Effect of arbuscular mycorrhizal fungi and different composition of growing medium on growth and production of potato seed cultivars Medians in Inceptisols Jatinangor

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Abstract. Arbuscular mycorrhiza fungi (AMF) has been known can increase the productivity of many crops including potatoes. Growing medium is also vital for the growth of potatoes, especially in medium-high land. Good combination of AMF and growing medium is expected to improve the physical and biological soil properties and increase growth and seed production. An experiment aimed to evaluate the effect of AMF and different media composition on growth and yield of potato seeds G² cultivars Medians in medium land has carried out at Jatinangor, Indonesia. The experiment used randomized block design with treatments: growing medium (soil + compost (2:1), soil + compost + cocopeat (2:1:1), and soil + compost + charcoal husk (2:1:1); and AMF (without and with AMF). Results showed that there was interaction effect between AMF and composition of growing medium on percentage of stolon formed into tuber and weight of potato tubers per plant. Treatment of medium soil + compost + cocopeat (2:1:1) and the addition of AMF increased the percentage stolon formed into tubers as high as 84%, and potato tuber weight to 328 g plant. Growing medium consisted of soil + compost + cocopeat (2:1:1) increased plant height, plant dry weight, shoot root ratio, and number of potato tubers. This finding showed that AMF application combined with proper growing medium increased the the production of potato seeds.

1. Introduction
Potato (Solanum tuberosum L.) is one of important crops, either as fresh product and processed products. One potato cultivars grown in Indonesia is Medians cultivar. The availability of seed potatoes in Indonesia is relatively limited and need to be imported, while the need for the seed higher is high [1]. Potato crops in Indonesia mainly cultivated in the highlands (1000-1300 m above sea level). To increase the potato production, it is necessary to expand the production area such as cultivation in the medium-high land that largely available in Indonesia [1].

Alternative efforts to increase the production of seed potatoes to the second generation (G²) in medium land in Indonesia could be through the quality improvement of the growing medium. Soil characteristics requirement for potato growing medium are good structure, high organic matter content, high fertility, and good water infiltration [2]. Furthermore, improvement of soil physical properties by modification of the composition of the growing medium such as a combination of soil, compost, cocopeat and husk is needed. Compost contains complete nutrients to improve the growth and yield of potato, while rice husk and cocopeat has good porosity and can hold water [3].

Arbuscular Mycorrhizal Fungi is a group of soil fungi that are obligate and cannot be cultured in the absence of a host plant roots. Mycorrhiza on plant roots can expand the field of root uptake in the presence of external hyphae that grow and develop through the roots [4]. The most important agronomic role of mycorrhiza is its ability to enhance uptake of plant nutrients, especially phosphate. This was because mycorrhizal infected root have higher energy metabolism and fat, and is active in P uptake [3]. AMF can interact positively with organic materials in the soil, therefore the presence of growing medium from organic materials could have advantage to increase fungal activity [5]. Rice husk is a source of organic material that is largely available in all parts of Indonesia that can be used as a material that can improve soil permeability and also be used as a carrier for biofertilizer such as mycorrhizal inoculant [6]. A study showed that rice husk + zeolite mixture (1: 3) gave the highest yield of the colonization of roots and root length infected with 20 g pot⁻¹ whereas the P uptake and the highest weight of grain sorghum rice husk + zeolite (1: 3) 30 g pot⁻¹ [7]. Based on these descriptions, it is expected that the exact composition of the growing medium and the addition of arbuscular mycorrhizal fungi can affect the growth and seed production of potato cultivars G2 Medians in medium-high land

2. Materials and Methods
The experiment was conducted at the Experimental Station of the Faculty of Agriculture, Universitas Padjadjaran (685 m above sea level). The type of soil used was Inceptisols from Jatinangor, West Java. The experimental design using a factorial randomized design consisted of two factors: the first factor was the composition of growth media consisting of soil + compost (2: 1), soil + compost + cocopeat (2: 1: 1), soil + compost + husk (2: 1: 1) and the second factor was AMF (without and with AMF). Each treatment was repeated three times and each experimental unit consisted of six plants planted in polybag with the size of 50 x 50 cm.

Arbuscular mycorrhizal fungi inoculants granulated with a mixture of zeolite carrier applied as much as 25 g per polybag with the density of 100 spores was given by putting the inoculant into the planting hole as deep ± 10 cm, and then covered with soil. After AMF applied, the growing media was incubated for seven days and watering every day to keep the sufficient moisture of the media. Seeds of potato cultivar Medians (G1) planted one week after inoculation of mycorrhiza, at a depth of ± 10 cm, and the seeds covered with soil.

Urea doses of inorganic fertilizer 300 kg ha⁻¹ (6.8 g plant⁻¹), SP-36 dose 200kg ha⁻¹ (3.4 g plant⁻¹), and KCl 150 kg ha⁻¹ (3.5 g plant⁻¹) was given to the media around the planting hole. The potatoes were harvested three months after planting. Observation of growth and seed production include: plant height, leaf area, shoot root ratio, percentage of stolon forming tuber, the number of tubers, and the weight of potatoes per plant.

3. Results and Discussion
Results showed that statistically there were no interaction between mycorrhiza and composition of growing medium (soil and compost) on plant height, leaf area, plant dry weight, and shoot root ratio (Table 1). When growing medium added with cocopeat or rice husk, the plant height were significantly different. On parameter of shoot dry weight, only growing medium added with cocopeat increased.

Arbuscular mycorrhizal fungi increased shoot dry weight, but not plant height and shoot root ration. The development of good root system by AMF affect the development of plant canopy includes the height and diameter of the plant stem [8]. The roots provide nutrients and water needed by plants for photosynthetic activity, while the plant provides carbohydrates as a result of photosynthesis for growth of roots and other parts. Normal plant growth are obtained when the availability of nutrients in the soil sufficient and balanced. Sufficient nutrient availability in the media have an impact on plant height increment [9]. Application of 50 g of compost derived from oil palm fruit bunches and 50 g per plant cocopeat can improve soil physical and chemical properties, because it can increase the availability of nutrients and increase nutrient uptake by plant [10]. Mycorrhizal plants produce hyphae that increase the absorption of nutrients [11]. The availability of nutrients and water availability in the media improve
Table 1. Effect of arbuscular mycorrhizal fungi and composition of growing medium on plant height, shoot dry weight, and shoot root ratio

| Treatments                              | Plant Height (cm) | Shoot Dry Weight (g) | Shoot Root Ratio |
|-----------------------------------------|-------------------|----------------------|------------------|
| soil + compost (2: 1)                   | 48.22 a           | 43.24 a              | 6:31 a           |
| soil + compost + cocopeat (2: 1: 1)     | 53.16 b           | 50.06 b              | 7:31 a           |
| soil + compost + rice husk (2: 1: 1)    | 51.96 b           | 44.95 a              | 6:12 a           |
| without AMF                             | 50.71 a           | 42.17 a              | 6:21 a           |
| with AMF                                | 51.17 a           | 46.15 b              | 6:56 a           |

Values followed by the same letter in the column is not significantly different according to DMRT 5%

The effect of arbuscular mycorrhizal fungi and composition of growing medium on percentage of stolon developed into tubers showed that application of AMF significantly increased the percentage of stolon formed into tubers Table 2. The composition of growing media gave significant difference on the percentage of stolon. When AMF applied, different composition has different effect, while when AMF applied, either medium added with cocopeat or rice husk have the same effect but still higher than standard growing medium (Table 2).

Table 2. Effect of arbuscular mycorrhizal fungi and composition of growing medium on percentage of stolon developed into tubers

| Treatments                              | Without AMF | With AMF |
|-----------------------------------------|-------------|----------|
| soil + compost (2: 1)                   | 54.23 a     | 76.46 a  |
|                                        | A           | B        |
| soil + compost + cocopeat (2: 1: 1)     | 64.87 b     | 84.08 b  |
|                                        | A           | B        |
| soil + compost + rice husk (2: 1: 1)    | 75.88 c     | 81.66 b  |
|                                        | A           | B        |

Values followed by the same letter in the column (small caps) and in row (capital) are not significantly different according to DMRT 5%

The growing medium of soil+ compost + cocopeat (2: 1: 1) with AMF was able to produce the highest percentage of potato stolon than the other treatments. Stolon on potatoes grown from the bottom of the stem at ground level. Tuber formation associated with the establishment of stolon and tuber formation at the end of the stolon, and not all stolon can be formed into potato tubers [13]. Formation of the potato is influenced by several factors such as growth hormones and the metabolism of carbohydrates, as well as environmental factors including day length, temperature, moisture, and nutrients.

Table 3. Effect of arbuscular mycorrhizal fungi and composition of growing medium on weight of tuber per plant (g)

| Treatments                              | Without AMF | With AMF |
|-----------------------------------------|-------------|----------|
| soil + compost (2: 1)                   | 225.0 b     | 330.8 b  |
|                                        | B           | C        |
| soil + compost + cocopeat (2: 1: 1)     | 158.9 a     | 328.7 b  |
|                                        | A           | B        |
| soil + compost + rice husk (2: 1: 1)    | 289.8 c     | 158.2 a  |
|                                        | B           | A        |

Values followed by the same letter in the column (small caps) and in row (capital) are not significantly different according to DMRT 5%

The combination treatment of AMF and the composition of the soil + compost + cocopeat (2: 1: 1) produce highest potato weight compared with other treatments (Table 3). Tubers weight depending on
the growth of plants. Ability of media in providing nutrients to plants is a major factor in the growth and crop production [15]. Based on analysis of physical properties of media (data not shown), medium soil + compost + cocopeat (2: 1: 1) has good porosity and water holding capacity which is optimum for plant growth. In addition, growing media added by cocopeat are able to hold more nutrients available plants. The ability of the roots in the absorption of nutrients was also supported by the addition of AMF. This is consistent with research that stated that planting potatoes on Inceptisols by addition of AMF increased the amount of potatoes, tubers weight and diameter of the potato tubers [16].

Growing medium consisted of soil + compost+ cocopeat (2: 1: 1) in general produced higher yield, dry weight and shoot root ratio, suggesting better growth hence able to absorb sunlight and assimilate high yield. Higher plants also could produce more photosynthates resulting in higher number and weight of tubers high [13, 16].

4. Conclusion
The combination between AMF and growing medium consists of soil + compost + cocopeat (2:1:1) increased the percentage stolon formed into tubers and potato tuber Furthermore, this growing medium increased plant height, plant dry weight, shoot root ratio, and number of potato tubers. This finding showed that AMF application combined with proper growing medium increased the the production of potato seeds.

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