloids, which exchanged the cations found within the soil.

Table 1 shows that the provision of amendments with NPK fertilizer had no significant effect on plant height. The dolomite containing Ca and Mg was able to improve soil chemical properties by increasing cation exchange capacity. The provision of porous dolomite was intended for good storage and flow of groundwater. The presence of micro-pores helped encourage the dolomite properties, namely small porosity, to be less conducive to water seepage, corrosion, and erosion [9]. Meanwhile, zeolites have pores which store nutrients to be used by plant roots. Zeolite can increase organic carbon, which functions as plant photosynthesis. However, light intensity, humidity, and environmental temperature also affect plant growth.

The more leaves a plant has, the more sunlight absorption is observed, available for photosynthesis. The statistical analysis results showed that at the age of 10 MST, the NPK dose of 3 g/plant increased the number of leaves significantly different from other NPK treatments. The application of zeolite combined with NPK fertilizer can withstand against any loss of NH₄⁺ and K⁺
elements in the soil because zeolites have pores that bind cations. Plant roots can utilize elements bound to zeolites to boost the rate of plant growth, especially the new leaves formation [10].

The results of the application of amendments and NPK fertilizer did not affect the leaf area. In dolomite, treatment P3 (3.0 g/plant) provided a higher leaf area than other treatments, namely 3,900.42 mm², while the lowest treatment was observed in P4 (4.5 g/plant) 2,247.04 mm². The surplus inorganic fertilizer reduces plant growth, which is indicated by the narrowing leaf area. In the zeolite, treatment P3 (3.0 g/plant) also had the widest leaves, 3,817.24 mm², and the lowest yield was obtained in the plant without NPK, 2,206.34 mm². The addition of fertilizers, especially the N (nitrogen) element, helped increase the production of protein, nucleic acids, and chlorophyll formation; however, the provision of N elements that exceed the needs of plants caused them to collapse easily and inhibit plant growth [11]. By providing NPK fertilizer according to plant needs, increased the soil nutrient availability. Sufficient nutrients boosted photosynthetic stored in plant tissue.

Statistical analysis showed that all treatments were not significantly different in root volume, root fresh and dry weight of Singawalang. Root growth was influenced by the availability of nutrients and soil types in the media, for it could penetrate the roots and increased the absorption range and growth of root hairs. The greater the root volume, the higher the root fresh and dry weight. According to Ginindza [12], NPK administration is useful for plant growth, where nitrogen functions as leaf growth, chlorophyll formation, phosphorus functions as root elongation, fruit, and seed ripening, while potassium as protein synthesis, supporting plant tissue, and root growth. The application of 3.0 g/plant in dolomite and zeolite is an appropriate fertilizer for root growth. According to Allen [13], giving fertilizer that exceeds plant needs can reduce crop production, environmental pollution, and the absence of other nutrients. The highest yield was observed in the zeolite with 3.0 g/plant NPK, and the lowest was in the plant without NPK fertilizer. Application of zeolite to growing media, according to Polat et al. [14], can improve soil structure and reduce root damage because zeolites have cavities that function as air and nutrient entrances and exits. In this study, it is known that zeolite with the addition of 3 g/plant NPK fertilizer can increase nutrient uptake and expand root coverage, presumably because the roots are free to penetrate the soil and the availability of nutrients needed. Additional NPK fertilizer, according to McCaule [11], can increase the availability of nutrients, one of which is to accelerate the formation of root hairs.

3.2. Nutrient uptake

All treatments were not significantly able to increase nutrient uptake. The age of 3 months harvesting was not enough to significantly increase absorption. However, the numbers showed that amendment and fertilizer increased the NPK nutrient uptake except for K absorption because K content availability in entisol soil is very low. Figure 1 shows that, although statistically, the NPK nutrient uptake in all treatments was not significantly different, Zeolite treatment showed a higher response in nutrient uptake except for K absorption, which had a higher dolomite response. Zeolite has
the ability to increase soil CEC; with its porous structure, it ensures soil moisture preservation within the root zone, which helped increase nutrient uptake by the roots and prevent loss of available nutrients [14,15].

4. Conclusion
The results showed that the amendment application had a significant effect on the number of leaves but did not significantly affect other growth parameters and nutrient absorption of NPK. In general, Zeolites can increase nutrients growth and absorption higher than dolomite.

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