Quality of Growth Media and Yields of *Allium ascalonicum* L. on Ultisol Soil Combined with Rabbit Manure

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Abstract. Onion cultivation in pots is a solution of limited land in urban areas. Nevertheless, the onion productivity is constrained by the quality of planting media. The utilization of rabbit manure is an alternative to improve the quality of planting media. This study was aimed to determine the effect of rabbit manure level in the planting media on the growth and yield of onion, as well as the effect of rabbit manure on planting media quality. The method used was a completely randomized design with one factor and 12 replications. The treatment was rabbit manure level on growth media i.e. 0%; 25%; 50%; 75%; and 100%. Parameters measured were leaf length, number of leaves, diameter and weight of bulbs, pH of planting media, Cation exchange capacity (CEC), Sodium, Phosphor and Potassium. The results showed that 25%-50% rabbit manure in planting media produced the best on leaf length, number of leaves, diameter of bulbs, and weight of bulbs. The application of rabbit manure on ultisol soil media was able to increase pH, nitrogen, phosphorus, and cation exchange capacity, vice versa decreased the content Potassium.

Key words: growth media, rabbit manure, shallot, ultisol, urban farming

1. Introduction

Onion (*Allium ascalonicum* L) is a horticultural commodity that has high economic value. The demand for onion every year increases along with the growth of Indonesian population. National consumption of onion in 2016 amount to 698,178 tons has been increased into 755,687 tons in 2020, with an average growth of 2.03% per year [1].

Currently, urban farming is one of the important solutions to meet the needs of onion at the household level. Onion cultivation in limited land by using pots has become a new trend in urban areas. However, the availability of planting media is one of the problems faced. Generally, ultisol soil was the main material available for the planting media. Ultisol is a type of soil that has been covered 45,794,000 ha or about 25% of the total land area in Indonesia. The distribution of ultisol land spread over Kalimantan (21,938,000 ha), Sumatra (9,469,000 ha), Maluku and Papua (8,859,000 ha), Sulawesi (4,303,000 ha), Java (1,172,000 ha), and Nusa Tenggara (53,000 ha) [2].

Ultisol soil has been known posses high soil acidity, low to moderate organic matter, low nutrient content of N, P, K, Ca, Mg, Mo, and cation exchange capacity (CEC) less than 24 me 100 g⁻¹ [3] [4][5][6]. The soil contained high Mn and Fe content, and has the potential for Al toxicity [7][8].
One way to improve the quality of ultisol soil, so that it can be used for cultivation, is by adding organic material such as rabbit manure. Rabbit manure contained 20% C organic matter, 1.3% N nutrient; P 2.18%; Mg 1.88%; K 0.2%; and pH 5.6 [9]. Manure (animal manure) has been widely used to increase soil fertility and soil physical properties [10].

The study was aimed to determine the level of rabbit manure in ultisol soil-based of planting media which provides the best effect on onion cultivation in pots and its effect on the chemistry characteristics of ultisol soil.

2. Materials and Method

The study was conducted at the screen house in Jakarta Assessment Institute for Agricultural Technology, from May to August 2017.

2.1. Material

The research material used namely onion of Bima variety, aerated ultisol soil, husk charcoal, and rabbit manure (pH H$_2$O 7.2; C-organic 40.91%; N-total 1.95%; C/N Ratio 21; P$_2$O$_5$-total 1.56 ppm; K2O-total 0.48%; Na-total 0.48%; Ca 1.71 ppm; Mg 0.48 ppm; S 0.07 ppm; Fe 793 ppm; Mn 368 ppm; Cu 2.5 ppm; Zn 226 ppm; Al-total 633 ppm; B 409 ppm; CEC 19.58), as well as basic fertilizer including TSP, urea, ZA and KCl.

2.2. Research design

The experiment was arranged as a completely randomized design with one factor and 12 replications. The treatment was 5 levels of rabbit manure composition on the planting media, namely 0%; 25%; 50%; 75%; and 100%. The basic material of the planting media was ultisol soil and husk charcoal on ratio of 1:1. The test was carried out using polybag with a size of 25 cm. Each polybag was planted with 1 (one) onion bulb.

Fertilization was in accordance with the recommended dosage; basic fertilizer TSP 0.6 g/polybag and dolomite 7.5 g/polybag. Followed by fertilizers application namely Urea 0.34 g/polybag, ZA 0.79 g/polybag, and KCl 0.45 g/polybag on day 10 and 30 after planting.

Leaf length, number of leaves, bulbs diameter, and bulbs weight were observed. Observations were also carried out on the chemistry characteristics of the planting media, namely soil pH, cation exchange capacity, nitrogen, phosphorus and potassium. The growth data obtained were analyzed using variance, and followed by Duncan Multiple Range Test (DMRT) at the 5% level if the differences were significant.

3. Results and Discussion

3.1. Soil chemistry characteristic

Soil chemistry characteristic indicated the ionic activity in the soil, an indicator to determine the capability level of land. The trait was also used as a reference for fertilization recommendation in plant cultivation activities [11]. Table 1 shows that the application of rabbit manure was enhance soil pH, nitrogen, phosphorus, and cation exchange capacity on ultisol soil-based of planting media. Nonetheless, the composition of rabbit manure more than 25% was reduced potassium level in the planting media.

| Parameter | Soil chemistry characteristics on different rabbit manure level |
|-----------|---------------------------------------------------------------|
| pH H$_2$O | 5.32 7.26 6.88 7.16 7.10 |
| KCL 1 M  | 4.34 5.89 6.22 6.52 6.78 |
| N-Total (%) | 0.29 0.55 0.66 0.98 1.50 |
| P$_2$O$_5$ (ppm) | 81.51 500 2300 2800 3800 |
| K (cmol(+)/kg) | 7.03 1.24 1.99 1.84 2.76 |
| KTK (cmol(+)/kg) | 22.17 26.47 31.02 35.56 38.96 |
3.2. Leaf Length
Table 2 shows the increase in leaf length of onion each week at various levels of rabbit manure in the planting media. The result showed that 25% rabbit manure in planting media affect significantly on leaf length at 1–9 weeks after planting. However, Media with 25% and 50% rabbit manure level produced the best leaf length from the first week to the end of vegetative growth.

Table 2. Effect of rabbit manure level in ultisol soil of planting media on onion leaf length

| Week after planting | Leaf length on different rabbit manure level |
|---------------------|---------------------------------------------|
|                     | 0%                           | 25%                          | 50%                          | 75%                          | 100%                         |
| 1                   | 16.28 ab                      | 17.38 a                      | 14.71 bc                     | 14.16 bc                     | 13.01 c                      |
| 2                   | 25.81 bc                      | 29.98 a                      | 28.01 ab                     | 25.83 bc                     | 24.00 c                      |
| 3                   | 33.63 c                       | 40.94 a                      | 38.91 b                      | 35.47 c                      | 32.65 c                      |
| 4                   | 34.30 bc                      | 42.25 a                      | 39.92 a                      | 36.51 b                      | 32.80 c                      |
| 5                   | 34.00 bc                      | 42.63 a                      | 40.55 a                      | 36.78 b                      | 31.88 c                      |
| 6                   | 34.32 bc                      | 42.68 a                      | 40.38 a                      | 36.13 b                      | 32.03 c                      |
| 7                   | 33.50 bc                      | 42.73 a                      | 42.06 a                      | 36.29 b                      | 32.20 c                      |
| 8                   | 32.83 c                       | 43.13 a                      | 42.71 a                      | 36.09 b                      | 31.41 c                      |
| 9                   | 32.83 c                       | 43.13 a                      | 42.71 a                      | 36.09 b                      | 31.02 c                      |

Notes: Numbers followed by different letter at each row were significantly different at $p=0.05$.

3.3. Number of Leaves
The 25% level of rabbit manure was significantly and continuously gave the best effect on the parameter of the leaves number of onion. Overall, the level of rabbit manure up to 75% might improve the capability of ultisol soil to support plant growth.

Table 3. Leaves number of onion on different rabbit manure level in ultisol soil of planting media

| Week after planting | Leaves number of onion on different rabbit manure level |
|---------------------|--------------------------------------------------------|
|                     | 0%                           | 25%                          | 50%                          | 75%                          | 100%                         |
| 1                   | 9.75 a                        | 11.67 a                      | 10.17 a                      | 11.64 a                      | 9.83 a                       |
| 2                   | 15.50 b                       | 19.50 a                      | 15.92 b                      | 18.00 ab                     | 15.50 b                      |
| 3                   | 33.63 b                       | 40.94 a                      | 38.91 a                      | 35.47 b                      | 32.65 b                      |
| 4                   | 19.75 b                       | 27.42 a                      | 23.00 ab                     | 24.67 ab                     | 20.00 b                      |
| 5                   | 20.75 c                       | 32.17 a                      | 25.17 b                      | 24.42 b                      | 20.08 c                      |
| 6                   | 19.08 c                       | 37.25 a                      | 28.83 b                      | 27.92 b                      | 19.67 c                      |
| 7                   | 16.92 c                       | 36.42 a                      | 30.83 ab                     | 29.00 b                      | 19.42 c                      |
| 8                   | 13.08 c                       | 32.42 a                      | 29.42 a                      | 23.42 b                      | 15.83 c                      |
| 9                   | 11.75 c                       | 31.17 a                      | 28.58 a                      | 21.42 b                      | 13.92 c                      |

Notes: Numbers followed by different letter at each row were significantly different at $p=0.05$.

3.4. Bulbs Yield
Consistent with the response shown in the vegetative growth parameters, the level of rabbit manure up to 75% increased the ability of ultisol soil to produce onion bulbs. Meanwhile, the best yield of bulbs obtained from the treatment of 25% and 50% rabbit manure level.
3.5. Discussion

The application of rabbit manure on ultisol soil media was able to increase pH, nitrogen, phosphorus, and cation exchange capacity, excluding K content (Table 1). Coherent with the results of [12][13], manure can improved the soil properties either physically or chemically.

The level of 25% and 50% rabbit manure on the media produced the best plant growth and yield of onions. The increase of nutrient availability supported the growth of leaf length (Table 2), number of leaves (table 3), as well as diameter and weight of onion bulbs (table 4). The results of this study were in line with [14] that an increase in leaf length as a response to an increase in N and P application can be associated with an increase in vegetative growth parameters which may be due to the important role of nitrogen in plant photosynthesis so that the vegetative growth rate is higher. [15][16] also stated that increasing on nitrogen concentration may increase the weight of onion bulbs. This can be attributed to the increase in photosynthesis in response to the increased availability of nitrogen in the growing medium, thereby increasing the assimilation yield and storing it in bulbs.

The rabbit manure application also increases the available phosphate content. In acidic ultisols, the availability of P in plants is very low because phosphate ions can react with Fe and Al to form insoluble compounds. Total P-content in soils is rarely more than 0.01% . Therefore, the availability of P is important to achieve optimum crop yields [17] . The increase in soil pH value was obtained from the alkaline released from rabbit manure such as the release of Ca, Mg, K, Na from animal manures [18][19][20].

Interestingly, even though the level of 75% and 100% rabbit manure in ultisol soil media increase the nutrient content and pH value of the ultisol soil, its effect on plant growth and yield of onions decreased when compared to the level of 25% and 50% of rabbit manure. This result is in line with [21] that the application of chicken manure as much as 15 tons/ha resulted in less potato crop yields than the application of 10 tons/ha. This is presumably because at the level of 75% and 100%, the capability of the planting medium to hold water decreases, resulted in leaching of nutrients during the watering process. The results of [22] showed that the application of animal manure can increase soil porosity, microporosity and macroporosity.

4. Conclusion

The application of rabbit manure on ultisol soil media was able to increase pH, nitrogen, phosphorus, and cation exchange capacity, vice versa decreased the content Potassium. The level of 25% and 50% rabbit manure on the media produced the best plant growth and yield of onions.

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