Growth and yield of shallot (*Allium ascalonicum* L.) on different types of media and nutrient solution on hydroponic wick system

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Abstract. Effect of planting media and nutrient solutions and their interaction on growth and yield of shallot on hydroponic wick system was studied. The study was conducted in a screen house. A two factor experiment with three replications, arranged in randomized completed block design, was carried out. First factor was types of planting media i.e. sand, sand+husk charcoal (1:1), and sand+sawdust (1:1). Second factor was types of nutrient solution i.e. AB Mix, fermented urine of rabbit, and fermented vermicompost. Observed variables were plant height, leaf, tiller, and bulb number, root volume, total root length, plant fresh weight, and bulb dry weight. Data were analysed by F test followed by DMRT at a 5% error level. Results showed that shallot grown on sand+sawdust was the lowest, but types of media did not have significant effect on the other variables; plants supplied with fermented vermicompost nutrient solution had the lowest values for all observed variables. It was concluded that 50% substitution of sand with husk charcoal or sawdust did not reduce yield of shallot; solution of fermented urine of rabbit could replace solution of AB Mix, but solution of fermented vermicompost could not replace AB Mix solution for growing shallot on wick system.

1. Introduction
Shallot is one of important horticultural commodities in Indonesia. It is grown intensively in some areas in Indonesia. Many pesticides are applied during shallot growing season for protecting plants from diseases and pests. The pesticides are applied twice a week [1]. Increasing awareness on healthy living and covid 19 pandemic forced many people grew their own vegetables in their homes. Growing plants by hydroponic systems became popular. Wick system was the cheapest and simplest hydroponic system suited for beginners. This system consisted of two parts: a based container for nutrient solution reservoir and pots contained supporting medium seated above the reservoir. Nutrient solution could reach plant roots in the supporting medium through one or more wicks [2].

Types of media and nutrient solution were two of many factors effecting growth and yield of plants on hydroponic systems. Some characteristics of good growing media were: supports plant growth, holds water and nutrients, good drainage, and do not easily degraded [3]. Sand was one of media commonly used in hydroponic for supporting plants to stand, however it quite heavy and hold water and nutrient poorly. For improving the sand based media, organic materials were added. Some of the organic materials were cocopeat, many types of charcoal, and sawdust [3].
Sawdust was the cheapest, however growth and yield of plants grown on the sawdust medium varied. Plant height, bulb diameter, bulb fresh weight and bulb dry weight of shallot hydroponically grown on sawdust were lower than that of on rice husk charcoal and on cocopeat [4]. Other study found that plant height, diameter of stem, number of leaves and leaf area of papaya grown on soil+sawdust was the lowest compare to that of on (soil + compost (1:1); soil + compost + husk charcoal (1:1:1); soil + compost + coco peat (1:1:1); or soil + compost + Albasia sawdust (1:1:1) [5]. Study in Africa found that height of tomato grown on sawdust was lower than that of on soil [6]. High soluble tannin in the sawdust might retard the growth of plants [5]. Soaking sawdust with water and pouring the water every day for removing the soluble tannin for 7 days result in that height of seedlings of pepper grown on sawdust that has been soaked for 7 days was better than that of grown on soil [7].

Rice husk charcoal was one of favourite media for planting. It was light, did not need to be sterilised, it contained 52% SiO2, 31% C, small amount Fe2O3, K2O, MgO, CaO, MnO, Cu, and organic matter, pH 8.5-9.0 [8]. Mixing rice husk charcoal and soil increase did not reduce the growth of papaya seedling [5]. AB Mix is one of commercially available media. It contained available complete inorganic nutrient for plant growth, however it relatively expensive. Researchers have been trying to find an alternative of AB Mix. Two of them were fermented urine of animals and fermented vermicompost. Liquid organic fertilizer made from fermented urine of rabbits contained 2.11-2.51% N organic, 2.37-3.12% P2O5 and 3.24-3.81% K2O [10]. Application 175 ml of fermented urine of rabbit/litter improved the plant height, number of leaves, biomass, and weight of shallot [11]. Vermicompost is product of decomposing organic material by worms. It contained 2 % N total, 545 mgkg⁻¹ NO3, 10.33 mgkg⁻¹P, and 12.30 mgkg⁻¹ K and other nutrient needed for plant growth. Application of fermented vermicompost increased biomass of Alpinia purpurata [13].

This study aimed to find out whether substitution of 50% of sand with rice husk charcoal or sawdust did not have negative effect on shallot plants grown in hydroponic wick system, to find out whether nutrient solution made from liquid organic fertilizer of fermented urine of rabbit or liquid organic fertilizer of vermicompost could replace AB Mix nutrient solution, and to find out whether growth and yield of shallot on wick system were affected significantly by interaction between types of media and types of nutrient solution.

2. Materials and methods
The experiment was carried out in a screenhouse, at Ledug village, Kembaran District, Banyumas Regency, Central Java Province, Indonesia. It was carried out from February until June 2020. Variety of shallot used was Batu ijo.

The experimental design used was a randomized completed block design with two factors. The first factor was types of planting media i.e. sand, sand+husk charcoal, and sand+sawdust. The second factor was types of hydroponic nutrient solution i.e. solution of AB Mix, solution of liquid organic fertilizer made from fermented urine of rabbit, and solution of liquid organic fertilizer made from fermented vermicompost. There were 9 combinations of treatments. There were 4 pots, each containing 1 plant, in each treatment unit and each treatment was repeated 3 times. Dimension of container for nutrient solution reservoir was 39 cm × 31 cm × 12 cm. Each reservoir contained 4 l of nutrient solution. There were for pots in each container. Electrical conductivity of the nutrient solution was set at 1.3 mS/cm in the first two weeks, then at 1.8 mS/cm in third week, last it was set at 2.3 mS/cm in the fourth week until the plants were harvested.

The observed variables were height of plant, number of leaves, number of tillers, volume of roots, total length of roots, number of bulbs, fresh weight of plant, and dry weight of bulbs after air dried for 5 days. The data were analyzed by F test, followed by Duncan’s Multiple Range test at a 5% error level if there was a significant effect.
3. Results and discussion

Table 1 showed that there was no significant interaction effect of Media and nutrition on the growth and yield of shallots grown on hydroponic wick system. However there was significant effect of Media in the height of shallot plants. In contrast, the others observed variables did not affected by the type of growth media.

On the other hand, growth and yield of shallot plants were effected by type of nutrient solutions.

Table 1. Result of F tests on all observed variables at 75 days after planting.

| No | Observed Variables          | Media (M) | Nutrient solutions (N) | Interaction of M and N |
|----|----------------------------|-----------|------------------------|------------------------|
| 1  | Plant height               | s         | s                      | ns                     |
| 2  | Number of leaves           | ns        | s                      | ns                     |
| 3  | Number of clumps           | ns        | s                      | ns                     |
| 4  | Volume of roots            | ns        | s                      | ns                     |
| 5  | Total root length          | ns        | s                      | ns                     |
| 6  | Number of bulbs            | ns        | s                      | ns                     |
| 7  | Fresh weight of plants     | ns        | s                      | ns                     |
| 8  | Weight of bulbs after air drying for 5 days | ns | s | ns |  

Notes: s=significant, and ns= not significant

Table 2. showed that the height of shallot grown on sand+sawdust was the lowest. This support previous study by Arjuna et al. [4] who found that height of shallot grown on sawdust lower than that of on rice husk charcoal and on cocopeat; and Prajwalita et al. [5] who found that the height of papaya grown on soil+sawdust was the lowest compare to that of on (soil + compost (1:1); soil + compost + husk charcoal (1:1:1); soil + compost + coco peat (1:1:1); or soil + compost + Albasia sawdust (1:1:1) and Agboola et al. [6] who found that the height of tomato grown on sawdust was lower than that of on soil. Prajwalita et al. [5] said that high soluble tannin in the sawdusk might retard the growth of plant. However substitution of 50% sand with rice husk charcoal or sawdust did not reduce number of leaves, number of tillers, number of bulbs, volume of root, total length of roots, fresh weight of plant and dry weight of bulbs after air dried for 5 days. This support study by Langgeng et al. [7] that found the height of seedlings of pepper on sawdust that has been soaked for 7 days was better than that of grown on soil.

Table 2. Growth and yield of shallots grown on different media at 75 days after planting.

| Types of media                  | Observed Variables         |
|--------------------------------|-----------------------------|
|                               | Plant height (cm) | Number of leaves | Number of tillers | Volume of roots (cm³) | Total length of roots (cm) | Number of bulbs | Fresh weight of plant (g) | Weight of air dried bulbs (g) |
| Sand                           | 46.62 a              | 25 a              | 5 a               | 5.05 a                | 11.11 a                 | 5 a              | 44.07 a                 | 21.53 a                 |
| Sand+rice husk charcoal        | 46.05 b              | 27 a              | 5 a               | 4.16 a                | 10.21 a                 | 5 a              | 41.47 a                 | 21.37 a                 |
| Sand+sawdust                   | 38.30 a              | 27 a              | 5 a               | 3.91 a                | 10.92 a                 | 5 a              | 53.11 a                 | 25.33 a                 |

Notes: values followed by same letter in the same column mean not significant different

Table 3 showed that plant height, number of leaves, number of tillers, number of bulbs, volume of roots, total length of roots, fresh dry weight of plants, and dry weight of bulbs of shallot plants supplemented with nutrient solution made from liquid organic fertilizer of fermented vermicompost were the lowest in contrast growth and yield of shallots plants supplemented with nutrient solution made from liquid organic fertilizer of fermented urine of rabbit were similar to that of shallot plants
supplemented with AB Mix solutions. At least two reasons causing this result. First, the nutrient content, in term of nitrat, Ammonium, phosphate, potassium and others ions of solution made from liquid organic fertilizer of fermented vermicompost was the lowest [12, 13]. Second, the viscosity of the solution made from liquid organic fertilizer of fermented vermicompost was the highest making the absorption of ions in the solution by the plants was retarded.

Table 3. Growth and yield of shallots on different nutrient solutions at 75 days after planting.

| Types of nutrient solutions | Observed variables |
|-----------------------------|--------------------|
|                             | Plant height (cm)  | Number of leaves | Number of tillers | Volume of roots (cm³) | Total length of roots (cm) | Number of bulbs | Fresh weight of plant (g) | Weight of air dried bulbs (g) |
| AB Mix                      | 52.30 c            | 33 b             | 6 b               | 5.91 b               | 15.46 b                   | 6 b             | 60.15 b                   | 30.49 b                      |
| LOF of fermented urine of rabbit | 46.75 b          | 28 ab            | 5 b               | 4.63 ab              | 10.57 ab                  | 5 b             | 60.07 b                   | 29.21 b                      |
| LOF of fermented vermicompost | 31.94 a           | 18 a             | 3 a               | 2.58 a               | 6.22 a                    | 3 a             | 18.44 a                   | 8.53 a                       |

Notes: values followed by same letter in the same column mean not significant different

4. Conclusions and recommendations

It could be concluded that substitution of 50% of sand with rice husk charcoal or sawdust did not reduce yield of shallot on hydroponic wick system; Nutrient solution made from liquid organic fertilizer of fermented urine of rabbit could replace AB Mix solution for growing shallots on hydroponic wick system; Nutrient solution made from liquid organic fertilizer of fermented vermicompost could not replace AB Mix solution for growing shallots on hydroponic wick system.

It could be recommended that the used of nutrient solution made from liquid organic fertilizer of fermented urine of rabbit as an alternative of AB mix nutrient solution should be studied on others plants; The used of nutrient solution made from liquid organic fertilizer of fermented urine of other animals as an alternative of AB mix nutrient solution should be studied.

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