The effect of mycorrhizal biofertilizer with the addition of rice washing water and eggshells on the growth of cayenne pepper plant (*Capsicum frutescens* L.)

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ABSTRACT

Cayenne pepper is a leading horticultural commodity in Indonesia. The need for cayenne pepper is constantly increasing, but it is not balanced with its production because there are obstacles, especially in areas that are less fertile or have low nutrients. This study aims to find out the effect of applying mycorrhizal biological fertilizer by adding rice-washing water and eggshells on the growth of cayenne pepper plants. This study used the Complete Randomized Design method, there were 16 treatments and 4 repetitions. The parameters tested include the number of leaves, branches, and roots, root length, wet weight of the crown, and the roots. The data were analyzed using One Way Anova (significant level of 5%) and an alternative test Kruskal-Wallis H. The results showed mycorrhizal biological fertilizer 5 gr + rice washing water 200 ml and eggshells 20 gr optimally affecting the number of leaves, branches, and roots, the dry weight of the crown. Mycorrhizal biofertilizer 10 gr + rice washing water 150 ml and eggshell 15 gr have an optimal effect on the wet weight of the crown and the roots. Mycorrhizal biofertilizer 15 gr + rice washing water 200 ml and eggshell 20 gr have an optimal effect on root length. Mycorrhizal biofertilizer 2 gr + rice washing water 150 ml and eggshell 15 gr have an optimal effect on the dry weight of roots.

Keywords: *cayenne pepper plant, eggshells, mycorrhizal biofertilizer, rice washing water*

INTRODUCTION

One of the horticultural crops that have great potential to be developed in Indonesia is cayenne pepper (*Capsicum frutescens* L.), the demand increases from year to year along with the increasing population and the development of industry (Siahaan et al., 2018). Based on data from the Central Statistics Agency at the beginning of January to June 2021, Indonesia imported 27,851.89 tons of cayenne pepper, a greater amount than the previous year which was only 18,075.16 tons (BPS, 2021). Imports continue to increase every year which shows that cayenne pepper production from local farmers has not been able to meet domestic demand.

Based on data from the Central Statistics Agency (2021), cayenne pepper production increases every year along with the increasing demand. However, the production is not proportional to the needs and is not evenly distributed in each region. This is due to the difficulty of producing, especially in less fertile areas or areas with low nutrient content. In 2019, Indonesia's cayenne pepper production was 1,374,217 tons/year and in 2020 it was 1,508,404 tons/year. According to Muliati et al. (2017) The spread of demand for cayenne pepper throughout the year makes farmers continue to plant without regard to environmental factors, thereby reducing cayenne pepper production.

Generally, farmers use chemical or inorganic fertilizers for the reason that the nutrients can be absorbed directly and accelerate the planting period. However, the use of inorganic fertilizers has significant long-term negative effects on soil and plants. Some plant expert studies state that chemical or inorganic fertilizers cannot be 100% absorbed by plants and leave residues in the soil that are not absorbed (Soekamto and Fahrizal, 2019). The impact of using inorganic fertilizers can disrupt the balance of chemical elements in the soil, so the use of biological and organic fertilizers can be an alternative.

Biofertilizers are live microorganisms that are added as inoculants to help and provide special nutrients to plants into the soil (Siahaan et al., 2018), one example is mycorrhizae. Doudi et al. (2018) stated that mycorrhiza is an association of soil fungi with plants. According to Wicaksono et al. (2014) The addition of mycorrhizae, especially arbuscular, can increase crop production in a stressful environment. According to Nurhayati (2012) mycorrhiza is not destructive or kills host plants. Plants will obtain nutrients from mycorrhiza that can absorb soil mineral nutrients and mycorrhiza obtain carbon compounds or nutrients assimilated from photosynthesis. Muryati et al. (2016) stated that germinated mycorrhizal spores form hyphae to absorb nutrients and water from the soil into the roots which are also used in the process of growth and development of host plants. Several studies prove that applying mycorrhizal fertilizers can increase the growth and production of cayenne pepper

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(*Capsicum frutescens* L.) (Adetya et al., 2018; Madusari et al., 2018; Wijayanti, 2018).

In contrast to biofertilizers that use microorganisms, organic fertilizers derived from forage, animal manure and household waste (Mamondol and Tungka, 2016). One example is rice washing wastewater, because it contains various organic compounds and minerals such as nitrogen, phosphorus, potassium, carbohydrates, vitamin B1, iron, magnesium, and sulfur (G.M Citra et al., 2012). According to Sudartini et al. (2020) empirically it has been proven that rice washing water can fertilize plants. Wardiah et al. (2014) in his research stated that fertilizer from rice washing water has a real effect in increasing plant growth and development, especially plant height. Meanwhile, according to Hamidah and Andi's research (2020), giving rice washing water has proven to have a significant effect on the growth and production of chili plants.

Another study states that eggshells are household waste that can be used as organic fertilizer. Sudartini et al. (2020) states that planting media given broken eggshells or eggshell soaking water can not only provide nutrients that are beneficial for plant growth and development. The eggshell contains calcium carbonate (CaCO3), 95% of the weight of the eggshell is 5.5 grams of CaCO3. The average eggshell contains 3% phosphorus, 3% magnesium, sodium, potassium, zinc, manganese and iron. Based on Novianti's research (2016), fertilizer from eggshells can increase the amount of cayenne pepper production. Meanwhile, in Huda's research (2020), organic fertilizer of chicken egg shells has a real effect on the growth of height, root length and wet weight of plants.

Each fertilizer has certain properties and characteristics that contain nutrients with specific properties or cannot be replaced by other nutrients (Mansyur et al., 2019). The use of one type of fertilizer such as biological or organic fertilizer, has been widely studied and shows a good effect on plant growth. Tests on the use of biological and organic fertilizers have been studied and proved that a combination of two or more types of fertilizers can increase the carrying capacity of the soil to plants because the combination of two or more fertilizers can increase the composition of nutrients in the soil (Muharam et al., 2011). Research on fertilizer from rice washing water and egg shells was conducted by Yusuf (2017) with results showing that there was an effect on height growth and number of leaves on tomato plants (*Solanum lycopersicum* L.). The results of Bandu's research (2019) also stated that fertilizer affects the growth of cayenne pepper (*Capsicum frutescens* L.). Research that combines mycorrhizal fertilizer with rice washing water and egg shells was conducted by Zakaria (2013) who proved that the combination of fertilizer affects the growth of tomato plants (*Solanum lycopersicum* L.). Firmansyah et al. (2015) states that the combination of organic and biological fertilizers has a significant effect on the yield of wet and dry bulb weights in onion plants.

Research on organic fertilizer of rice washing water and eggshells has been carried out on cayenne pepper plants (*Capsicum frutescens* L.), but combination with mycorrhizal biofertilizer has not been carried out. In addition, the right dose or combination of fertilizers should be researched. This study aims to determine the effect of mycorrhizal biofertilizer with the addition of rice washing water and eggshells on the growth of cayenne pepper (*Capsicum frutescens* L.).

MATERIALS AND METHODS

This research was conducted in the green house of Mojokrapak Village, Tembelang District, Jombang Regency, East Java. The research was conducted from February 2022 to July 2022. The materials used were cayenne pepper seeds (*Capsicum frutescens* L.) Anjasmara variety, mycorrhizal biofertilizer Biosaccharofet species *Glomus aggregatum*.

This type of research is an experiment using the Completely Randomized Design method. There were 16 treatments and 4 repetitions consisting of P1: a combination of mycorrhizal fertilizer 2 g + without rice washing water and eggshells; P2: combination of mycorrhizal fertilizer 2 g + rice washing water 100 ml + eggshell 10 g; P3: combination of mycorrhizal fertilizer 2 g + rice washing water 150 ml + eggshell 15 g; P4: combination of mycorrhizal fertilizer 2 g + rice washing water 200 ml + eggshell 20 g; P5: combination of mycorrhizal fertilizer 5 g + without rice washing water and eggshells; P6: combination of mycorrhizal fertilizer 5 g + rice washing water 100 ml + eggshell 10 g; P7: combination of mycorrhizal fertilizer 5 g + rice washing water 150 ml + eggshell 15 g; P8: combination of mycorrhizal fertilizer 5 g + rice washing water 200 ml + eggshell 20 g; P9: combination of mycorrhizal fertilizer 10 g + without rice washing water and eggshells; P10: combination of mycorrhizal fertilizer 10 g + rice washing water 100 ml + eggshell 10 g; P11: combination of mycorrhizal fertilizer 10 g + rice washing water 150 ml + eggshell 15 g; P12: combination of mycorrhizal fertilizer 10 g + rice washing water 200 ml + eggshell 20 g; P13: combination of mycorrhizal fertilizer 15 g + without rice washing water and eggshells; P14: combination of mycorrhizal fertilizer 15 g + rice washing water 100 ml + eggshell 10 g; P15: combination of mycorrhizal fertilizer 15 g + rice washing water 150 ml + eggshell 15 g; P16: combination of mycorrhizal fertilizer 15 g + rice washing water 200 ml + eggshell 20 g.

The parameters tested include: the number of leaves, branches and roots, root lenght, wet weight of the crown and the roots. Plant observation is carried out every week, consisting of observation of the number of leaves and the number of branches on the stem. The leaf count starts from the perfectly open young leaves to the oldest leaves. Observation 56 days after seed transfer to polybag consists of the number of roots calculated based on the position of the roots in the root system and calculated manually using a counter, then root length, wet weight of the crown measured from all parts of the plant except the roots and wet weight of the roots measured from the roots of plants which were cut and cleaned of adhering soil, rinsed and then weighed using digital scale. While the dry weight of the crown and roots was measured from the crown and roots of plants which were cut and then dried in direct sunlight until completely dry for 1 week before being weighed using analytical balance.

Analysis of the data that has been obtained using statistical tests. In this analysis, normality and homogeneity

tests were carried out. The normality test aims to see whether the data is normally distributed. The homogeneity test aims to see whether the variants of several populations are homogeneous or not. Data that distributed normal and homogeneous continued with the One Way Anova (Analysis of Variances) test and follow-up test or Post Hoc Duncan's. While data that are not normally distributed are continued with other test alternatives, namely the Kruskal-Wallis H. and Mann-Whitney U tests.

RESULTS AND DISCUSSION

Research on the effect of mycorrhizal biofertilizer application with the addition of rice washing water and eggshells on the growth of cayenne pepper plants (*Capsicum frutescens* L.) which has been carried out produces some data by measuring several parameters.

Number of Leaves

Based on the One Way Anova test, the significance value in the observation of the number of leaves did not differ significantly between one treatment to another because the value was >0.05, which is 0.323. But based on the data presented in Table 1. it shows a difference in the average value of each treatment.

The highest average was shown by P8, a combination of mycorrhizal biofertilizer 5 grams with rice washing water 200 ml and eggshells 20 grams, namely 25,125 leaves. Based on this treatment, the combination of fertilizers provided was very sufficient for nutritional needs and works optimally in stimulating leaf formation. According to research by Nainggolan et al. (2020), mycorrhiza 5 grams is able to work optimally in helping the roots to supply the availability of N elements in the soil. The dose of rice washing water 200 ml to increase plant growth is also in accordance with the research of Sudartini et al. (2020) and Fadli et al. (2021). While the dose of eggshells 20 grams refers to the research of Gadu et al. (2018), this dose is very effective to increase plant growth especially with the addition of rice washing water.

The lowest average was shown by P4, a combination of mycorrhizal biofertilizer 2 grams with rice washing water 200 ml and eggshell 20 grams which is 11,775 leaves. The mycorrhiza given in this treatment is a low dose, this affects the less optimal absorption of nutrients from the soil, rice washing water and eggshells. In accordance with the research of Nainggolan et al. (2020) that mycorrhizal doses below 5 grams have not been effective for increasing plant growth. So even though the nutritional content of rice washing water and eggshells is given in high doses, it has not affected growth because the dose of mycorrhiza is too low so it cannot help the roots absorb nutrients in the soil.

The higher and lower doses of mycorrhizal given, the results did not have a good effect on the number of leaves. This is not comparable to the higher the doses of rice washing water and eggshells given, the results are very influential. As explained by Kogoya et al. (2018) in his research, the dose of fertilizer given to plants must be given in sufficient quantities to meet their nutritional needs. If nutrients are lacking, the plants will also give a less growth response (Sheliana et al., 2018) and can cause nutrient poisoning in plants if too many nutrients are absorbed (Kogoya et al., 2018).

Mycorrhiza helps plants absorb nutrients. More than 50% of nutrient absorption in the soil is supplied from the associations of plants with mycorrhiza (Adetya et al., 2018). Rombe and Pakasi (2020) in their research stated that rice washing water contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe) and vitamin B1. The addition of eggshells as a combination will increase the content of Phosphorus (P), Calcium (Ca) and Potassium (K). The formation of the leaves itself is closely related to the role of available nutrients. The nutrients N (nitrogen), P (phosphorus) and K (potassium) are very influential elements. According to Haryadi et al. (2015) and Rizal (2017) element N plays a role in the formation of plant cells, tissues and organs. Element N helps the process of cell division and enlargement so that leaves are formed and grow faster. Element P plays an important role in the process of plant metabolism as a form of photosynthesis needs in the form of phosphate sugar, where the photosynthate produced from photosynthesis will be used by plants in plant growth and development. While the K element has a role in regulating the movement of stomata which can increase the growth of the number of leaves. The content of N, P, K and other nutrients found in rice washing water and eggshells is what affects leaf formation.

Number of Branches

Based on the Kruskal-Wallis H. statistical test, the significance value in the observations did not differ significantly between one treatment to another because the value was >0.05, namely 0.247. But based on the data presented in Table 1. shows a difference in average values in each treatment although not too significant.

The highest average was shown by P8, a combination of mycorrhizal biofertilizer 5 grams with rice washing water 200 ml and eggshells 20 grams, namely 11.25. Based on the observational data, the combination of fertilizers provided is very sufficient for nutritional needs and works optimally in stimulating the formation and propagation of the number of branches. In accordance with the research of Nainggolan et al. (2020) that mycorrhiza with a dose of 5 grams given to growing media was proven to produce better vegetative and generative growth of plants. Fadli et al. (2021) in his research also stated that plants fertilized with 200 ml rice washing water produced a greater number of branches among other treatments. In accordance with Hamidah and Andi (2020) which stated that rice washing water affects plant height and the number of branches. While the calcium content in the eggshell helps supplement plant nutrition for the formation of branche

The dose of 20 grams of eggshell is very effective to increase plant growth especially with the addition of rice washing water (Gadu et al., 2018).

The lowest average is shown by P3, a combination of mycorrhizal biofertilizer 2 grams with rice washing water 150 ml and eggshell 15 grams, namely 5.75. According to Nainggolan et al. (2020) The right dose of mycorrhiza is proportional to the amount of nutrient absorption in the soil.

So if the dose is too low, then the absorption of nutrients in rice washing water and eggshells is also not optimal. The dose of 150 ml rice washing water given in this treatment refers to the research of Gadu et al. (2018) which uses 100 ml rice washing water and has a good effect on plant growth, therefore increasing the dose of 150 ml was tried to see if it had a better effect than the dose of previous studies. While the dose of 15 grams of eggshell is in accordance with the research of Makromah et al. (2011) whose results can increase the availability of calcium elements in the soil.

The higher and lower the dose of mycorrhiza given, the results do not have a good effect on branch formation. Meanwhile, the higher the rice washing water and eggshells, the results are very influential. This shows that the provision of rice washing water and eggshells is sufficient to meet the nutritional needs of cayenne pepper plants but absorption is less if the mycorrhiza given is low and excessive if the mycorrhiza given is too much.

Fatikah et al. (2018) states that giving mycorrhizal can increase the absorption of P nutrients, thus affecting meristematic tissue in the bud which can increase branch development. According to Rombe and Pakasi (2020) in their research, rice washing water contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe) and vitamin B1. The addition of eggshells as a combination will increase the content of Phosphorus (P), Calcium (Ca) and Potassium (K). The formation of branches itself is closely related to the role of available nutrients. Haryadi et al. (2015) and Rizal (2017) mentioned that element N plays a role in the formation of plant cells, tissues and organs. This N element helps the process of cell division and enlargement so as to spur branch growth and increase their number. Wijayanti et al. (2013) states that the nutrient that is needed for branch formation is nitrogen. The nitrogen content in rice washing water given to plants with the right dose will increase the vegetative growth of plants. Supported by the calcium content present in the eggshell. Element P plays an important role in the process of plant metabolism as a form of photosynthesis needs in the form of phosphate sugar, where the photosynthate produced from photosynthesis will be used by plants in plant growth and development.

Root Length

Kruskal-Wallis H. test results (Table 1.) in the root length parameter that has been analyzed is stated significant because the value is <0.05, namely 0.019. This value means that the result of the root length parameter has a significant difference. Because the significance value <0.05, it is continued with the Mann-Whitney U test (Table 2).

Based on the data in Table 2., it is known that some treatments have significant differences with other treatments. The treatment of P1 was significantly different from P9, P10, P11, P12, P15 and P16. The treatment of P2 was significantly different from P15 and P16. The treatment of P5 was significantly different from P10, P11, P12, P15, and P16. The treatment of P9 was significantly different from P16.

The highest average was shown by P16, a combination of mycorrhizal biofertilizer 15 grams with rice washing water 200 ml and eggshells 20 grams, namely 48,500. In this treatment, the dose given to cayenne pepper plant samples is a high dose. Based on the data of observational results, it is known that at high doses of fertilizer, root elongation is also getting better. Mycorrhiza can loosen the soil around the roots so that the roots can easily develop. The use of a 15 grams mycorrhizal dose refers to the research of Halis et al. (2008); Sampurno et al. (2010); Safriyani et al. (2020) which proves that the mycorrhiza dose of 15 grams has a good impact on plant growth and production. The dose of rice washing water of 200 ml to increase plant growth is also in accordance with the research of Sudartini et al. (2020) and Fadli et al. (2021). While the dose of 20 grams of eggshells refers to the research of Gadu et al. (2018), this eggshell dose is very effective to increase plant growth especially with the addition of rice washing water.

The lowest average was shown by P1, a combination of mycorrhizal biofertilizer 2 grams without rice washing water and eggshells, namely 20,500. The mycorrhizal dose given in this treatment is a low dose so that nutrient absorption does not run optimally. In accordance with the research of Nainggolan et al. (2020) that mycorrhizal doses below 5 grams have not been effective for increasing plant growth. According to Adetya et al. (2018) More than 50% of nutrient absorption in the soil is supplied from plant associations with mycorrhiza. Based on the observational data, it can be seen that treatment without the addition of washing water, rice and eggshells affects the root elongation less. Research Purnami et al. (2014) about the effect of rice washing water and Huda (2020) about the effect of eggshells on plant growth stated that these two ingredients are very helpful for plants in meeting their nutritional needs.

The higher the dose of mycorrhiza given, the results are also very influential on root length. Comparable to the higher dose of rice washing water and eggshells given, the results are very influential. This shows that the application of rice washing water and eggshells is appropriate and sufficient to meet the nutritional needs of plants in root elongation, but their absorption in plants is affected by the mycorrhizal dose given. If the dose given is low, the root elongation process will not be optimal. According to Sheliana et al. (2018) less nutrient concentration will inhibit plant metabolic processes. In accordance with the statement of Kogoya et al. (2018) that the dose of fertilizer given to plants must be given in sufficient quantities to meet their nutritional needs. According to Eliyani et al. (2022) plants symbiotic with mycorrhiza can extend their root system. Mycorrhiza enters the root tissue of plants and penetrates the cortex then forms mycelium which will increase the extension of the root coat, along with that the roots of the plant will also be longer.

This is in accordance with Adetya et al. (2018) which states that the presence of mycorrhizae symbiotic with plants will make roots easier to develop and extend. Purnami et al. (2014) in his research stated that rice washing water contains vitamin B1 which affects root length. In addition, rice washing water also contains Mn elements that can deactivate the enzyme IAA (Indole Acetic Acid) Oxidase which functions to break the auxin hormone. The auxin hormone itself plays a role in cell division which affects plant height

Tabel 1. The average yield of *Capsicum frutescen*s L. growth of all parameters

Treatment Data	Number of Leaves	Number of Branches	Root Length	Number of Roots	Wet Weight of Crown	Wet Weight of Roots	Dry Weight of Crown	Dry Weight of Roots
P1	15,925±3,9778	7,25±1,708	20,500±7,0475	47,500±4,9329	7,000±2,4495	3,250±1,8930	1,725±0,6652	1,000±0,7789
P2	15,550±3,9383	7,00±1,155	32,750±5,9090	56,250±12,5000	10,250±4,0311	5,000±1,8257	2,700±1,2302	1,475±0,6131
P3	13,200±3,3675	5,75±3,3675	35,500±10,8781	58,000±13,3915	6,750±2,2174	2,750±0,9574	2,500±1,3589	1,725±1,6049
P4	11,775±4,0582	6,50±4,0582	36,500±7,6811	65,750±9,9457	8,750±4,5735	4,500±3,6968	1,900± 1,3736	1,375±1,3672
P5	17,000±3,6670	6,75±3,6670	28,250±3,8622	52,250±9,6047	7,500±4,0415	2,750±0,9574	1,550± 0,8813	0,750±0,5196
P6	16,100±7,1148	8,75±7,1148	36,500±10,8474	59,500±9,2556	8,000±2,1602	2,750±0,5000	1,950± 0,5972	0,975±0,3862
P7	21,275±7,0628	9,25±7,0628	37,750±6,8496	84,000±20,1990	13,250±5,1235	4,250±0,9574	2,850± 1,0661	1,500±0,2944
P8	25,125±11,8148	11,25±11,8148	37,500±11,8148	105,750±76,6741	16,250±14,0564	4,500±3,6968	4,400± 3,9791	1,700±1,2832
P9	14,125±2,3415	8,50±2,3415	38,500±2,3415	64,750±16,1529	9,750±2,0616	4,000±1,6330	2,150± 1,1030	0,800±0,6683
P10	21,700±9,9180	9,25±9,9180	39,500±9,9180	76,000±13,9523	13,000±8,0416	4,750±0,9574	1,875± 1,6378	0,775±0,4113
P11	15,150±5,9355	9,25±5,9355	46,000±5,9355	78,000±31,2836	16,750±13,2004	6,000±3,6515	3,575± 3,1256	1,350±1,1269
P12	17,550±5,2259	8,50±5,2259	44,000±5,2259	58,000±14,6969	7,500±3,8730	3,250±1,5000	1,875± 0,8995	0,625±0,5965
P13	16,350±3,3312	7,00±3,3312	38,000±3,3312	57,250±16,7606	9,750±5,373	3,750±2,2174	2,275± 1,7538	0,525±0,1893
P14	17,800±1,4445	8,75±1,4445	33,000±1,4445	56,250±16,5806	6,500±3,0000	2,750±0,9574	1,275± 0,6238	0,425±0,2217
P15	17,475±9,5688	8,50±9,5688	43,750±9,5688	78,750±11,8708	12,500±5,4467	4,250±0,5000	2,550± 1,2557	0,850±0,3317
P16	17,300±4,1384	9,50±4,1384	48,500±4,1384	84,750±9,9791	10,500±3,6968	4,250±1,7078	2,625± 1,0436	0,850±0,4655
Test								

Treatment Data	Number of Leaves	Number of Branches	Root Length	Number of Roots	Wet Weight of Crown	Wet Weight of Roots	Dry Weight of Crown	Dry Weight of Roots
One Way Anova (a=0,05) Sig.	0,323	-						
Kruskal-Wallis H. (a=0,05) Sig.	-	0,247	0,019	0,015	0,450	0,350	0,595	0,185

Tabel 2. *Mann-Whitney* U. Test Result Root Length

Treatment	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
P1																
P2																
P3	tb	tb														
P4	tb	tb	tb													
P5	tb	tb	tb	tb												
P6	tb	tb	tb	tb	tb											
P7	tb	tb	tb	tb	tb	tb										
P8	tb	tb	tb	tb	tb	tb	tb									
P9	b*	tb	tb	tb	b*	tb	tb	tb								
P10	b*	tb	tb	tb	b*	tb	tb	tb	tb							
P11	b*	tb	tb	tb	b*	tb	tb	tb	tb	tb						
P12	b*	tb	tb	tb	b*	tb	tb	tb	tb	tb	tb					
P13	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb				
P14	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb			
P15	b*	b*	tb	tb	b*	tb	tb	tb	tb	tb	tb	tb	tb	tb		
P16	b*	b*	tb	tb	b*	tb	tb	tb	b*	tb	tb	tb	tb	tb	tb	

Description : b: real different tb: no real difference The sign (*) behind the number indicates that the value is significantly different from each treatment tested, because the value is <0.05.

Source : Research Data, 2022

and root length. Huda's (2020) research on eggshells also states that organic fertilizer from eggshells significantly affects root growth. The content of Ca (calcium) in the eggshell affects the meristem tissue in the roots, so the volume of the roots increases and accelerates plant growth.

Number of Roots

Kruskal-Wallis H. test results(Table 1.) In the parameter the number of roots that have been analyzed is declared significant because the value is <0.05 which is 0.015. This value means that the result of the root number parameter has a noticeable difference. Because the significance value <0.05, it is continued with the Mann-Whitney U test (Table 3.). Based on the data in Table 3., it is known that some treatments have significant differences with other treatments. The treatment of P1 differs markedly from that of P4, P7, P8, P10, P15 and P16. The treatment of P2 differs markedly from that of P15 and P16. The treatment of P5 differs markedly from that of P15, and P16. The treatment of P6 differs markedly from that of P16.

The highest average is shown by P8, a combination of 5 grams of mycorrhizal biofertilizer with 200 ml of rice washing water and 20 grams of eggshell which is 105,750. Based on this treatment, the combination of fertilizers provided is very sufficient for plant nutritional needs and works optimally in spurring root growth. This is in accordance with the research of Nainggolan et al. (2020) that the 5-gram mycorrhiza given to the planting media is able to work optimally in helping the roots to supply the availability of N elements in the soil. Hastuti et al. (2007) stated in his research that arbuscular mycorrhizal inoculation was proven to increase the number of roots. Plants whose root systems are symbiotic with mycorrhiza will develop better than those that are not. The dose of rice washing water of 200 ml to increase plant growth is also in accordance with the research of Sudartini et al. (2020) and Fadli et al. (2021). While the dose of 20 grams of eggshells refers to the research of Gadu et al. (2018), this eggshell dose is very effective to increase plant growth especially with the addition of rice washing water.

The lowest average was shown by P1, a combination of 2 grams of mycorrhizal biofertilizer without rice washing water and egg shells which was 47,500. The mycorrhizal dose given in this treatment is a low dose. If the mycorrhizal dose given to plants is low, then nutrient absorption does not run optimally. In accordance with the research of Nainggolan et al. (2020) that mycorrhizal doses below 5 grams have not been effective for increasing plant growth. According to Adetya et al. (2018) More than 50% of nutrient absorption in the soil is supplied from plant associations with mycorrhiza. Based on the observational data, it can be seen that treatment without the addition of washing water of rice and eggshells affects the number of roots. Research Purnami et al. (2014) about the effect of rice washing water and Huda (2020) about the effect of eggshells on plant growth stated that these two ingredients are very helpful for plants in meeting their nutritional needs.

The higher and lower the dose of mycorrhiza given, the result has no good effect on the number of roots. This is not comparable to the higher the dose of rice washing water and eggshells given, the results are very influential. The provision of rice washing water and egg shells is appropriate and sufficient to meet the nutritional needs of plants in increasing the number of roots. As explained by Kogoya et al. (2018) in his research, the dose of fertilizer given to plants must be given in sufficient quantities to meet their nutritional needs. If nutrients are lacking, plants will also provide less growth response (Sheliana et al., 2018). This shows that the provision of rice washing water and eggshells is appropriate and sufficient to meet the nutritional needs of plants in root growth but their absorption in plants is also influenced by the mycorrhizal dose given.

According to Susilo (2018), mycorrhizal provision helps plants obtain essential nutrients that make up plant vegetative growth, namely P elements to increase plant growth, one of which is roots. Plant nutrients that are given rice washing water and eggshells are more fulfilled than those that are not. Bahar (2016) states that the content of P elements in rice washing water can encourage the growth of shoots and plant roots. According to Salpiyana (2019) in her research, eggshells contain calcium carbonate (CaCO3) which can neutralize soil acidity. In addition, elemental calcium can accelerate root formation and growth. Based on this explanation, the influence of rice washing water and eggshells is very helpful in meeting the nutrients needed by plants.

Wet Weight of the Crown

Kruskal-Wallis H. test results (Table 1.) In the wet weight parameter of the header that has been analyzed it is declared insignificant because the value is >0.05 which is 0.450. This value means that the result of the header wet weight parameter has no noticeable difference. Because the significance value is >0.05, it is not continued with the Mann-Whitney U test. but based on the average data presented in Table 1. shows different results.

The highest average is shown by P11, a combination of 10 grams of mycorrhizal biofertilizer with 150 ml of rice washing water and 15 grams of eggshells of 16,750. Based on the observed data, the combination of fertilizers given is very sufficient and works optimally in meeting the nutritional needs of cayenne pepper plants which are useful for increasing the wet weight of the header. The use of mycorrhiza of 10 grams refers to the research of Herawati et al. (2020) which proves that 10 grams of mycorrhiza has a good impact on soil organic C and has the potential to increase P concentrations in plant tissues. Azman (2016) and Matondang et al. (2020) in his research stated that mycorrhiza of 10 grams was able to increase the wet weight of chili plants.

The dose of rice washing water 150 ml refers to the study of Gadu et al. (2018) which uses 100 ml rice washing water and has a good effect on plant growth, therefore increasing the dose of 150 ml was tried to see if it had a better effect than the dose of previous studies. While the dose of 15 grams of eggshells refers to the research of Makromah et al. (2011) which states that at a dose of eggshell 15 grams can increase the availability of calcium elements in the soil. Radha and Karthikeyan (2019) in their research stated that 15 grams of eggshells were proven to be able to produce good plant wet weight. The lowest average is shown by P14, the

application of mycorrhizal biofertilizer 15 grams with the addition of rice washing water 100 ml and egg shells 10 grams which is 20,500. According to Adetya et al. (2018) More than 50% of nutrient absorption in the soil is supplied from plant associations with mycorrhiza. Nainggolan et al. (2020) states that the right dose of mycorrhiza will work optimally to help the roots absorb nutrients in the soil. However, its function is also influenced by the little or the amount of nutrients from the fertilizer given. Based on this, it can be seen that the dose on P14 does not have an optimal effect in increasing the wet weight of the header.

The higher and lower the dose of mycorrhiza given, the result did not have a good effect on the wet weight of the header. Similarly, giving rice washing water and egg shells that are too high and low has little effect. As explained by Kogoya et al. (2018) in his research, the dose of fertilizer given to plants must be given in sufficient quantities to meet their nutritional needs. If nutrients are lacking, plants will also provide less growth response (Sheliana et al., 2018). However, if the nutrients absorbed are too high, it can also make plants poisoned by certain nutrients.

Mycorrhiza has a good impact on soil organic C and has the potential to increase P concentrations in plant tissues, so that it can spur plant growth and development (Fatikah et al., 2018). According to Rombe and Pakasi (2020) rice washing water contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe) and vitamin B1. The addition of eggshells as a combination will increase the content of Phosphorus (P), Calcium (Ca) and Potassium (K). Plant growth and development are related to available nutrients. Nada (2021) in her research stated that the combination of biological and organic fertilizers was proven to have an effect on the wet weight of mustard. Meanwhile, Huda (2020) in her research stated that organic fertilizer made from chicken egg shells can increase the wet weight of lettuce plants. So it can be known that the combination of mycorrhiza as plant fertilizer will help the absorption of nutrients available from rice washing water and eggshells which can increase the wet weight of the header.

Wet Weight of Roots

Kruskal-Wallis H. test results (Table 1.) In the wet weight parameter of the roots that have been analyzed it is declared insignificant because the value is >0.05 which is 0.350. This value means that the yield of the wet weight parameter of the roots has no noticeable difference. Because the significance value >0.05, it was not continued with the Mann-Whitney U test. But based on the average data presented in Table 1. shows different results.

The highest average is shown by P11, a combination of 10 grams of mycorrhizal biofertilizer with 150 ml of rice washing water and 15 grams of eggshell which is 6,000. Rice washing water and eggshells provide nutrients to plants, while mycorrhizae aid nutrient absorption. Based on observational data, the combination of fertilizers provided is very sufficient and works optimally in meeting the nutritional needs of cayenne pepper plants which are useful for increasing the wet weight of the roots. This is in accordance with the research of Matondang et al. (2020) which states that the mycorrhizal dose of 10 grams given to chili plants affects the wet weight of the roots. The dose of rice washing water 150 ml refers to the study of Gadu et al. (2018) which uses 100 ml rice washing water and has a good effect on plant growth, therefore increasing the dose of 150 ml was tried to see if it had a better effect than the dose of previous studies. While the dose of 15 grams of eggshells refers to the research of Makromah et al. (2011) which states that at a dose of eggshell 15 grams can increase the availability of calcium elements in the soil.

The lowest average is indicated by P6, a combination of mycorrhizal biofertilizer of 5 grams with rice washing water of 150 ml and eggshells of 15 grams with an average of 2,750. Based on these values, it can be seen that this combination cannot work optimally in increasing the wet weight of the roots. At the highest and lowest averages, the doses of rice washing water and eggshells given were the same but the mycorrhizal doses given were different. This can happen because the mycorrhizal dose of 5 grams may not be able to absorb nutrients optimally that promote the development of root volume, even though the nutrients available in the soil from rice washing water and egg shells are sufficient.

The higher and lower the dose of mycorrhiza given, the result does not have a good effect on the wet weight of the roots. Similarly, the higher and lower the dose of rice washing water and eggshells given, the results did not have a good effect. Provision of mycorrhiza, rice washing water and egg shells that are suitable to meet the nutritional needs of plants in multiplying the wet weight of roots is a moderate dose. According to Sheliana et al. (2018) Insufficient and excessive nutrient concentration will inhibit plant metabolic processes.

Herawati et al. (2020) which proves that mycorrhiza has a good impact on soil organic C and has the potential to increase P concentration in plant tissue. Adetya et al. (2018) and Eliyani et al. (2022) states that plants symbiotic with mycorrhiza can lengthen the root system and make plant roots easier to develop. According to Rombe and Pakasi (2020) in their research, rice washing water contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe) and vitamin B1. The addition of eggshells as a combination will increase the content of Phosphorus (P), Calcium (Ca) and Potassium (K). Plant growth and development are related to the nutrients available. Nada (2021) in her research stated that the combination of biological and organic fertilizers was proven to have an effect on the wet weight of mustard. Meanwhile, Huda (2020) in her research stated that organic fertilizer made from chicken eggshells can increase the wet weight of lettuce plants. So it can be known that the combination of mycorrhiza as plant fertilizer will help the absorption of nutrients available from rice washing water and eggshells which can increase the wet weight of the roots.

Tabel 3. *Mann-Whitney U.* Test Results Number of Roots

Perlakuan	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11	P12	P13	P14	P15	P16
P1																
P2	tb															
P3	tb	tb														
P4	b*	tb	tb													
P5	tb	tb	tb	tb												
P6	tb	tb	tb	tb	tb											
P7	b*	tb	tb	tb	tb	tb										
P8	b*	tb	tb	tb	tb	tb	tb									
P9	tb	tb	tb	tb	tb	tb	tb	tb								
P10	b*	tb	tb	tb	tb	tb	tb	tb	tb							
P11	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb						
P12	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb					
P13	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb				
P14	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb	tb			
P15	b*	b*	tb	tb	b*	tb	tb	tb	tb	tb	tb	tb	tb	tb		
P16	b*	b*	tb	tb	b*	b*	tb	tb	tb	tb	tb	tb	tb	tb	tb	

Description : b: real different tb: no real difference The sign (*) behind the number indicates that the value is significantly different from each treatment tested, because the value is <0.05.

Source : Research Data, 2022

Dry Weight of the Crown

Kruskal-Wallis H. test results (Table 1.) In the dry weight parameter of the header that has been analyzed it is declared insignificant because the value is >0.05 which is 0.595. This value means that the result of the dry weight parameter of the header has no noticeable difference. Because the significance value >0.05, it was not continued with the Mann-Whitney U test. But based on the average data presented in Table 1. shows different results.

The highest average is shown by P8, a combination of 5 grams of mycorrhizal biofertilizer with 200 ml of rice washing water and 20 grams of egg shells which is 4,400. Based on this combination, it can be seen that rice washing water and eggshells provide enough nutrients for cayenne pepper plants, while mycorrhiza helps optimal absorption of nutrients in the header. Madusari et al. (2018) in his research stated that mycorrhizal doses of 5 grams/plant were able to produce the highest dry weight of plants among other treatments. The dose of rice washing water of 200 ml to increase plant growth is also in accordance with the research of Sudartini et al. (2020) and Fadli et al. (2021). While the dose of 20 grams of eggshells refers to the research of Gadu et al. (2018), this eggshell dose is very effective to increase plant growth especially with the addition of rice washing water.

The lowest average is shown by P14, a combination of mycorrhizal biofertilizer of 15 grams with rice washing water of 100 ml and eggshell of 10 grams which is 1.275. Based on these values, this combination cannot work optimally in increasing the dry weight of the header. The dose of mycorrhiza in this treatment is a high dose, it is possible that mycorrhiza absorbs excessive nutrients so that the growth of chili plants becomes bad due to poisoning certain nutrients. Wibowo et al. (2019) states that plants that are symbiotic with mycorrhiza in large quantities and grow on soils that contain a lot of P elements, then their dry weight is lower than those that are not symbiotic with mycorrhiza. Such as the research of Nainggolan et al. (2020) which states that the right dose of mycorrhiza will work optimally to help the roots absorb nutrients in the soil. So if the dose given is too low and high it will have a negative impact on plants.

The higher and lower the mycorrhizal dose given, the results did not have a favorable effect on the dry weight of the header. This is not comparable to the higher the dose of rice washing water and eggshells given, the results are very influential. As explained by Kogoya et al. (2018) in his research, the dose of fertilizer given to plants must be given in sufficient quantities to meet their nutritional needs. If nutrients are lacking, plants will also provide less growth response (Sheliana et al., 2018).

Mycorrhiza has a good impact on soil organic C and has the potential to increase P concentrations in plant tissues, so that it can spur plant growth and development (Fatikah et al., 2018). Research results of Matondang et al. (2020) states that mycorrhiza has a very real effect on the dry weight of plants. According to Rombe and Pakasi (2020) in their research, rice washing water contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe) and vitamin B1. The addition of eggshells as a combination will increase the content of Phosphorus (P), Calcium (Ca) and Potassium (K). Plant growth and development are related to the nutrients available. Dry weight is related to photosynthate, as it is influential in the growth and vegetative development of plants. A very important element in this process is element P. In addition, photosynthate itself is influenced by the process of photosynthesis which requires a source of sunlight. According to Eliyani et al. (2022) Rainfall, high humidity and low sunlight intensity cause low dry weight because it affects photosynthesis, respiration and nutrient transport in plants.

Dry weight of Roots

Kruskal-Wallis H. test results (Table 1.) In the dry weight parameter of the roots that have been analyzed it is declared insignificant because the value is >0.05 which is 0.185. This value means that the yield of the dry weight parameter of the roots has no noticeable difference. Because the significance value >0.05, it was not continued with the Mann-Whitney test. But based on the average data presented in Table 1. shows different results.

The highest average is shown by P3, a combination of mycorrhizal biofertilizer of 2 grams with rice washing water of 150 ml and eggshells of 15 grams which is 1.725. Based on this combination, it can be seen that rice washing water and eggshells provide enough nutrients for cayenne pepper plants, while mycorrhiza helps optimal absorption of nutrients in the roots. The use of mycorrhizal doses of 2 grams refers to the research of Setiawan et al. (2020) which proves that the mycorrhiza dose of 2 grams has a real influence on plant growth and production. The dose of rice washing water 150 ml refers to the study of Gadu et al. (2018) which uses 100 ml rice washing water and has a good effect on plant growth, therefore increasing the dose of 150 ml was tried to see if it had a better effect than the dose of previous studies. While the dose of 15 grams of eggshells refers to the research of Makromah et al. (2011) which states that at a dose of eggshell 15 grams can increase the availability of calcium elements in the soil.

The lowest average is indicated by P14, a combination of mycorrhizal biofertilizer of 15 grams with rice washing water of 100 ml and eggshell of 10 grams which is 0.425. Based on these values, this combination cannot work optimally in increasing the dry weight of the roots. The dose of mycorrhiza in this treatment is a high dose, it is possible that mycorrhiza absorbs excessive nutrients so that the growth of chili plants becomes bad due to poisoning certain nutrients. Wibowo et al. (2019) states that plants that are symbiotic with mycorrhiza in large quantities and grow on soils that contain a lot of P elements, then their dry weight is lower than those that are not symbiotic with mycorrhiza. Such as the research of Nainggolan et al. (2020) which states that the right dose of mycorrhiza will work optimally to help the roots absorb nutrients in the soil. So if the dose given is too low and high it will have a negative impact on plants.

The higher the dose of mycorrhiza given, the results did not have a good effect on the dry weight of the roots. This is comparable to the higher the dose of rice washing water and eggshells given, the results also have no good effect. As

explained by Kogoya et al. (2018) in his research, the dose of fertilizer given to plants must be given in sufficient quantities to meet their nutritional needs. If nutrients are lacking, plants will also provide less growth response (Sheliana et al., 2018).

Mycorrhiza has a good enough influence to help plants absorb nutrients. More than 50% of nutrient absorption in the soil is supplied from plant associations with mycorrhizae. (Adetya et al., 2018). According to Fikrinda et al. (2007) Arbuscular mycorrhizal inoculation can affect plant growth and development including dry weight. Rombe and Pakasi (2020) in their research stated that rice washing water contains nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), sulfur (S), iron (Fe) and vitamin B1. The addition of eggshells as a combination will increase the content of Phosphorus (P), Calcium (Ca) and Potassium (K). All these nutrients are needed by plants to meet their nutritional needs. According to Eliyani et al. (2022) The dry weight of roots is influenced by the high and low absorption of nutrients absorbed by roots during the growth process. The combination of mycorrhizal biofertilizer with rice washing water and eggshells can increase the dry weight of the roots when given in sufficient doses.

CONCLUSION

Based on the research that has been done, it can be concluded that the effect of mycorrhizal with the addition of rice washing water and eggshells on the growth of cayenne pepper plant (*Capsicum frutescens* L.) has a significant effect on root length and number of roots. This happens because the combination of organic fertilizer and mycorrhiza given to plants works well on the root system. The most effective dose in increasing the growth of cayenne pepper plants (*Capsicum frutescens* L.), which is a combination of 5 grams of mycorrhizal biofertilizer with 200 ml of rice washing water and 20 grams of eggshells on the number of leaves, number of branches, number of roots, and dry weight of the crown. The combination of mycorrhizal biofertilizer 10 grams with rice washing water 150 ml and eggshell 15 grams at the wet weight of the crown and wet weight of the roots. The combination of mycorrhizal biofertilizer 15 grams with rice washing water 200 ml and eggshell 20 grams at root length. The combination of mycorrhizal biofertilizer 2 grams with rice washing water 150 ml and eggshell 15 grams at the dry weight of the roots.

AUTHORS CONTRIBUTIONS

NM considered and planned the experimen. SR and HF improved the experimental design and added growth test parameters for *Capsicum frutescens* L. All authors provided responses and comments on the research flow, data analysis, and interpretation as well as the shape of the manuscript. NM conducted experiments with agreed parameters, wrote data and prepared the manuscript. All authors have read and approved the final manuscript.

CONFLICT OF INTEREST

Declare conflicts of interest or state “The authors declare no conflict of interest.

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