Effect of Zeolite size measures and urea fertilizers to growth and yield endive Plant (Cichorium endivia L.)

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Abstract. This research aimed was to determine the growth and yield of endive plant (Cichorium endivia L.) due to the application of zeolite in various sizes and urea fertilizers in various doses. The treatments are zeolite size <0.25 mm, 0.26-0.50 mm, 0.60-5.00 mm; and urea dose 2%, 4%, 6% of total compost. The parameters of responses in this study are growth plant such as plant height (PH), chlorophyll content of leaf (CH), root length (RL); and yield of plant such as wet (WW) and dry weight (DW) of plant, shoot root ratio (SRR). The data analyzed by Anova, through DMRT in 5 %. The results showed that the application of zeolite and urea fertilizer significantly affected the growth and yield of endive plants in parameters observed were plant height and dry weight of plant, with the best zeolite size is 0.26-0.50 mm and 2% urea dose of total compost. Smaller dose of urea (2 %) from compost combine to medium size of zeolite (0.26 – 0.5 mm), result better effect to growth and yield of endive.

1. Introduction
Endive (Cichorium endivia L.) is a leaf vegetable contain high vitamin and nutritional values [1] and need high Nitrogen. Organic fertilizer like compost, contain highly organic matter that can improve physical, chemical and biological traits of soil, but nutritive value of the compost is poor, so to apply it need much of the compost [2]. Organic fertilizer combine to an-organic fertilizer source of Nitrogen is a solution to improve soil fertility and the plant nutritive requirements [3].

Urea is a source of nitrogen, but it easy to water soluble and vaporize to sunlight exposure [4]. Utilization of zeolites in agriculture is possible because of zeolites special cation exchange properties, molecular sieving and desorption [5], [6]. Zeolite is a material to bond nitrogen before mix to organic fertilizer.

Compost is a product that is made through the process of Composting made from gardeners’ and landscapers’ plant trimmings and prunings, also include small amounts of other source-separated biodegradable materials such as manure [7] The organic compost application rates promoted changes in the concentrations of these nutrients in the soil. Compost application promoted higher N and P concentrations in the soil than mineral fertilization did [8].

Previous study showed that ratio of urea and zeolite, influence to nitrogen release [9]. Zeolite size, also influence to plants absorption and binding nitrogen, smallest size better than the larger.
This research aimed was to determine the growth and yield of endive plant (Cichorium endivia L.) due to the application of zeolite in various sizes and urea fertilizers in various dosages. The benefit of this research is reduce urea using without reducing of growth and yield of plant.

2. Methods
The research treatments in this study are three level of zeolite size such as < 0.25 mm (z1), 0.26 – 0.50 mm (z2) and 0.51 – 5.00 mm (z3); and three levels of the urea dosages are 2 % (d1), 4 % (d2) and 6 % (d3) in total compost. The parameters of responses in this study are growth plant such as plant height (PH), chlorophyll content of leaf (CH), root length (RL); and yield of plant such as wet (WW) and dry weight (DW) of plant, shoot root ratio (SRR). The data analyzed by Anova, through DMRT in 5 %.

3. Results and discussion

3.1. Media characteristics
Soil characteristic of media (Table 1) showed that pH is acid while compost is alkali. C/N ratio of compost not different to soil, it indicate the nutrition in the compost can be absorption to the plant [10], [11]. Soil chemical properties of mixture zeolites, manure and NPK fertilizer, pH 6.67; N total 0.17%, P 330.0 mg kg\(^{-1}\), and K 350.0 mg kg\(^{-1}\) [12].

| Chemical Characteristics | Sources         |
|-------------------------|-----------------|
|                         | Soil | Compost |
| pH                      | 4.6  | 8.94    |
| C-organic (%)           | 1.77 | 14.99   |
| N total                 | 0.16 | 1.27    |
| C/N Ratio               | 11   | 12      |

3.2. Growth and yield of endive

3.2.1. Plant height. The effects of treatments on growth responses of endive such as plant height, chlorophyll content and root length showed in Table 2. There are interaction effect of zeolite size and urea dosage to plant height, the treatment d1z2 is better than other treatments. Since zeolite particle size smaller, increase the area of surface [13]. Sunlight exposure increase soil temperature throughout rise the zeolite ability to nitrogen binding; when the nitrogen content in the soil decrease, the nitrogen in zeolite gradually release to the soil.

3.2.2. Chlorophyll content. No different content of chlorophyll between treatments. Plant need Magnesium (Mg\(^{2+}\)) to chlorophyll synthesis [14], laboratory analysis showed that magnesium content in research area is 1.34 me 100 g\(^{-1}\) soil, it is sufficient to complete endive to magnesium. The chlorophyll content in this study higher then reported [1] but less than reported [15]. Chlorophyll are synthesized from glutamate in chloroplasts through the cooperative activity of many enzymes [16] Chlorophyll content affect the photosynthesis rate through the assimilation yield [17].
### Table 2. Mean of growth and yield of endive responses.

| Treatment | Plant Height | Chlorophyll Content | Root Length |
|-----------|--------------|---------------------|-------------|
|           | -- cm --     | mg kg⁻¹              | - cm -      |
| d₁z₁      | 14.04b       | 51.03a              | 21.00a      |
| d₁z₂      | 17.07c       | 53.31a              | 16.83a      |
| d₁z₃      | 15.22b       | 50.93a              | 23.13a      |
| d₂z₁      | 14.75b       | 52.49a              | 21.3a       |
| d₂z₂      | 13.30ab      | 51.99a              | 17.67a      |
| d₂z₃      | 12.07a       | 51.33a              | 28.93a      |
| d₃z₁      | 12.95a       | 51.95a              | 23.10a      |
| d₃z₂      | 12.69a       | 48.27a              | 19.97a      |
| d₃z₃      | 12.13a       | 48.19a              | 17.53a      |

Interaction Yes No No

Means followed by different letters between rows differ statistically (P<0.05) by the DMRT

3.2.3. **Root length.** As chlorophyll contents, the root length also no different length between treatments. Growth of root correlated to water and nutrient absorption, generally length of root showed positive correlated to the plant growth (Gould, 1974). In our study, the length of root is not correlated to the plant height, it is evidence that adding zeolite to fertilizer adequate to hold nutrient, finally the root growth near to around the planting area.

According to plant height, chlorophyll content and root length, 2 % urea dosage in total compost and the zeolite size 0.26 – 0.5 mm (d₁z₂) is the best treatment to growth of endive.

3.2.4. **Fresh weight.** The effects of treatments on yield responses of endive such as fresh weight, dry weight and shoot root ratio showed in Table 3. No interaction effect between zeolite size and urea dosage to endive fresh weight. Urea dosage effect to wet weight, while zeolite size no. Endive need 217 kg urea ha⁻¹ or 138 kg N ha⁻¹ [18]. In this study, smallest dosage (d₁) equivalent to 300 kg urea ha⁻¹ or 138 kg N ha⁻¹ is best compare to larger dosages. Fresh weight of endive in this study very light than reported [1,19].

3.2.5. **Dry weight.** Zeolite size and urea dosage have interaction effect to dry weigh, the treatment d₁z₂ is better than other treatments. Dry weight correlated to fresh weight, in our study dry weight measure in gram, while previous study in percent. Since dry weight value in this study convert to percent, there are highest than previous study [1,15,19].

Like on effect of treatment on endive growth, the treatment of d₁z₂ also the best effect on yield of endive.
Table 3. Mean of growth and yield of endive responses

| Treatment | Fresh Weight | Dry Weight |
|-----------|--------------|------------|
| $d_1 z_1$ | 50.26$^{ab}$ | 6.34$^b$   |
| $d_1 z_2$ | 90.51$^a$   | 9.19$^a$   |
| $d_1 z_3$ | 64.86$^a$   | 7.42$^{ab}$|
| $d_2 z_1$ | 56.12$^a$   | 6.89$^b$   |
| $d_2 z_2$ | 40.17$^b$   | 5.06$^a$   |
| $d_2 z_3$ | 29.65$^c$   | 4.07$^c$   |
| $d_3 z_1$ | 29.73$^c$   | 3.61$^c$   |
| $d_3 z_2$ | 26.95$^c$   | 4.22$^c$   |
| $d_3 z_3$ | 28.26$^c$   | 3.48$^c$   |

Interaction | No | Yes

Means followed by different letters between rows differ statistically ($P<0.05$) by the DMRT

4. Conclusion
Smaller dose of urea (2 %) from compost combine to medium size of zeolite (0.26 – 0.5 mm), result better effect to growth and yield of endive.

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