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The Effectiveness of Mycorrhizal and Nitrogen Fertilizer on the Production of Chili (*Capsicum annuum*) in Tidal Land

Efektivitas Pupuk Mikoriza dan Nitrogen terhadap Produksi Cabai (*Capsicum annuum*) *pada Tanah Pasang Surut*

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ABSTRAK

Penggunaan pupuk mikoriza dan nitrogen dapat dijadikan sebagai alternatif untuk mengatasi masalah di pasang surut yang memiliki berbagai kendala diantaranya rendahnya ketersediaan unsur hara, adanya senyawa toksik, salinitas yang tinggi, dan senyawa pirit untuk dikembangkan sebagai lahan pertanian. Tujuan dari penelitian yaitu untuk mengetahui peranan dari pupuk mikoriza dan nitrogen produksi cabai (*Capsicum annuum)* di tanah pasang surut. Penelitian menggunakan metode Rancangan Acak Kelompok dengan 4 perlakuan diantaranya kontrol, Mikoriza 10 g, Mikoriza 10 g dan urea 0,375 g, Urea 0,375 g yang memiliki 5 ulangan. Sehingga jumlah seluruh perlakuan adalah 20 unit percobaan. Hasil penelitian menunjukkan pemberian pupuk mikoriza 10 g berpengaruh terhadap tinggi tanaman, jumlah daun, luas daun, dan produksi cabai. Tanaman yang memiliki mikoriza memiliki kemampuan menyerap unsur hara makro dan mikro lebih banyak. Adanya hifa jamur mampu memperluas daerah penyerapan hara dan air sehingga nutrisi tanaman tersedia. Rendahnya perlakuan pupuk mikoriza dan nitrogen dikarenakan adanya penurunan efisiensi pemupukan karena pupuk yang diberikan dalam jumlah yang berlebihan.

Kata kunci: hifa jamur, pupuk hayati, unsur hara

ABSTRACT

Mycorrhizal fertilizer and urea can be used as an alternative to overcome problems in the tidal land that have various obstacles including low availability of nutrients, the presence of toxic compounds, high salinity, and pyrite compounds to be developed as agricultural land. The purpose of this research was to determine the role of mycorrhizal fertilizer and urea on the yield of chilli (*Capsicum annuum*) in tidal land. The study used a Randomized Block Design Method with 4 treatments including control, Mychorrhizal 10 g, Mychorrhizal 10 g and urea 0,375 g, urea 0,375 g with 5 replicat. So that the total treatments are 20 units. The results show that the application of mycorrhizal fertilizer 10 g

had affected on plant height, number of leaves, and leaf area. Plants that have mycorrhizae have the ability to absorb more macro and micronutrient. The presence of fungal hyphae can expand the area of absorption of nutrients and water so that plant nutrients are available. The low treatment of mycorrhizal and urea fertilizers was due to a decrease in fertilizer efficiency because fertilizer was given in excessive amounts.

Keywords: biofertilizers, hifa, nutrients

INTRODUCTION

Tidal land are potential as an alternative land in agricultural development even though they are directly affected by tides. Potentials that can be used as alternative land include having sufficient area to be developed (Sarwani, 2013). According to (Susilawati *et al.,* 2016) based on the compilation of swamp maps conducted by BBSDLP (2014), it is known that the tidal swamp area is 14.97 million ha (Figure 1). The land consists of a typology of potential land area of 2.1 million ha, acid sulfate (6.7 million ha), peat (10.9 million ha), and saline (0.4 million ha). However, the natural ecosystems of tidal swamps are lower and thus require appropriate and integrated management technology to increase land productivity. According to the research of (Annisa and Rachman, 2016) with the shrink of agricultural land, the development of agricultural businesses on swamps is very important. According to (Aksani *et al*., 2016) the swamp natural ecosystem is fragile so it requires proper and integrated management to realize a sustainable farming system.

Tidal land has various obstacles when used as agricultural land. These constraints include low soil fertility, high salinity due to the influence of intrusion, high soil acidity (Sihaloho *et al.,* 2015), Mn and H_2S are toxic, and poor micro-water can be a limiting factor for plant growth (Irwandi, 2015). According to Susilawati *et al*. (2016) swampy land naturally has several obstacles including the high acidity of the soil, the dynamics of tidal inundation that is difficult to predict. (Husna, 2014) Adding tidal land is land affected by intrusion of sea water, there is a shallow layer of pyrite which becomes a threat when it is oxidized (Firmansyah and Anang, 2017) very poor in nutrients, difficulty in regulating water system, thick peat layers, and intrusion thus requires extra effort to become productive land for plants. Efforts to overcome problems in the tidal land include making improvements to the land by providing fertilizer to restore the physical, chemical, and biological properties of the soil. Soil improvement using inorganic fertilizers and organic fertilizers such as Arbuscular Mycorrhiza (MA) is the best alternative to increase crop productivity (Suryawati *et al.,* 2011). According to the research of Adetya *et al*. (2018) the use of Arbuscular Mycorrhiza (MA) in sandy soils can increase plant growth. The use of mycorrhizae can increase the availability of nutrients, bind toxic substances, and make plants resistant to drought stress. (Nurhayati *et al.,* 2014) while inorganic fertilizers such as urea play a role in the formation of chlorophyll and leaf area growth. According to Siburian *et al*. (2016) mustard green requires the addition of an efficient application of organic and inorganic fertilizers for its growth in sandy soils. (Djazuli, 2011) added based on research conducted that the use of P fertilizer and mycorrhizae can increase the Purwoceng active ingredients. Meanwhile, according to research of (Ramadhan *et al*., 2015) the use of 10 ton/ ha of gamal fertilizer and 10 g of mycorrhizae can increase the growth of chili. Therefore, the purpose of this research was to determine the role of mycorrhizal fertilizer and urea on the yield of chilli (*Capsicum annum*) in tidal land.

MATERIALS AND METHODS

The research was conducted in the greenhouse at Jalan Terusan, km.6

Sukarami District, Palembang, South Sumatra Province from September to January 2020 while microbial analysis was carried out at the Laboratory of PT. BinasawitMakmur. The method used in this study was a Randomized Block Design Method with 4 treatments 5 replications. With treatment (1) T_0 = Control, (2) T_1 = giving 10 g of Mycorrhizae, (3) T_2 = giving 0.375 g of nitrogen fertilizer (Urea) and 10 g of mycorrhizae fertilizer, (4) T_3 = giving 0.375 g of nitrogen fertilizer (Urea). So the total number of treatments is 5 x 4 = 20 treatments. If the results of variance indicated the treatment had a significant effect, it would be continued to the Least Significant Difference Test (LSD) at the 5% level. The stages of the procedures in conducting this research were as follows:

Research Preparation

The initial stage of research was the literature study by collecting some literatures related to the research. Then, the preparation of a research proposal, selectionof research, preparation of tools and materials, and preparation of needed equipment were conducted for research in the field.

Research Activities

1. Intake of Tidal Swamp Soil

Tidal swamp soil was taken in the SematangBorang District. The swamp soil that used was 100 kg for 20 pieces of5kg polybags. The swamp soil that was taken as a planting medium was a part of top soil with the depth of 20 cm. The collecting was carried out using a hoe.

2. Chili Seedbed Nursery

The chili seeds were first sown using compost mixed soil as a planting medium with a ratio of 1: 1. Before the seed was planted, the seed was soaked formerly, and thenit was planted on a round rattan tray that has a spacing of 2 cm x 2 cm.

3. Chili Preservation

At the stage of chili preservation during the planting, it was started from stitching, weeding, and eradicating pests. Stitching was done by replacing dead plants and was usually done when the plants had been planted for one week. Meanwhile, pest eradication was done manually.

4. Measurement of Vegetative Mass

Vegetative mass measurements were carried out at the 3 weeks of plant age. Measurements made were included plant height, number of leaves, and leaves widethat carried out until the generative period with measurements done weekly.

5. Biomass Production of Chili

Calculation of chili production was done after 3 months and weighed with an analytical balance and then roasted for 2x24 hours in order to calculate the wet weight and dry weight of the chili (*Capsicum annum*).

RESULTS AND DISCUSSION

The results of plant height measurements are presented in Table 1. In Table 1. the application of mycorrhizal fertilizer and nitrogen does not significantly affect plant height. The table shows that the highest treatment was found in T_1 (mycorrhizal 10 g) with an average of 17.80 cm.While the lowest treatment was in the T_3 treatment (Mycorrhiza and nitrogen fertilizer) with a mean plant height of 14.78. Data on various analyzes of mycorrhizal and urea influences are presented in Table 1. Based on the results of the analysis of Table 1, the application of mycorrhizal fertilizer and nitrogen did not significantly affect the number of plant leaf (Figure 2). The highest treatment was found in T_1 (mycorrhizal 10 g) with 11.83 leaf. While the lowest treatment on T_3 (mycorrhizal fertilizer and nitrogen) with an average of 10.83 strands. The results of leaf area measurement are presented in Figure 3. Based on Figure 3, treatment T_1 has the highest leaf area compared to the other three treatments with an average of 17.12 cm^2.

Whereas for production of chili is presented in Table 1.Based on Table 1.the highest production is in the treatment of T_1 (mycorrhizal fertilizer) with 19.17 g. while

the lowest production is at T_0 (without fertilizer application), which is 10.56 g. The dry weight of the chili is presented in Table 1. The highest value is found in T_1 and the lowest value is in T_0. The results of the analysis of the number spores of mycorrhizal are presented in Figure 4. Based on Figure 4, the highest number of spores is in the treatment of T_1 with 47 spores. While the lowest is at T_3 with 13 spores.

The application of mycorrhizal fertilizer and urea has no significant effect (Table 1) due to the treatment of T_2 (mycorrhizal 10 g and urea fertilizer 0.375 g) resulting in a decrease in fertilizer efficiency so that plant growth is not optimal Nutrients given in excessive amounts will not have an impact on increasing plant height. This is in line with the law of the production curve, the higher the nutrient content is given, the less production. The working principle of mycorrhizae is by infecting roots and producing hyphae intensively so that plants containing mycorrhizae can increase the absorption capacity of nutrients such as N, P, K, Ca, Mg and increase crop yields (Herlina and Syafruddin, 2016). *(Subandi et al.*, 2017) states that the use of biological fertilizers can reduce the efficiency of the use of inorganic fertilizers. If inorganic fertilizers are given in excessive quantities will reduce the productivity of the land.

Table 1. Effects of mycorrhizal and nitrogen fertilizer on height, the growth of the number of leaves, the wet weight, and the dry weight of chili (*Capsicum annum*) with Randomized Block Design Method

Treatment	Average			
	The Height f Chili (cm^2)	The Growth of the Number of Leaves of Chili (Strands)	Chili Wet Weight (g)	Chili Dry Weight (g)
Control	16.26	9.73	10.56	8.68
Mychorrhizal	17.80	11.83	19.17	16.32
Mychorrhizal and urea	16.31	11.13	13.17	11.56
Urea	14.78	10.83	14.93	12.72
Average	16.29	10.88	14.46	12.32

Note: Mycorrhizae and urea were applied at the beginning of planting with different doses of control, T_1 (mycorrhiza 10 g), T_2 (mycorrhiza 10 g and urea 0.375), and T_3 (urea 0.375 g) and 5 replicat. Data points with asterisks denote significant differences ($p < 0.05$), and "ns" indicates no significant difference ($p \geq 0.05$)

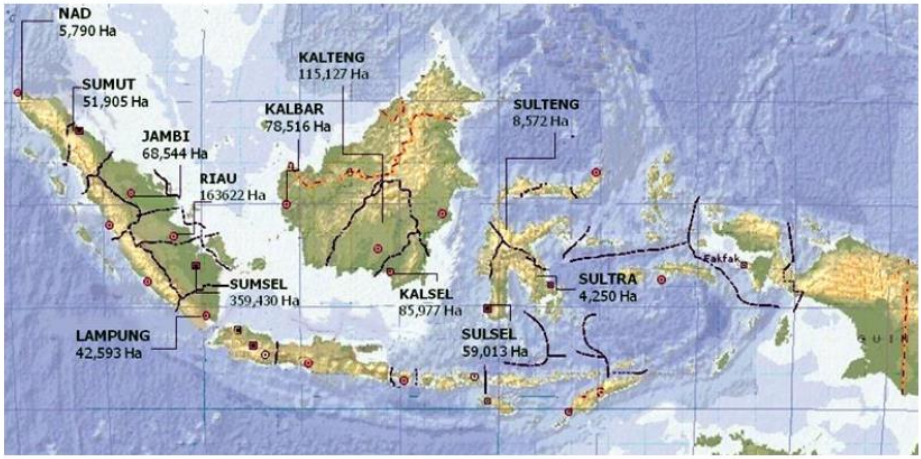

Figure 1. Map of tidal land distribution (BBSDLP, 2014)

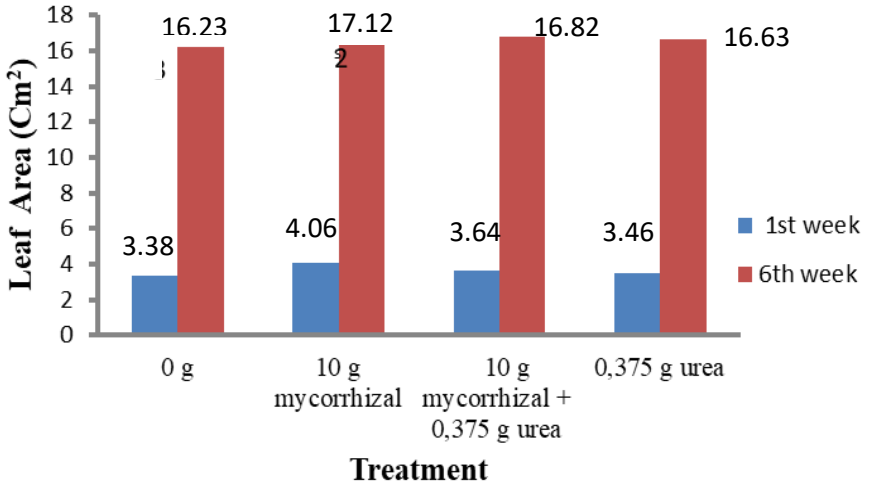

Figure 2. The comparison of the effect of mycorrhizal and nitrogen on plant leaf area (cm^2) in the first and sixth week. Mycorrhizae and urea were applied at the beginning of planting with different doses of T_0 (control), T_1 (mycorrhiza 10 g), T_2 (mycorrhiza 10 g and urea 0.375), and T_3 (urea 0.375 g) and 5 replicat

Based on statistical data that Mycorrhizal 10 g treatment gives an average height of 17.80 cm^2 (Table 1). Mycorrhiza plays a role in increasing the availability of nutrients for plants, due to the ability of mycorrhiza to bind Al and Fe in tidal land causing nutrients available to plants, especially P. Plant height can affect the amount of chili production. The higher the plant, the ability of plants to capture photosynthesis is higher, and the higher the chili yield. According to the results of research (Rofidah *et al*., 2018) the relationship between plant height and yield of red chili (*Capsicum annum* L) has a positive correlation. Plant height character affects fruit weight per plant of 0.412 and 0.8.

Based on the results of research (Herlina *et al*., 2016) that with the addition of mycorrhizae can increase the growth and activity of soybean roots through external hyphae so that the absorption of nutrients and water is more. Furthermore (Oktaviana and Harso, 2019) said to overcome the problem of drought and limited nutrients in the soil which can be a limiting factor in plant cultivation can utilize JMA as an input of microbial technology that might be developed. According to research (Afrinda and Islami, 2018) by giving mycorrhizae can increase the growth of peanuts. That is because the presence of external hyphae that grow expansively can increase the absorption of nutrients, especially phosphate (P). Phosphate (P) plays a role in the process of photosynthesis, decomposition of collaboration, and synthesis of organic compounds to increase plant height. While the smallest treatment was found in the T_4 (Urea 0.375 g) treatment with an average plant height of only 14.78 cm. The low plant height in the treatment of T_4 (Urea 0.375 g) due to nitrogen nutrients available in the soil is not enough for vegetative development of plants. That is because nitrogen is a mobile, easy nutrient washed, and volatile.

According to research (Siburian *et al.*, 2016) urea and liquid organic fertilizer administration did not significantly affect plant height. That is because there is a balance in providing nutrients. The nature of urea that is easily available and dissolves quickly makes the availability of urea nutrients much shorter.. The highest number of leaves produced by treatment 10 g mycorrhiza (Table 1). That is because plants with mycorrhiza can absorb macro and micronutrients more than without mycorrhizae with the help of external and internal hyphae mycorrhizal can absorb nutrients that are not available to be available to plants.According to research

(Ridwan *et al*., 2018) the use of biological fertilizers can increase the growth and yield of corn, pakcoy, and peanut crops. That is because with the presence of mycorrhizae able to increase the hormone IAA (Indole Acetic Acid) around 73-159% which plays a role in increasing growth such as the amount so that the yield of peanuts, pakcoy, and corn increases.

The number of leaves also affects the yield, because the more the number of leaves the more photosynthesis and the higher the chili yield. According to research (Idayanti and Purnamaningsih, 2018) the more fruit, the more leaves, the wider the canopy, and the longer the harvest, the higher the yield of cayenne pepper. A large number of leaves will contribute in the form of photosynthesis that many.

Figure 3. Effect of mycorrhizae and nitrogen on plant height per treatment. Mycorrhizae and urea were applied at the beginning of planting with different doses of T_0 (control), T_1 (mycorrhizal 10 g), T_2 (mycorrhizal 10 g and urea 0.375), and T_3 (urea 0.375 g) and 5 replicat

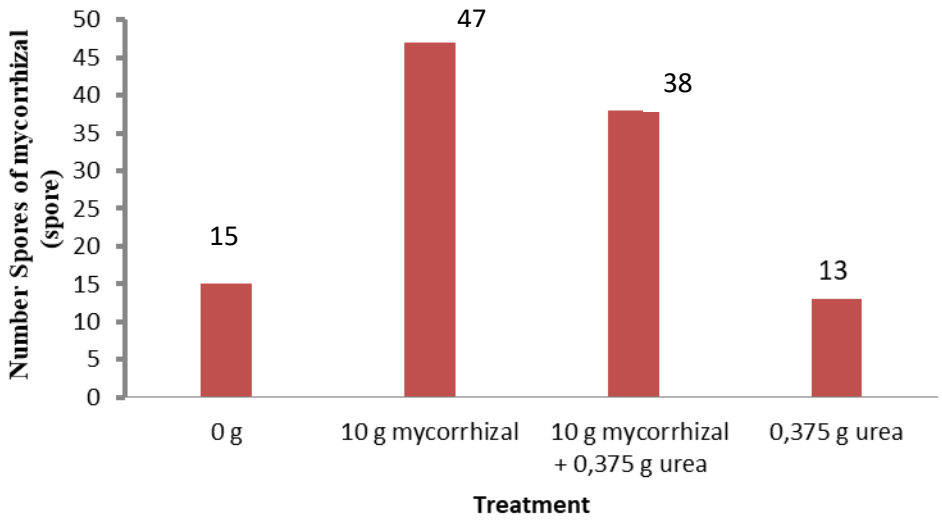

Figure 4. The comparison of the effect of mycorrhizae and nitrogen on the number of spores per treatment. Soil sampel are taken random with different doses of T_0 (control), T_1 (mycorrhiza 10 g), T_2 (mycorrhizal 10 g and urea 0.375), and T_3 (urea 0.375 g) and 5 replicat. Data source: PT. Binasawit Makmur Tbk

T_1 treatment had the highest leaf area compared to the other three treatments (Figure 3). That is because the administration of mycorrhizal influences the addition of leaf area. Giving mycorrhizae can increase nutrient uptake especially N, and P of plants through hypha which is contained in mycorrhiza can expand the absorption area and cause nutrients. which is not available becomes available to plants. According to research (Adetya *et al.*, 2018) states that more than 50% of the N nutrients needed by plants are produced by mycorrhizal associations.

Through the fungus arbuscular mycorrhizal fungus can utilize inorganic N such as NO_3 and NH_4 more efficiently and transfer it into the soil as far as 10-30 cm through the external hyphae of Glomus intergradation. Nitrogen plays a role in the addition of protein in plants so that it can increase the area of leaves and leaves grow wider. While the P element plays a role in the formation of plant tissue, especially leaves and plant organs to produce. According to (Adetya *et al*., 2018) phosphate (P) plays a role in the formation of enzymes, nucleic acids, fat and protein formation as well as the formation of meristem tissue. Phosphate deficiency causes slow leaf growth and a reduced number of leaves.

The effect of mycorrhizal fertilizer and nitrogen does not significantly affect the production of chili (*Capsicum annum*) The T_1 (mycorrhizal 10 g) treatment can give better results compared to other treatments (Table 1). That is because the administration of mycorrhizae can increase nutrient uptake with mycorrhizal spore infections in plant roots. This is in line with research (Afrinda and Islami, 2018) that by giving mycorrhiza can increase P uptake in plants that function in increasing peanut yields. Besides, the T_1 (Mycorrhizal 10 g) treatment was able to produce the highest plant height, have the most number of leaves, and the largest leaf area so that the highest yields. According to research (Murniati *et al*., 2013) chili plants that produce many flowers are high chili plants, have a large number of leaves and a large leaf area. Based on Figure 4. The low treatment of T_2 (mycorrhizae and urea fertilizer) due to nutrients present in the soil is available so that mycorrhizal spores reduce the amount of infection because basically, mycorrhizal fungi play a role in adding nutrient elements. This is in line with research (Saputra *et al.*, 2015) higher the nutrient levels in the soil for plants, the lower the MVA fungal infection.

CONCLUSION

Addition mycorrhizae and urea (10 g mychorrhizal and 0,375 g urea) had no significant effect on the growth of chili (*Capsicum annum*). Treatment with mycorrhizal (T_1) effect on plant height, number of leaves, leaf area, and chili yields. Plants that have mycorrhizae have the ability to absorb more macro and micronutrient. The presence of fungal hyphae can expand the area of absorption of nutrients and water so that plant nutrients are available.

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