

The Effect Of Mycorrhizal Inoculant And Compost Of Volcanic Ash On Growth And Yield Of Chilli (*Capsicum Annum L.*)

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Abstract. The purpose of this research is to determine the effect of mycorrhizal inoculation and volcanic ash as composting material on growth and yield of chilli. The materials used were mycorrhizal inoculant, chilli seeds of local varieties, cow feces, volcanic ash, EM4, and molasses. This research was conducted in the village Payung, District of Tanah Karo, North Sumatera Province, started from May to September 2015. The research consists of several steps, those were the producing of the compost, analysis of chemical composition, and biological test by cultivating chilli seeds using inoculating micorrhizal and compost of volcanic ash. Observed physical parameters were temperature and pH during the composting process. Observed chemistry parameters were including: organic carbon (C), nitrogen(N), phosphorus (P₂O₅), potassium (K₂O), and C/N ratio. Biological parameters were the plant height, the number of branches, total fruit yield, wet weight root, and root dry weight. Design of the experiment was used factorial randomized block design consisting of two factors and three replications namely providing mycorrhizal consisted of 3 levels ; without any mycorrhizal, with mycorrhizal 3, 5 and 7 g / plant, and compost of volcanic ash consists of 3 levels ; without any compost of volcanic ash, 1, 2 and 3 kg / bed. The data were analyzed with analysis of variance $\alpha = 5\%$, continued by Duncan's Multiple Range Test $\alpha = 5\%$. The result showed that using of volcanic ash as composting matter gave no effect on composting process. Based on the results chemical analysis of the soil showed improved soil fertility (C : 4,25%; N: 1.83%; P: 1.06 ppm; K: 0.35%, C/N : 2,32% and pH: 7.2). Biological test showed that mycorrhizal inoculation 7 g / plant give a real contribution to increase the plant height, the number of branches, total fruit yield, wet weight root, root dry weight. The compost of volcanic ash up to 3 kg / bed show no significant difference on the growth and yield of chilli peppers.

Keywords: inoculation, mycorrhizal, compost of volcanic ash, chilli

INTRODUCTION

Mount Sinabung, which in Karo language we called "Deleng Sinabung", is located in Karo highlands, North Sumatra. The eruption of Mount Sinabung emit bursts of lava and hot clouds, also a volcanic ash. Volcanic ash is composed of large-sized and small-sized rocks, causing huge losses to Karonese farmers [1].

Volcanic ash is a kind of tephra (volcanic extrusion air), which is usually destructive at first, but within a certain time can be useful. Volcanic material consists of large rocks to small-sized, in which the large-sized usually falls around the crater within a radius of 5-7 km, while the small ones fall hundreds or even thousands of kilometers from the crater caused by the wind gusts [2]. Sand and mud particle size range from 0.001 mm to 2 mm. Volcanic ash is not soluble in water, very rough, and somewhat corrosive [3]. Indirectly, the elements contained in volcanic ash contributed to the fertility of the land around the mountain [5].

The physical character of volcanic ash is when it touches the surface of the ground, it will fall quickly, harden, and impenetrable by water either from above or from below the ground surface. This is due to the high enough moisture content of the volcanic ash. At the bottom layer of water where the water content is high enough, it is quite hard coating causes water can not exit through evaporation. One way to resolve is destruction through tillage [6].

The technology accelerated the dissolution of volcanic ash can be done by mixing the ash with organic material. Organic materials containing various kinds of organic acids were able to release the nutrients bound in the mineral structure of a dust explosion. Besides, the organic material is also able to keep moisture conditions that physical weathering, chemical and biological take place simultaneously to speed up the release of plant nutrients from the mineral carrier reserves of nutrients. The release of macro nutrients either attached to the surface of the dust by condensation or as part of the mineralized structure easily weathered (Easily weatherable minerals) are Si, Ca, Mg, K, P and S. In addition, there are also micro elements such as Fe, Zn, Mn and Cu [7].

The addition of mycorrhizae in plant cultivation provides high benefits. The use of mycorrhizae can improve crop production on the environment stress. Results of research [8]. showed that the use of this type of mycorrhiza *Gigaspora margarita* and *Acaulospora* sp. to increase the production of pepper plants in stress condition Al (aluminum). Results of research Agustin et

al., 2010, note that the mycorrhizae to increase the production of chili combined with phosphate fertilizer. Mycorrhizae also play a role in improving the environmental condition of the land, this is evidenced in the research [9]. that mycorrhiza increased the percentage of living plant red meranti used in the rehabilitation of forest land in East Kalimantan. Mycorrhiza can adapt to the environmental conditions that are less suitable for its growth. This is in line with research [10]. which shows that the type of mycorrhiza *Gigaspora margarita*, *Acaulospora* sp. and *glomus* sp. able to survive in the conditions of post-mining land nickel.

Red chili pepper is one of the vegetables are quite important in Indonesia, both as a commodity that is consumed in the country and as an export commodity. Red chili pepper national productivity still very low at 7.34 ton / ha. One effort to increase the productivity of red chili is intensification [11]. Fertilization is one of the important components in the intensification program. Fertilization using inorganic fertilizer by farmers Karo is used these times, with the recommended dose and long term usage, lead to land degradation (decrease in soil fertility). This is evidenced by the results of the analysis of some chemical properties of soil in the study, indicating a very low nutrient content (pH: 5.1; C: 2.24%; N: 0.26%; P <001 ppm; K: 0,05%). The importance of materials or organic fertilizer is very useful for the improvement of agricultural production both in quality and quantity, reduce environmental pollution and improve the quality of land in a sustainable manner. The use of organic fertilizers in the long term can increase the productivity of land and prevent land degradation.

Based on the above need to do research on the effect of volcanic ash compost and mycorrhizal inoculation on growth and yield of red pepper (*Capsicum annum L.*) in the Payung village of Tanah Karo Regency".

This study aimed to determine the effect of volcanic ash compost and mycorrhiza on growth and yield of red pepper (*Capsicum annum L.*) in the Payung village of Tanah Karo Regency.

MATERIAL AND METHODS

This experiment was conducted from May to September 2015 in the Payung village of Payung district, Tanah Karo Regency, with a height of 600 m above sea level. Materials and equipment used were: Taro F1 of *C. annum L* variety, volcanic ash, endomikoriza used is of the genus *gigaspora* and *glomus* mikoriza, bioactivator, chicken manure, dolomite, meter, buckets, plastic mulch,

stakes, analytical balance, drill ground, hand sprayer and other supporting materials.

This study using a factorial randomized block design with two factoris and three replications. The first factor was compost of volcanic ash with four dosages level i.e: volcanic ash 0, 1, 2, 3 ton/ha and the second factor was mycorrhizal consists 3, 5, 7 g / plant. Data were analyzed using analysis variance (ANOVA) followed by DMRT test at $\alpha = 0.05$ probability level.

Implementation research were: composting volcanic ash, nursery, fertilization and inoculation, planting, maintenance and harvesting.

The parameters observed were plant height (cm), stem diameter (cm), the number of productive branches (branch), the weight of fruit per plant (g) and root wet weight (g).

RESULT AND DISCUSSION

a. The plant height (cm)

Average red chili plant height at 2 sampai 10 weeks after transplanting (wat) in the treatment of compost volcanic ash and mycorrhizal can be shown in Table 1.

Table 1. The average plant height (cm) 2-10 MSPT treatment due to the volcanic ash and mycorrhizal

Treatment	2 wat	4 wat	6 wat	8 wat	10 wat
Volcanic ash compost					
V ₀	6.00	17.50	33.63	54.88	56.97
V ₁	5.86	18.10	34.87	57.18	59.38
V ₂	6.33	18.64	35.47	57.88	60.07
V ₃	6.23	19.21	36.95	60.61	62.93
Mycorrhizal					
M ₀	6.06	17.09	32.17	a 52.27	a 54.23
M ₁	6.40	18.41	35.23	b 57.39	b 59.58
M ₂	6.08	18.98	36.63	b 60.15	b 62.43
M ₃	5.88	18.98	36.89	b 60.75	b 63.09

Description : Figures followed by the same letter in the same column no significant effect on the level of $\alpha = 0.05$ by Duncan range test

The results of analysis variance showed that the compost volcanic ash and its interactions with mycorrhizal effect no significant effect on plant height at for all treatments, though not real observations indicate that crops (68.57 cm) in the delivery of 1 ton/ha compost volcanic ash and 5 g mycorrhizal /plant. Mycorrhizal inoculation significantly increased the plant height at age 6 to 10 week affter transplanting. Table 1 shows from age 6 to 10 week affter transplanting seen that treatment M3 (7 g mycorrhizal/plant) is always the highest and significantly different from other treatments.

b. Diameter of the plant stem (cm)

The observation and analysis of variance showed that no interaction between compost volcanic ash and mycorrhizal to the diameter of the plant stem red chilli pepper at all ages observations, although its not significant, it is indicate that the aplication of 1 ton/ha plot compost volcanic ash and 7 g mycorrhizal/plant caused the largest diameter of the plants (10,73cm). Table 2 shows that there are significant differences in mycorrhizal inoculation treatment to the diameter of the plant stem at the age of 4 to 10 week after transplanting.

Table 2 shows from age 4 to 10 wat seen that treatment M3 (7 g mycorrhizal / plant) is always the highest and significantly different from other treatments.

c. Total Productive of Branch

The observation and analysis of variance showed that the compost volcanic ash and its interactions with mycorrhizal effect no significant on the number of productive branches, but although it is not apparent that the composting of volcanic ash 3 ton/hapt and mycorrhizal 7 g/ plant resulted in the number of

productive branches most (Table 3). Table 3 shows that there are significant differences in the number of productive branches as a result of mycorrhizal inoculation at 7 g / plant with treatment without mycorrhizae. The dosage of mycorrhizal inoculation that increased caused the increasing amount of productive branches.

Table 2. The average diameter of the stem of the plant (cm) aged 2-10 weeks after transplanting (wat) treatment due to volcanic ash compost and mycorrhizal

Treatment	2 wat	4 wat	6 wat	8 wat	10 wat
Volcanic ash compost					
V ₀	1.90	3.50	5.71	8.66	8.94
V ₁	2.10	3.72	5.93	8.89	9.18
V ₂	2.08	3.76	6.05	9.11	9.38
V ₃	2.22	3.93	6.29	9.49	9.81
Mycorriza					
M ₀	1.82	3.23	a 5.17	a 7.76	a 8.01
M ₁	2.16	3.77	a 5.98	a 8.95	b 9.23
M ₂	2.10	3.87	ab 6.31	ab 9.56	bc 9.87
M ₃	2.23	4.03	b 6.53	b 9.88	c 10.20

Description : Figures followed by the same letter in the same column no significant effect on the level of $\alpha = 0.05$ by Duncan range test

Table 3. Average number of productive branches (branch) red chilly pepper compost treatment due to the volcanic ash and mycorrhizal

Treatment	Total of productive branch (branch)				
compost volcanic ash					
Mycorriza	V ₀	V ₁	V ₂	V ₃	The mean
M ₀	9.23	11.80	13.23	14.00	12.07
M ₁	13.87	12.77	13.00	12.63	13.07
M ₂	13.23	14.87	12.47	14.23	13.70
M ₃	13.67	12.57	14.33	15.43	14.00
The mean	12.50	13.00	13.26	14.08	13.21

Description: Figures followed by the same letter in the same column no significant effect on the level of $\alpha = 0.05$ by Duncan range test

d. The weight of fruit each plant (g)

The average weight of fruit per plant can be seen in Table 4. The observation and analysis of variance showed that there were significant differences in the weight of fruit per plant on mycorrhizal inoculation treatment, while the compost treatment volcanic ash and mycorrhizal effect is not real, shown that aplication of compost volcanic ash 1 ton/ha and mycorrhizal 5 g / plant produces the highest weight of fruit each plant than others.

Table 4. Average plant fruit weight (g) due to the compost volcanic ash and mycorrhizae

Treatment	Fruit weight for each plat (g)				
compost volcanic ash					
Mycorriza	V ₀	V ₁	V ₂	V ₃	The mean
M ₀	51.13	66.33	73.80	78.77	67.51
M ₁	79.23	72.37	73.70	71.30	74.15
M ₂	74.70	85.27	69.70	81.07	77.68
M ₃	78.50	71.53	81.83	82.80	78.67
The mean	70.89	73.88	74.76	78.48	74.50

Description: Figures followed by the same letter in the same column no significant effect on the level of $\alpha = 0.05$ by Duncan range test

Table 4 shows that mycorrhizal inoculation treatment amounted to 7 g / plant caused the biggest weight of fruit per plant compare other treatments.

e. Weights of Wet Roots (g)

The observation and analysis of variance showed that no interaction between composting volcanic ash with mycorrhiza against wet weight root, but the treatment V3M3 (3 ton of compost ash/ha and 7 g

mycorrhizal/plants) produce wet weight of the largest plant roots. Table 5 shows that there are significant differences in root dry weight as a result of inoculation of mycorrhiza. Inoculation mycorrhiza of M3 (7 g / plant) produce wet weight of the largest plant roots.

Table 5. Average fresh weight of plant roots (g) due to the compost volcanic ash and mycorrhizae

Treatment	Fresh weight of plant roots (g)				
	volcanic ash compost				The mean
Mycorriza	V ₀	V ₁	V ₂	V ₃	
M ₀	23.67	31.00	27.33	26.67	27.17 a
M ₁	33.33	34.67	34.67	38.67	35.33 b
M ₂	35.00	33.00	38.00	41.00	36.75 b
M ₃	38.00	31.67	45.67	48.33	40.92 c
The mean	32.50	32.58	36.42	38.67	35.04

Description: Figures followed by the same letter in the same column no significant effect on the level of $\alpha = 0.05$ by Duncan range test

f. Dry Root Weight (g)

The observation and analysis of variance showed that no interaction between the volcanic ash composting with mycorrhiza on root dry weight, but it appears that the treatment V3M3 (3 ton compost volcanic ash / ha and 7 g mycorrhizal / plants) produce wet weight of the largest plant roots. Table 5 shows that there are significant differences in root dry weight due to mycorrhizal inoculation. Mycorrhizal inoculation of M3 (7 g / plant) causes the greatest root dry weight.

Table 6. Average dry root weight of red pepper plants (g) due to treatment of compost volcanic ash and mycorrhizal

Treatment	Dry root weight (g)				
	Compost volcanic ash				The mean
Mycorriza	V ₀	V ₁	V ₂	V ₃	
M ₀	11.33	9.33	10.00	9.33	10.00 a
M ₁	13.00	12.67	12.67	13.67	13.00 b
M ₂	12.00	13.33	13.67	14.67	13.42 b
M ₃	11.33	14.33	16.33	18.00	15.00 c
The mean	11.92	12.42	13.17	13.92	12.85

Description: Figures followed by the same letter in the same column no significant effect on the level of $\alpha = 0.05$ by Duncan range test

Giving compost volcanic ash and its interactions with mycorrhizal has no real effect on all variables of observation that plant height, stem diameter, number of productive branch, fruit weight, fresh weight and dry root weight. The influence of this unreal allegedly still incomplete due to volcanic ash materials that can decompose to fertilize the soil, so it still takes a relatively longer so that the compost is donating a complete nutrient in the soil so it can be absorbed by plants. The results of the analysis of volcanic ash mineral nutrient content is quite high and beneficial to plants (P₂O₅: 0.56%, K₂O: 0.27%, MgO: 0.05%, Al₂O₃: 7.57%, SiO₂: 68.43% organic C: 0.45%, N: 0.12%, Fe: 15.11%), while the heavy metal content Pb <LOD and Cd <LOD. The result of chemical parameters of composting volcanic ash for one month shown that contents of C-organic, Nitrogen, ratio C/N are 4,57%, 2,18%, 2,06%. Satino, et al.2012, research results mention that to produce the good quality of compost from volcanic ash it must be take time longer. The important parameters untuk know the quality of compost is ratio of C/N between 10-20.

Mycorrhizal inoculation effect on all parameters, this is due to the function of mycorrhiza to improve nutrient uptake through external hyphae especially of P and K that directly affect the growth and yield of chilli pepper (Suherman et al, 2007). Other than that symbiosis with the plant roots has several benefits, such : which helps increase the absorption of plant nutrients, especially P element, able to increase resistance to drought conditions,

diseases or other unfavorable conditions (Moelyohadi, et al 2012, Berman and Dejoong, 1996).

According to [13]. that inoculation of mycorrhizae in the soil will directly benefit in increasing the uptake of water, nutrients and also protects plants from root pathogens and toxins elements, in addition to the mycorrhizal also known synergistically with bacterial solvent phosphate and nitrogen-fixing bacteria.

The presence of mycorrhizal roots both in the network and outside the network can accelerate the growth of plant roots. Mycorrhizae can help phosphorus taking to accelerate the growth of plants. On growth, the carbohydrates overhauled through the process of respiration produces great energy. Remaining carbohydrates are converted into protein and fat. Protein and fat deposited in organs such as stem plants in the form of fibers grow as energy reserves [14]. thus increasing the stem diameter.

Red chili crop production parameters were observed (fruit weight) showed a marked improvement in line with the increase mycorrhizal inoculation. This is due to the improvement of soil fertility has led to increased availability of nutrients in the soil. The nutrients will be absorbed by plants and then used to speed up the process of photosynthesis. As a result, during the vegetative growth, the amount of carbohydrates produced became more widely used as an energy source for growth and the rest will be accumulated in parts (organ) storage of foodstuffs. Materials stored food will be transferred to the reproductive organs (production) during the generative growth.

Mycorrhizae indirectly function in improving soil structure and increase the weathering process of the parent material so that the soil becomes better and contain more nutrients that plants need.

Root growth is strongly influenced by the physical and chemical properties of soil, where the land is fertile, the roots tend to grow and thrive better than in soils hard and dense. Soil aeration also determine the size or length of the short roots, it is closely related to the availability of oxygen needed for root growth and development. With optimal root growth, the absorption of water and nutrients that plants need also be maximized, which in turn will increase the fresh weight of roots and dry root weights. It is evident from the result of the research in where an increase of nutrient in the soil at the study site.

The results of soil analysis before treatment showed a very low nutrient content (pH: 5.1; C: 2.24%; N: 0.26%; P <001 ppm; K: 0.05%), but after the application of compost volcanic ash and mycorrhizae with organic cultivation technology an increased soil fertility (pH: 7.2; C: 4.25%; N: 1.83%; P: 1.06 ppm; and K: 0, 35%).

The interaction of both treatment above is not real thought to be due inoculation of mycorrhizae has contributed with enough nutrients, so it does not affect the treatment of compost to the volcanic ash in the individual treatment has yet to respond real on the growth and production of red chilli resulting compost volcanic ash still takes a long time to fertilize the plants.

CONCLUSION

Treatment of compost volcanic ash has not been able to increased growth and yield of red chilli pepper plants. Treatment of mycorrhizae can increased growth and yiel of red chilli pepper plants, but there is no interaction between the volcanic ash compost with mycorrhizal inoculation for on all parameters observed.

SUGGESTION

It is advisable to continue research using volcanic ash wich is decomposed with perfect as well as varieties of chilli more resistant to extreme climate condition.

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