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Growth response of pepper (*Piper nigrum* L.) seedlings to application of Arbuscula Mychorrizae Fungi (AMF) and NPK fertilizer

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Growth response of pepper (*Piper nigrum* L.) seedlings to application of Arbuscula Mychorrizae Fungi (AMF) and NPK fertilizer

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Abstract. This study aims to determine the effect of mycorrhizal fungi and NPK fertilizers on the growth of pepper (*Piper nigrum* L.) seedlings. The study was conducted from December 2017 to February 2018 in the form of a two-factor factorial randomized block design (RBD) trial. The first factor was the inoculation of mycorrhizae fungi which consisted of four levels, namely control or without mycorrhizae, 10 g plant^{-1}, 15 g plant^{-1}, and 20 g plant^{-1} of the mycorrhizae. The second factor is the application of NPK fertilizer with three levels, namely without NPK fertilizer, NPK fertilizer 1 g plant^{-1}, NPK fertilizer 1.5 g plant^{-1}, NPK fertilizer 2 g plant^{-1}. The results of this study indicate that the application of 20 g of mycorrhizae per plant resulted in better growth of pepper seedlings indicated by the parameters of root volume (1.83 mL). The application of NPK fertilizer 1.5 g per plant resulted in highest plant height (3.32 cm). There was no interaction between mycorrhizal fungi treatment and NPK fertilizer in affecting the growth of pepper seedlings.

1. Introduction

Many pepper plantations are scattered in various provinces in Indonesia, one of which is in South Sulawesi. South Sulawesi is the producer of pepper in Indonesia with the production of pepper in 2015 amounting to 5,067 tons from smallholder agricultural production, where the area of pepper farming from smallholder plantations is 14,323 ha [1]. Given the excellent prospects for this plant, pepper production needs to be developed with good cultivation efforts, especially at the nursery stage. This allows pepper farmers to increase income and ultimately support the country's foreign exchange earnings. Nurseries are indispensable as a means of providing large quantities of planting material. The level of availability of healthy seeds in large quantities is the key to successful pepper production. Because it is necessary to do efforts for nurseries that are able to support the formation of healthy roots. Pepper propagation can be done by generative (seeds) and vegetative (cuttings). Generative propagation is usually carried out by research institutions to produce hybrid plants and new varieties that are superior and genetic diversity, whereas, the vegetative propagation method is the most effective and efficient way for the process of cultivating pepper plants. Propagation of pepper plants is generally carried out by vegetative means, namely cuttings. Cuttings are a separation treatment, cutting some parts of a plant such as roots, stems, leaves, and shoots with the intention that these parts form roots. Propagation of pepper by cuttings is more profitable because it can be done quickly, is simple, and does not require

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trained personnel than tissue culture. In addition, vegetative propagation through cuttings can produce a homogeneous plant population and have the same characteristics as the parent [2].
The weakness of the seedlings from cuttings is that they have poor roots. According to Wahid and Suparman (1996) in Rismunandar [3], pepper seedlings from cuttings only have lateral roots as the main roots, their numbers are limited and the fiber roots are only in the topsoil or often referred to as top soil. This causes the extent and surface of plant root uptake to be limited, so that the absorption capacity of nutrients and water is low and less effective and efficient. For that we need a plantation technology package that is able to improve the root system and can increase the nutrient absorption capacity of pepper plants.

The vegetative growth of pepper during the nursery period really requires nutrients, especially the nutrient Phosphorus (P). It is hoped that P fertilization can increase the availability of these nutrient elements for plants. The problem is that almost all P compounds found in the soil have low solubility [4]. Therefore, the development of biotechnology offers a new approach by utilizing microorganisms to increase the efficiency of nutrient uptake by plant roots, one of which is the Arbuscular Mycorrhizal Fungi (CMA). CMA is a form of mutualistic symbiotic relationship between fungi and plants, both fungi and plants benefit from this association.

The need for plants for nutrients is also inseparable from fertilizing with the right dose. The purpose of fertilization is to meet the nutrient needs of plants and optimize growth. One type of fertilizer that is usually given is NPK fertilizer. Inorganic fertilizer (NPK) can be given for direct seeding in the field in the form of NPK compound fertilizer at a dose of 2.5 grams every 3 months at the age of 3, 6, and 9 months [5].

Based on the description above, where the inoculation of CMA and application of fertilizers had a positive effect on plant growth, a study was conducted on the growth of pepper plant seedlings in Bulukumba Regency.

2. Methodology

This research was conducted in Bonto Minasa Village, Bulukumpa District, Bulukumba Regency, and was conducted from December 2017 to February 2018. The tools used in this study were a stake, a CAMRY digital scale, a camera, a polybag, a ruler, a measuring cup and writing instruments. The materials used in this study were 1 month old pepper cuttings, CMA, label paper, and NPK fertilizer.

2.1. Research Methodology

This experiment was carried out in the form of a 2-factor factorial design, namely a randomized block design (RBD). The first factor was the mycorrhizal treatment (M) which consisted of 4 levels, namely: no mycorrhizae (M0), 10 g plant^{-1} mycorrhizae (M1), 15 g plant^{-1} (M2) and 20 g plant^{-1} (M3). The second factor is the application of NPK fertilizer (P) which consists of 3 levels, namely: without NPK fertilizer (P0), NPK fertilizer 1 g plant^{-1} (P1), NPK fertilizer 1.5 g plant^{-1} (P2), and NPK fertilizer 2 g plant^{-1} (P3).

Based on these two factors, the treatment combination, 16 treatment combinations obtained and each treatment combination was repeated 3 times so there was a total of 48 experimental units obtained. Data was analysed using analysis of variance (ANOVA) and when there is a significant effect of the treatment, then a Honest Significance Difference Test (HSD) was performed at a level of confidence of 5%.

2.2. Seedlings materials

Selection of pepper plant seeds was carried out on plant seeds that were physically healthy, relatively uniform, and came from the same brood stock with an average height of 12.41 cm, the number of leaves 1-2 segment.

2.3. Treatment application
The treatments were given in the form of mycorrhizal and NPK fertilizer. Each plant was given mycorrhizae in the first month based on their respective treatments. Each plant was also fertilized with NPK fertilizer based on their respective treatments, NPK fertilization was carried out twice, namely in the first month and the third month of the study.

2.4. Plant maintenance
Maintenance of the pepper plant seeds was carried out by weeding. Weeding was done every two weeks by cleaning the weeds around the pepper plant seeds. Apart from weeding, other maintenance is watering pepper plant seeds every day.

3. Results

3.1. Plant height
The analysis of variance showed that NPK (P) fertilizer treatment had a significant effect on plant height increase, while mycorrhizal (M) treatment had no significant effect on plant height increase.

Table 1. The increase in plant height in the application of NPK and mycorrhizal fertilizers.

NPK Fertilizer	Mycorrhizae				Average	$HSD_{0.05}$
	M0 (0 g plant^{-1})	M1 (10 g plant^{-1})	M2 (15 g plant^{-1})	M3 (20 g plant^{-1})		
P0 (0 g plant^{-1})	1.00	1.20	2.18	1.87	1.56 a	1.26
P1 (1 g plant^{-1})	1.62	3.05	2.48	4.43	2.90 b	
P2 (1.5 g plant^{-1})	3.77	3.10	2.72	3.70	3.32 b	
P3 (2 g plant^{-1})	1.48	1.57	3.36	3.32	2.43 ab	
Average	1.97	2.23	2.86	3.33		

The numbers followed by the same letter (a, b) indicate that it is not significantly different at the HSD test level of 0.05.

The results of the HSD test in table 1 shows that the treatment of NPK fertilizer application of 1.5 g per plant (P2) produces the highest average plant height increase of 3.32 cm and is significantly different from the treatment of 0 g per poly bag (P0) or control which produced an average. The lowest average plant height increase is 1.56 cm, however not significantly different from NPK fertilizer 2 g per polybag (P3).

3.2. Number of leaves
The analysis of variance showed that the treatment of NPK (P) and mycorrhizal (M) fertilizers had no significant effect on the increase in the number of leaves.

Figure 2 shows that the treatment of NPK fertilizer 1.5 g per poly bag and 20 g mycorrhizae per polybag (M3P2) resulted in the highest average increase in the number of leaves (2.67), while the lowest average increase in the number of leaves was obtained in the mycorrhizal treatment of 0 g per polybag and 1 g of NPK fertilizer per poly bag (M0P1), 0 g of mycorrhizae per poly bag and 2 g of NPK fertilizer per polybag (M0P3), namely 1.50 pieces.

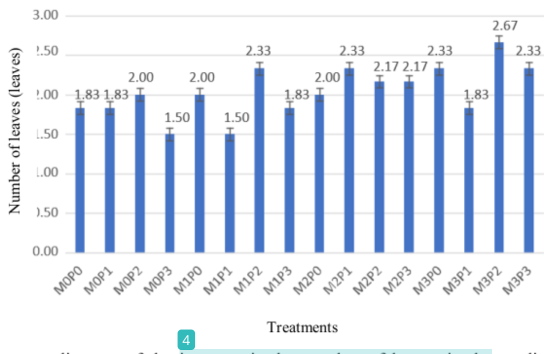

Figure 1. The stem diagram of the increase in the number of leaves in the application of NPK and Mycorrhizal fertilizers.

3.3. Leaf area

The analysis of variance showed that the treatment of NPK (P) and mycorrhizal (M) fertilizers had no significant effect on leaf area. Figure 3 shows that the treatment of NPK fertilizer 2 g per poly bag and mycorrhizae 15 g per poly bag (M2P3) resulted in the largest leaf area (19.91 cm^2), while the lowest average leaf area was obtained in the mycorrhizal treatment of 0 g per polybag and 0 g of NPK fertilizer. per polybag (M0P0) or control (13.01 cm^2).

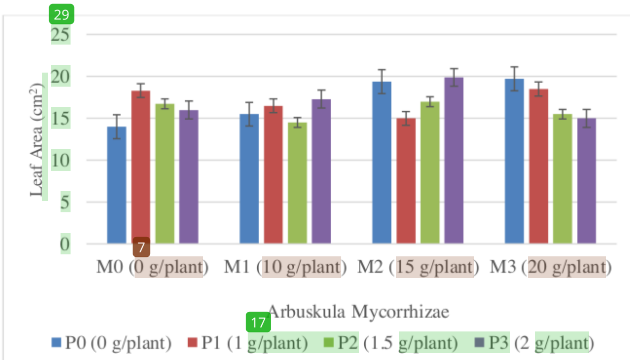

Figure 2. Leaf area of pepper seedlings on the application of NPK and mycorrhizal fertilizers.

3.4. Number of segments

The analysis of variance showed that the NPK fertilizer treatment (P) and mycorrhizae (M) had no significant effect on the increase in the number of internodes. Figure 4 shows that the treatment of NPK fertilizer 1.5 g per poly bag and 20 g mycorrhizae per polybag (M3P2) resulted in the increase in the highest number of internodes (1.67), while the lowest average increase in the number of internodes was

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obtained in the mycorrhizal treatment of 0 g per poly bag and 0 g of NPK fertilizer. per polybag (M0P0) or control (0.67).

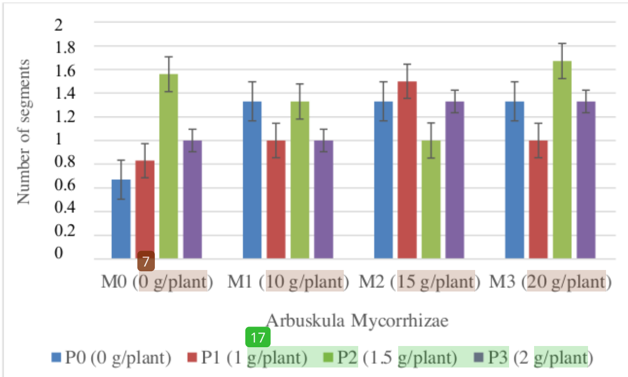

Figure 3. Increase in the number of internodes of pepper seedlings on the application of NPK and Mycorrhizal fertilizers

3.5. Root volume

The analysis of variance showed that NPK (P) fertilizer treatment had no significant effect on root volume, while mycorrhizal (M) treatment had no significant effect on root volume. The results of the HSD further test in table 2 shows that the application of mycorrhizal treatment of 20 g per poly bag (M3) produces the highest average root volume of 1.83 cm^3 and is significantly different from the mycorrhizal treatment of 10 g per polybag (M1) which produces the lowest average root volume 1.25 cm3, but not significantly different from mycorrhizae of 15 g per polybag (M2) and control (M0).

Table 2.Root volume of pepper seedlings on the application of NPK and mycorrhizal fertilizers.

NPK Fertilizer	Mycorrhizae				Average
	M0 (0 g plant^{-1})	M1 (10 g plant^{-1})	M2 (15 g plant^{-1})	M3 (20 g plant^{-1})	
P0 (0 g plant^{-1})	1.50	1.33	1.50	1.50	1.46
P1 (1 g plant^{-1})	1.33	1.33	1.50	2.67	1.71
P2 (1.5 g plant^{-1})	1.17	1.00	1.50	1.33	1.25
P3 (2 g plant^{-1})	1.50	1.33	1.33	1.83	1.50
Average	1.38a	1.25a	1.46ab	1.83b	
$HSD_{0.05}$		0.41			

The numbers followed by the same letter (a, b) indicate that it is not significantly different at the HSD test level of 0.05.

4. Discussion

Nursery is one of the stages in the cultivation process of pepper (*Piper nigrum*. L), although the pepper plant itself can be planted directly without going through the nursery process. The growth of pepper plant seedlings can be done by utilizing microorganisms to increase the efficiency of nutrient uptake by plant roots, one of which is the Arbuscular Mycorrhizal Fungi. The need for plants for nutrients is also inseparable from fertilization with the right dose, one of the types of fertilizers that can be given is NPK fertilizer.

The results showed that mycorrhizal treatment showed insignificant results on plant vegetative growth on the parameters of observation of plant height, number of leaves, number of tendrils, and leaf area. However, it has a significant effect on the root volume parameter. This shows that mycorrhizal administration is effective in optimizing the growth of pepper plants. Mycorrhizae that infect plant roots will produce external hyphae networks that grow expansively, thereby increasing the capacity of the roots to absorb water and nutrients. The maximum amount of water and nutrients absorbed by plants makes optimal plant growth. This is in accordance with the opinion of Utami (2009) in his research suggesting that the working principle of mycorrhizae is to infect the root system of the host plant, produce hyphae strands intensively so that plants containing mycorrhizae will be able to increase the capacity for nutrient absorption.

Auge [6] stated that mycorrhizae have enormous potential to increase plant growth and improve soil aggregation. Various experiments have shown that CMA is able to change water relations and play a big role in the growth of host plants under drought stress conditions. The results of Sakti's research [7] stated that the increase in growth with the application of mycorrhizal doses, namely the 10 g treatment was better than the treatment without mycorrhizae on the root volume parameter with a value of 27.50 ml per polybag.

The results of statistical analysis of HSD at the 0.05 level (table 1) showed that the NPK fertilizer application treatment had a significant effect on plant height gain parameters. The NPK fertilizer treatment that produced the highest plant height increase (3.32 cm) was the application of 1.5 g of NPK fertilizer per poly bag and was significantly different from the application of 0 g mycorrhizae per polybag (1.56 cm) or control. This could occur because carried out a balanced fertilizer on plants. If the nutrients in the soil are met, the plants will thrive. This is in accordance with the opinion of Pratama (2008) which states that plants will thrive if the nutrients needed by plants are available in balanced proportions, especially macro nutrients such as N, P and K. The role of macro nutrients contained in NPK compound fertilizer, where the elements -These elements have their respective functions in the metabolic processes of plants.

Lingga [8] stated that the element N plays a role in the formation of chlorophyll which is useful in the photosynthetic process, where if photosynthesis is smooth, more carbohydrates will be produced. Muchlis and Fauizi [9] stated that excess nitrogen nutrients can increase damage caused by pests and diseases, prolong life, and make plants fall more easily. Meanwhile, nitrogen deficiency cannot meet the needs of plants to achieve optimal production levels.

The effect of NPK fertilizer on plant growth is very influential, especially the element nitrogen. This is in accordance with the opinion of Novizan [10] which stated that nitrogen is the main nutrient for plant growth, which is generally very necessary for the formation or growth of vegetative parts of plants, such as leaves, stems, and roots, but if too much can inhibit flowering and fertilization of the plant. Meanwhile, Pratama [11] stated that balanced fertilizers also affect plant growth, especially soil. Balanced fertilization is defined as fertilization to achieve the optimum status of all nutrients in the soil for the growth and yield of a plant.

The results showed that the NPK fertilizer treatment of 1.5 g per polybag showed better results on the parameters of plant height increase (3.32 cm) than the treatment of NPK fertilizer 2 g per polybag which only resulted in an increase in plant height of (2.43 cm) . This is due to the excessive use of inorganic / chemical fertilizers according to the opinion of Hardjowigeno [12], the weakness of inorganic fertilizers is that when they are used excessively they will have a bad impact on the soil (the soil hardens quickly, is less able to hold water and becomes acidic) so that the growth rate plants become stunted.

5. Conclusion

Based on the results obtained from the observations that have been made, it can be concluded that the best dose of mycorrhizae was 20 g per poly bag resulted in the highest root volume parameter with an average root volume of 1.83 ml. Use of NPK fertilizer of 1.5 g per polybag resulted in the highest increase in plant height with an average plant height increase of 3.32 cm. No significant interaction between mycorrhizal fungi and NPK fertilizer on the growth of pepper seedlings.

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