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Exploration on Biological Resources to Reduce Carbon Emissions and Increase Nutritional Value of Corn (Zea mays) using Arbuscular Mycorrhizal Fungi and Glomalin

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ABSTRACT

Zero emissions have been a prominent topic in recent years, referring to the concept of reducing or eliminating greenhouse gas emissions, particularly carbon dioxide, from human activities such as transportation, energy production, and industrial processes. Agricultural practices, such as excessive or improper application of lime, inorganic fertilizers, and pesticides, can alter the physical and chemical properties of soil, affecting the abundance and diversity of beneficial organisms that support plant growth. have demonstrated that the use of Arbuscular Mycorrhizal Fungi (AMF) and glomalin can enhance protein and amino acid content in plants. The research found that the combined treatment of AMF and glomalin yielded better results than using each treatment separately. Additionally, this study indicated that AMF and glomalin applications could improve micro-nutrient content, including Fe, Zn, and Cu. The research was conducted in the Soil Microbiology and Ecology Laboratory and the Food Production and Analysis Laboratory at the Faculty of Agriculture, Universitas Muhammadiyah Sumatera Utara, from February 2023 to June 2023. The experimental design used was a Randomized Block Design (RBD) with three treatments: control, AMF, and AMF+Glomalin. The conclusion of this research is that the use of AMF and glomalin effectively enhances the nutritional value of corn, particularly in terms of organic matter, carbohydrates, and proteins. The findings are closely aligned with Indonesia's Vision 2045, which aims to increase agricultural productivity, maintain environmental sustainability in farming, secure food supplies, reduce greenhouse gas emissions, encourage sector collaboration, enhance agricultural education, and achieve Sustainable Development Goals (SDGs). The study demonstrates that the use of AMF+Glomalin in agriculture significantly improves soil organic matter, corn nutrition, and sustainable practices, thus contributing to Indonesia's Vision 2045 for a better future.

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1. INTRODUCTION

In recent years, the topic of Zero Emission has gained significant attention, particularly due to the global challenges of climate change and the need for sustainable development. The concept aims to reduce or eliminate greenhouse gas emissions, especially carbon dioxide, resulting from various human activities such as transportation, energy production, and industrial processes. One major source of greenhouse gas emissions, including carbon emissions, is agricultural practices that often involve the use of harmful chemicals. These chemicals can impair the soil's ability to absorb carbon effectively, leading to increased carbon emissions into the atmosphere.

Corn (*Zea mays L*.) plays a crucial role as a food source for the Indonesian population and as a primary raw material for animal feed production. However, corn production in Indonesia is still insufficient to meet domestic needs, and the low nutritional value of corn presents a significant problem that must be addressed. To support food security and sustainable development in Indonesia, enhancing the nutritional value of corn is essential. One approach is to utilize arbuscular mycorrhizal fungi (AMF) and glomalin, which can increase the nutrient content in corn. Thus, efforts to improve the nutritional value of corn should continue to meet the demand for food and animal feed while promoting sustainable development in Indonesia.

Corn growth is influenced by various factors, one of which is the availability of nutrients in the soil. One strategy to enhance nutrient availability for corn is to use AMF and glomalin. A diverse soil community not only helps prevent losses due to soil-borne pests and diseases but also accelerates the decomposition of organic matter and toxic compounds, improves nutrient cycling, and enhances soil structure. Microorganisms are the most abundant members of soil biota, including species responsible for nutrient mineralization and cycling, antagonists (biological control agents against plant pests and diseases), species that produce substances capable of modifying plant growth, and species that form mutually beneficial (symbiotic) relationships with plant roots. The rhizosphere is a zone directly influenced by plant roots and has a high population of active microorganisms. In the rhizosphere, plant roots affect the microbial community by releasing photosynthates, promoting the growth and development of plant-associated organisms (Napoli et al., 2018).

Agricultural practices such as the addition of lime, inorganic fertilizers, and pesticides can alter the physical and chemical properties of the soil environment, thereby changing the number of organisms and the ratio of various organism groups. Since plant health is closely related to soil health, managing soil in a way that preserves and enhances soil biota can improve crop yield and quality. Unfortunately, soil biological responses are often overlooked or unnoticed, resulting in rapid changes with unintended consequences, particularly concerning long-term soil health and agricultural sustainability.

Previous studies have demonstrated that the use of arbuscular mycorrhizal fungi and glomalin can increase nutrient availability for corn. For example, research by Nisa et al. (2021) showed that the use of arbuscular mycorrhizal fungi could increase the availability of nitrogen and phosphorus in corn. Similarly, a study by Tripathi et al. (2019) indicated that glomalin application could improve nutrient availability for corn.

In addition to increasing nutrient availability, using arbuscular mycorrhiza and glomalin can also enhance corn plant productivity. Research by Kusmiyati et al., (2020) showed that using arbuscular mycorrhiza could increase corn yield by up to 30%. Likewise, Zainab et al. (2020) found that using glomalin could boost corn production.

Enhancing the nutritional value of corn is crucial to achieving sustainable development goals in Indonesia. One of the sustainable development goals in Indonesia is improving community welfare through food security. Increasing corn production and quality can enhance food availability for the population. Additionally, by improving the nutritional value of corn, the community can access healthier food sources.

Therefore, based on the description above, the author is interested in conducting research on the **Exploration on Biological Resources to Reduce Carbon Emissions and Increase Nutritional Value of Corn (*Zea mays*) Using AMF and Glomalin.**

2. METHODS

2.1 Place and time

This research was conducted at the Laboratory of Soil Microbiology and Forest Ecology, Faculty of Forestry, National Pingtung University of Science and Technology, Taiwan from February 2023 to June 2023.

2.2 Research Stages

Table 1. Timeline of research activities

Activity Description	March	April	May
Soil Properties:	■		
Soil Texture, Soil Organic Matter, pH and Water Content	■		
Isolation and Identification of AMF	■		
AMF Colonization	■		
Glomalin:	■	■	
EE-GRSP	■	■	
T-GRSP	■	■	
AMF Inoculation		■	
Single Spora		■	
Pot Experiment		■	■
Data analysis:			■
Zero emission			■
Corn plant nutrition			■

2.3 Materials for Research

The materials used in this study include 11 soil samples from different locations (3 citrus soil samples, 2 pomelo soil samples, 1 pear soil sample, and 6 guava soil samples). Additional materials consist of distilled water (DD water), potassium dichromate ($K_2Cr_2O_7$), ferroin indicator, sulfuric acid (H_2SO_4), ferrous sulfate ($FeSO_4$), phosphoric acid (H_3PO_4), 10% potassium hydroxide (KOH), a mixture of 3 mL 20% ammonium hydroxide (NH_4OH) and 30 mL 3% hydrogen peroxide (H_2O_2), 1% hydrochloric acid (HCl), 0.005% tropaeolin blue (tropaeolin blue solution with a concentration of 0.005%), arbuscular mycorrhizal fungi (AMF), glomalin, and sand.

2.4 Research Equipment

The equipment used in this study includes an oven, shaker, pH meter, beaker glass, digital scale, platform shaker, filter paper no. 2, spatula, Kjeldahl apparatus, 35 mm mesh sieve, dropper pipette, filter paper, heating machine, digital balance, magnetic stirrer, Erlenmeyer flask, gloves, hoe, pots, and a microscope.

2.5 Research Methodology

The study employed a factorial Randomized Block Design (RBD) consisting of a single factor. The aim of this research is to investigate the ability of Arbuscular Mycorrhizal Fungi (AMF) to reduce emissions and enhance the nutritional value of corn (Zea mays). The research will be conducted through three distinct treatments.

Treatment 1 **Treatment 2** **Treatment 3**

Figure 1. Research experimental design

In the first treatment, corn plants will be left without any additional interventions. This aims to establish baseline data on the growth, emissions, and nutritional value of corn plants under natural conditions, without the influence of AMF.

In the second treatment, corn plants will be subjected to the addition of three AMF spores into the root system. The goal of this treatment is to determine whether the presence of AMF can enhance the nutritional value of the corn plants and reduce the emissions produced by the plants.

In the third treatment, corn plants will receive an intervention with the addition of three AMF spores along with glomalin to the root system. Glomalin, a compound produced by AMF, plays a crucial role in soil structure formation and nutrient retention. This treatment will investigate whether the addition of glomalin, in conjunction with AMF, can further improve the effectiveness of emission reduction and nutritional enhancement in corn plants.

2.6 Data Processing Method

Data processing and compilation were conducted using Microsoft Excel 2003. Statistical analysis was performed using IBM SPSS software version 19.0 (IBM Corporation, New York, NY, USA). Pearson correlation analysis was employed to test the relationship between Soil Organic Matter (SOM) and Glomalin-Related Soil Protein (GRSP), as well as between GRSP and AM-like fungi abundance. All graphs were created using Origin 8.0. To analyze the effect of GRSP concentration using dependent variables and SOM content or AM-like fungi abundance as independent variables, and to assess the significant impact on the nutritional outcomes of corn for each treatment, a one-way ANOVA was conducted, followed by Tukey's test for multiple comparisons at a significance level of $p < 0.05$, including the testing of corn nutritional values.

2.7 Research Steps

2.7.1 Soil Texture Measurement Procedure

To determine soil texture, the first step is to prepare a 50-gram soil sample in a mixing glass. Next, add 300 ml of deionized water (DD Water) and 10 ml of phosphoric acid solution (H_3PO_4) into the mixing glass containing the soil sample. The suspension is then stirred with a mechanical stirrer at low speed for 5 minutes to ensure even mixing. After stirring, the sediment solution is poured into a 1500 ml sedimentation tube. Add more DD Water until the total volume reaches 1050 ml in the tube. The solution is homogenized by stirring for 20 seconds to ensure the soil particles are evenly dispersed in the liquid. Next, insert the hydrometer into the solution to measure the suspension particle value (PS). Record the measurement after 40 seconds, and measure the solution temperature with a thermometer to obtain the first temperature (T_1). Then, let the sediment solution stand for 2 hours to allow the soil particles to settle. After 2 hours, repeat the measurement using a hydrometer to determine the clay particle value (PC) and measure the solution temperature again to obtain the second temperature (T_2). The data obtained from these measurements will be used to calculate soil texture, including the proportions of sand, silt, and clay.

2.7.2 AMF Isolation Method

For the analysis, a 250-gram sample is taken and placed in stacked sieves of 250, 200, 150, 106, and 53 µm to remove odors and filter the sample. The soil samples filtered at mesh sizes of 150, 106, and 53 µm are collected. The filtered samples are then placed in a 3000 ml glass beaker, and this process is repeated several times until the final sample is obtained and placed in a sample bottle. Next, 20 ml of distilled water is added to the sample, and it is centrifuged for 5 minutes at a temperature of 20-25°C at a speed of 500 rpm. The middle layer of the centrifuged sample is taken and placed on the smallest sieve, which is then washed with clean water. The remaining sample is transferred into a test tube and filled with water to reach 40 ml. To count and identify the sample, 100 microliters are taken from the test tube using a dropper pipette and placed under a microscope. The sample is identified based on its color, which could be black, brown, orange, yellow, or white/transparent. Afterward, the species of the sample are identified.

2.7.3 Glomalin Extraction Procedure

The procedure for extracting Easily Extracted Glomalin (EE-GRSP) begins by adding 1 gram of soil sample to 8 ml of 20 mM sodium citrate solution, adjusted to a pH of 7. This mixture is then autoclaved at 121°C with a pressure of 1.4 kg/cm² for 30 minutes. After autoclaving, the extract is centrifuged at 3220 G for 15-20 minutes. The supernatant obtained is then poured off and stored at 4°C for further analysis. To extract Total Glomalin (TG), add 1 gram of soil sample to 8 ml of 50 mM sodium citrate solution, adjusted to a pH of 8. The mixture is autoclaved at 121°C with a pressure of 1.4 kg/cm² for 60 minutes. After autoclaving, the extract is centrifuged at 3220 G for 15-20 minutes, and the supernatant is stored at 4°C for analysis. The process is continued by resuspending the soil particles with the same amount of solvent and repeating the procedure until the extract no longer shows the characteristic reddish-brown color of glomalin.

3. RESULT AND DISCUSSION

3.1 Success of AMF Spore Inoculation on Single Spore

The ruptured form of the Arbuscular Mycorrhizal Fungi (AMF) indicates successful inoculation of AMF in corn plants. After inoculation, AMF grows and develops within the corn plant roots, forming a structure known as arbuscular mycorrhiza. The success of inoculation is reflected by the penetration of AMF hyphae into the root tissues and the formation of arbuscular structures, which appear as fine branches or small threads within the root cortex cells.

The ruptured form of AMF shows a successful interaction between AMF hyphae and the corn plant roots. The rupture indicates that a connection has been established between the AMF hyphae and the plant roots, forming a symbiotic network that enables nutrient exchange between the fungi and the plant. Through this symbiotic relationship, AMF can enhance nutrient absorption by the plant roots, particularly phosphate, which is often difficult for plant roots to access independently.

The ruptured AMF form also demonstrates the success of the AMF colonization strategy in the corn plant roots. With the formation of arbuscular mycorrhiza, AMF can help improve the growth, productivity, and resilience of corn plants against unfavorable environmental conditions, such as drought and nutrient deficiency. Therefore, observing the ruptured form of AMF serves as an indicator that the inoculation of AMF in corn plants has been successfully carried out, offering potential benefits to enhance plant health and productivity.

Figure 2. AMF that has ruptured due to inoculation

According to Wang et al. (2016), the rupture of AMF spores is a crucial indicator of the successful inoculation of mycorrhizae in plants. When spores break, it signifies that the mycorrhizal fungi have entered an active phase of forming a symbiotic relationship with the host plant roots. Furthermore, Putra (2013) states that the spore rupture process is an essential stage in the life cycle of mycorrhizal fungi. The rupture of spores exposes hyphae that can grow and penetrate plant root tissues, allowing a mutually beneficial exchange of nutrients between the fungi and the plant. Meanwhile, Yin (2016) mentions that the rupture of AMF spores results from the adaptive response of mycorrhizal fungi to their surrounding environment. Successful inoculation will trigger enzymatic activity, causing the spores to break and initiating the colonization of plants by beneficial mycorrhizal fungi.

3.2 AMF Before and After Inoculation

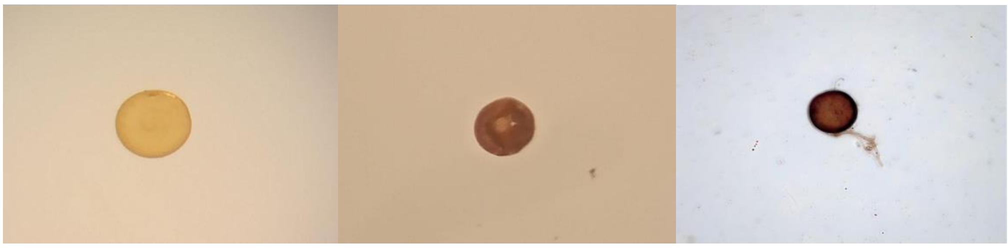


Figure 3. AMF Before Inoculation

Figure 4. AMF After Inoculation

The rupture of AMF structures indicates that AMF inoculation in maize plants has been successful. Following inoculation, AMF grows and develops within the maize roots, forming structures known as arbuscular mycorrhiza. This rupture signifies a successful interaction between AMF hyphae and the maize roots. The breakdown of AMF structures indicates that a connection has been established between the fungi and the plant roots, forming a symbiotic network that facilitates nutrient exchange between the fungi and the plant. Through this symbiotic relationship, AMF enhances nutrient absorption by the plant roots, particularly phosphorus, which is often difficult for plants to access independently. The occurrence of this interaction and the enhanced nutrient absorption are illustrated in the following image:

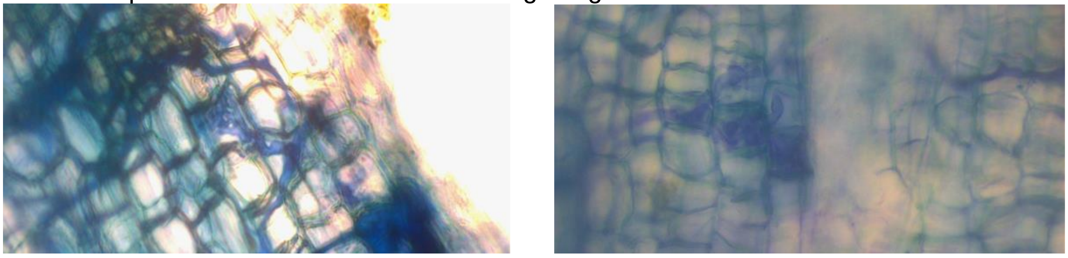


Figure 5. Occurrence of this interaction and the enhanced nutrient absorption

The results of the study provide deeper insight into the ability of AMF to reduce emissions and increase nutritional value in corn plants. In addition, the data obtained can also be a basis for developing more efficient sustainable agricultural strategies in optimizing corn production and quality.

3.3 Result Data for Each Treatment

Tabel 2. Results of treatment data on corn plants

Treatment	OM(%)	T-GRSP	EE-GRSP	Protein Kasar	Karbohidrat	Lemak kasar	Serat kasar
CO1	7.12	1.50	6.75	8.96	74	4.40	25.65
CO2	5.60	0.50	5.40	8.00	70	4.43	25.43
CO3	6.40	1.03	5.00	8.92	72	4.23	25.60
CO4	6.95	1.33	5.70	8.34	73	4.65	24.40
CO5	6.74	0.90	5.80	7.90	73	4.43	25.76
CO6	7.23	0.78	5.50	8.80	72	4.80	25.65
CO7	7.25	2.03	6.80	8.65	74	4.76	26.60
CO8	6.30	1.50	6.60	8.76	72	4.40	25.40
CO9	6.10	1.08	6.23	6.50	72	4.76	25.01
Rataan	6.63±0,19	1.18±0.15	5.97±0.21	8.31±0.26	72.44±0.41	4.54±0.07	25.50±0.19
PA1	8.30	2.54	7.60	8.90	76	4.50	24.40
PA2	8.70	2.68	7.89	8.96	76	4.52	25.63
PA3	9.50	3.05	8.03	8.80	77	4.70	25.60
PA4	8.00	2.56	7.50	8.67	75	4.50	24.43
PA5	7.80	2.00	6.98	8.50	74	4.40	23.40
PA6	9.80	2.40	6.78	9.23	78	4.65	26.50
PA7	8.00	1.98	7.80	8.78	75	4.98	25.89
PA8	8.60	2.40	7.50	8.90	76	4.76	25.80
PA9	8.00	2.87	7.45	8.60	74	4.65	25.40
Rataan	8.52±0,23	2.49±0,11	7.50±0,13	8.51±0.07	75.66±0,44	4.62±0,05	25.22±0,32
PAM1	09.50	3.05	7.80	9.00	79	5.00	24.30
PAM2	10.00	4.50	6.50	9.23	78	4.92	25.76
PAM3	10.20	4.87	7.65	9.70	80	5.02	24.30
PAM4	09.80	3.67	8.80	8.80	77	4.76	26.50
PAM5	10.65	4.76	7.65	9.02	80	4.82	25.30
PAM6	11.63	4.40	9.56	9.45	81	4.40	26.10
PAM7	11.40	4.90	8.80	8.70	81	5.60	25.98
PAM8	10.40	3.50	7.80	9.00	79	4.43	26.50
PAM9	12.30	4.90	9.08	9.50	82	4.60	27.98
Rataan	10.85±0,31	4.28±0,23	8.18±0,31	9.15±0,11	79.66±0,52	4.83±0,12	25.85±0,38

Keterangan: CO=Control, PA=AMF, PAM=AMF+Glomalin

3.4 Effect of Interaction Between AMF and Glomalin Application on SOM Levels

Based on the variance analysis, it was found that the interaction effect of AMF and Glomalin application in each treatment showed a highly significant difference ($p<0.01$) on the soil organic matter (SOM) formation test. The level of these differences has been tested using a mean difference test, as shown in Table 3.

Table 3. Results of the Mean Difference Test for the Effect of Interaction Between AMF and Glomalin Application on Soil SOM Formation

SK	DB	JK	KT	Fhit	Ftab		Ket
					0,05	0,01	
Perlakuan	2	65,324	32,662	74,32	3,4028	5,6136	**
Galat	24	10,547	0,4395				

Total	26	75,871					

Note: tn = not significantly different, * = significantly different, and ** = highly significantly different

Based on Table 3, it can be observed that the interaction of each treatment given among the control, AMF, and AMF+Glomalin treatments shows a highly significant difference (**), as indicated by the F-value (74.32), which is greater than the F-table value at $p<0.05$ (3.4) and $p<0.01$ (5.61).

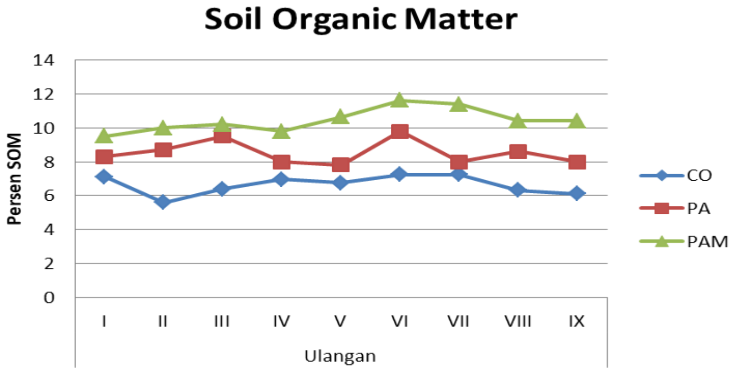


Figure 6. Effect of Treatments on SOM Increase

In Figure 6, it can be seen that the soil organic matter (SOM) content in the PAM9 sample reached the highest value of 12.3, while the CO2 sample exhibited the lowest value of 5.6. This result indicates that the PAM9 treatment significantly increased the soil organic matter content compared to the CO2 treatment.

3.5 Effect of the Interaction Between AMF and Glomalin Application on T-GRSP Levels

Based on the variance analysis, it was found that the interaction effect of AMF and Glomalin application in each treatment showed a highly significant difference (*p<0.01*) on the Total Glomalin-Related Soil Protein (T-GRSP) formation test. The level of these differences has been tested using a mean difference test, as shown in Table 4.

Table 4. Results of the Mean Difference Test for the Effect of Interaction Between AMF and Glomalin Application on T-GRSP Formation

SK	DB	JK	KT	Fhit	Ftab		Ket
					0,05	0,01	
Perlakuan	2	43,577	21,79	79,19	3,4028	5,6135	**
Galat	24	6,6037	0,275				
Total	26	50,181					

Note: tn = not significantly different, * = significantly different, and ** = highly significantly different

Based on Table 4, it can be observed that the interaction of each treatment among the control, AMF, and AMF+Glomalin treatments shows a highly significant difference (**) in the formation of T-GRSP, as indicated by the F-value (79.19), which is greater than the F-table value at *p<0.05* (3.4) and *p<0.01* (5.61).

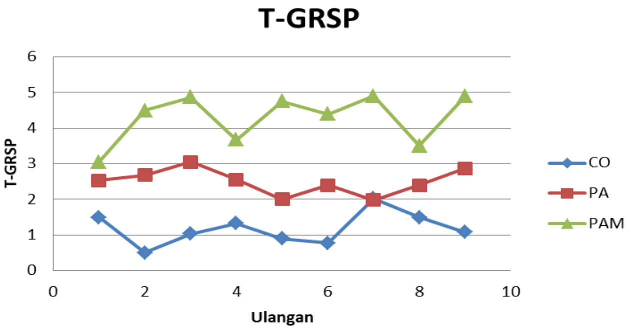


Figure 7. Effect of Treatments on T-GRSP Increase

In Figure 7, we can observe that the Total Glomalin (T-GRSP) content in the PAM9 sample reached the highest value of 4.90, while the CO2 sample exhibited the lowest value of 0.5. These results indicate that the PAM9 treatment has a significant effect in increasing T-GRSP content compared to the CO2 treatment.

3.6 Effect of the Interaction Between AMF and Glomalin Application on EE-GRSP Levels

Based on the variance analysis (Appendix 3), it was found that the interaction effect of AMF and Glomalin application in each treatment showed a highly significant difference ($p<0.01$) on the formation of Easily Extracted Glomalin-Related Soil Protein (EE-GRSP). The level of these differences has been tested using a mean difference test, as shown in Table 5.

Table 5. Results of the Mean Difference Test for the Effect of Interaction Between AMF and Glomalin Application on EE-GRSP Formation

SK	DB	JK	KT	Fhit	Ftab		Ket
					0,05	0,01	
Perlakuan	2	22,99	11,49	23,32	3,402	5,613	**
Galat	24	11,83	0,492				
Total	26	34,82					

Note: tn = not significantly different, * = significantly different, and ** = highly significantly different

Based on Table 5, it can be observed that the interaction of each treatment among the control, AMF, and AMF+Glomalin treatments shows a highly significant difference (**) in the formation of EE-GRSP, as indicated by the F-value (23.32), which is greater than the F-table value at $p<0.05$ (3.4) and $p<0.01$ (5.61).

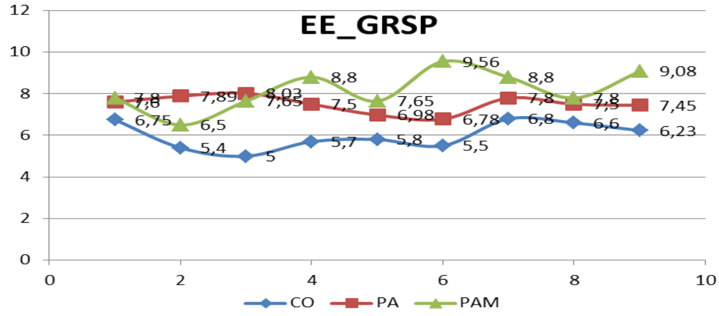


Figure 8. Effect of Treatments on EE-GRSP Increase

In Figure 8, the comparison of Easily Extractable Glomalin (EE-GRSP) content shows that the PAM6 sample reached the highest value of 9.56, while the CO3 sample exhibited the lowest value of 5.00. The graph indicates that the PAM6 treatment significantly contributes to increasing EE-GRSP content compared to the CO3 treatment.

3.7 Contribution of EE-GRSP to SOM Formation

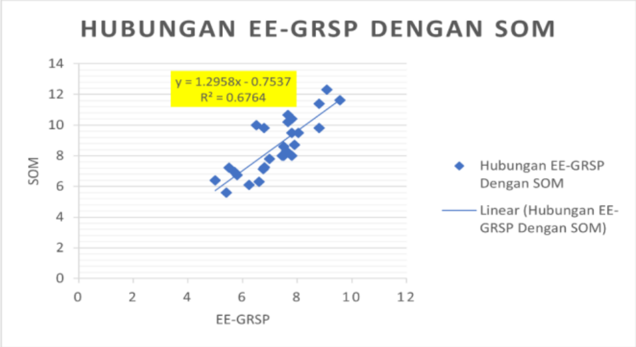


Figure 9. Relationship Between EE-GRSP and SOM

The regression equation ($y = 1.2958x - 0.7537$) with a coefficient of determination (R^2) of 0.6764 illustrates the linear relationship between Easily Extractable Glomalin (EE-GRSP) and Soil Organic Matter (SOM). The coefficient of 1.2958 indicates that for each unit increase in SOM, EE-GRSP is expected to increase by 1.2958 units, while the coefficient -0.7537 represents the intercept when SOM is zero. The R^2 value of 0.6764 suggests that 67.64% of the variation in EE-

GRSP can be explained by the variation in SOM, indicating a strong relationship between the two variables. Visually, the graph will display an upward-sloping linear pattern, signifying a positive relationship between EE-GRSP and SOM, where an increase in SOM tends to enhance EE-GRSP.

3.8 Contribution of T-GRSP to SOM Formation

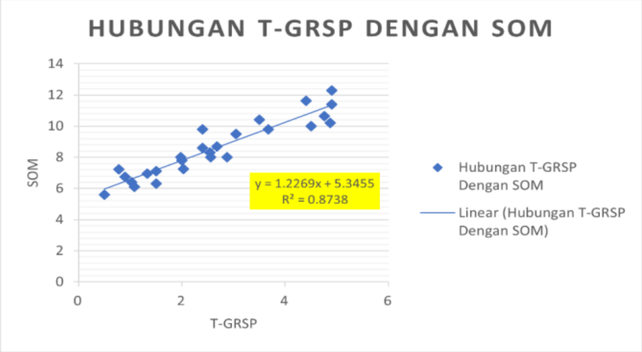


Figure 10. Relationship Between T-GRSP and SOM

The regression equation (y = 1.2269x + 5.3455\) with a coefficient of determination (R^2) of 0.8738 illustrates a linear relationship between Total Glomalin (T-GRSP) and Soil Organic Matter (SOM). The coefficient of 1.2269 indicates that for each unit increase in SOM, T-GRSP is expected to increase by 1.2269 units, while the coefficient 5.3455 represents the intercept when SOM is zero. The R^2 value of 0.8738 suggests that 87.38% of the variation in T-GRSP can be explained by the variation in SOM, demonstrating a strong relationship between the two variables. Previous studies, such as those reported by Fokom et al. (2012), show that an increase in SOM contributes to a rise in T-GRSP. Glomalin, an important protein produced by arbuscular mycorrhizal fungi (AMF), tends to accumulate in the soil as SOM increases.

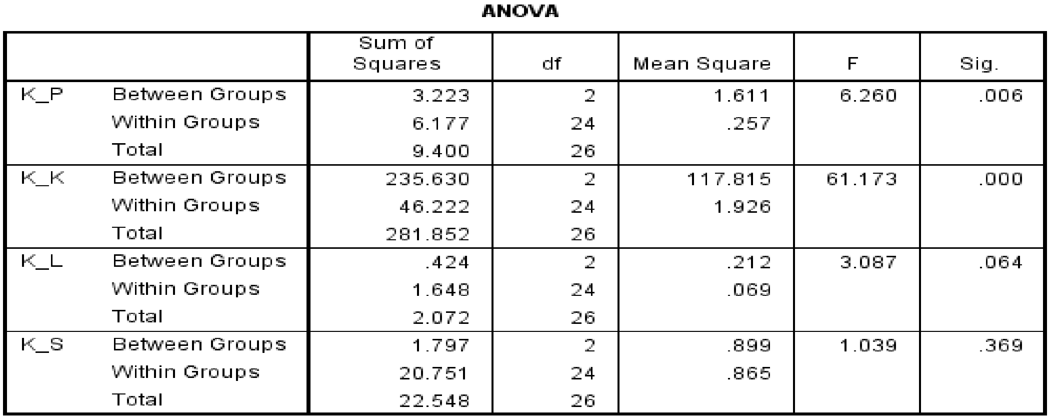
3.9 Nutritional Value of Corn under Each Treatment

Table 6. Nutritional Value of Corn under Each Treatment

Treatment	OM(%)	Crude protein	Karbohidrat	Crude Fut	Crude Fiber
Co1	7.12	8.96	74	4.40	25.65
Co2	5.60	8.00	70	4.43	25.43
Co3	6.40	8.92	72	4.23	25.60
Co4	6.95	8.34	73	4.65	24.40
Co5	6.74	7.90	73	4.43	25.76
Co6	7.23	8.80	72	4.80	25.65
Co7	7.25	8.65	74	4.76	26.60
Co8	6.30	8.76	72	4.40	25.40
Co9	6.10	6.50	72	4.76	25.01
Rataan	6,63^{c}±0,19	8,31±0,26	72,44±0,41	4,54±0,06	25,5±0,19
PA1	8.30	8.90	76	4.50	24.40
PA2	8.70	8.96	76	4.52	25.63
PA3	9.50	8.80	77	4.70	25.60
PA4	8.00	8.67	75	4.50	24.43
PA5	7.80	8.50	74	4.40	23.40
PA6	9.80	9.23	78	4.65	26.50
PA7	8.00	8.78	75	4.98	25.89
PA8	8.60	8.90	76	4.76	25.80
PA9	8.00	8.60	74	4.65	25.40
Rataan	8,52^{b}±0,23	8,81±0,07	75,66±0,44	4,62±0,05	25,22±0,32
PAM1	9.50	9.00	79	5.00	24.30
PAM2	10.00	9.23	78	4.92	25.76
PAM3	10.20	9.70	80	5.02	24.30
PAM4	9.80	8.80	77	4.76	26.50
PAM5	10.65	9.02	80	4.82	25.30
PAM6	11.63	9.45	81	4.40	26.10
PAM7	11.40	8.70	81	5.60	25.98
PAM8	10.40	9.00	79	4.43	26.50
PAM9	12.30	9.50	82	4.60	27.98
Rataan	10,65^{a}±0,31	9,15±0,11	79,66±0,52	4,83±0,12	25,83±0,38

3.10 ANOVA Results for Each Treatment (Control, AMF, and AMF+Glomalin) on Corn Nutritional Value

Table 7. ANOVA Results for Each Treatment and Their Effects on Corn Nutritional Value



ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
K_P	Between Groups	3.223	2	1.611	6.260	.006
	Within Groups	6.177	24	.257		
	Total	9.400	26			
K_K	Between Groups	235.630	2	117.815	61.173	.000
	Within Groups	46.222	24	1.926		
	Total	281.852	26			
K_L	Between Groups	.424	2	.212	3.087	.064
	Within Groups	1.648	24	.069		
	Total	2.072	26			
K_S	Between Groups	1.797	2	.899	1.039	.369
	Within Groups	20.751	24	.865		
	Total	22.548	26			

The AMF (arbuscular mycorrhizal fungi) and glomalin treatments have a highly significant impact on the carbohydrate and protein nutritional values of corn compared to the control and AMF treatments alone. Both treatments led to a notable increase in these nutrients. However, there was no significant difference observed in the fat and fiber content among the control, AMF, and glomalin treatments.

In terms of nutritional value, AMF and glomalin significantly enhance the carbohydrate and protein content. On the other hand, there are no significant differences in fat and fiber content among the control, AMF, and glomalin treatments. This suggests that AMF and glomalin specifically influence certain nutritional components of the corn, while other aspects, such as fat and fiber, remain relatively stable across the treatments.

The results of this study have significant implications for achieving zero emission goals and enhancing food security in Indonesia. Treatment 3, which utilizes AMF+Glomalin, has been shown to improve soil organic matter (SOM) content, a key factor in reducing carbon emissions and supporting zero emissions objectives. Increased SOM enhances carbon sequestration and storage efficiency in the soil, thereby reducing carbon emissions into the atmosphere, aligning with Indonesia's climate change mitigation efforts.

Furthermore, Treatment 3 also supports improved nutritional value and plant growth, contributing positively to food security. Healthier and more productive plants lead to increased food production and the availability of nutritious food for the population. Thus, the use of AMF+Glomalin not only aids in carbon emission reduction but also enhances food security by improving agricultural productivity and quality. This underscores the importance of sustainable and environmentally friendly agricultural practices in achieving sustainable development goals in Indonesia.

4. CONCLUSION

Research on the use of AMF and glomalin for reducing carbon emissions and improving the nutritional value of corn (Zea mays) in Pingtung, Taiwan, shows significant results. The treatment using the AMF+glomalin combination significantly increased soil organic matter content, both before and after the treatment, indicating improved soil quality. Compared to other treatments, this combination also resulted in higher organic matter and protein content, and increased carbohydrates and proteins in the plants, although there were no significant differences in fat and fiber content. Additionally, the increase in soil organic matter through this treatment plays a crucial role in reducing carbon emissions and supporting zero emissions concepts, aligning with Indonesia's efforts in mitigating global climate change. Another positive implication of the enhanced nutritional value and plant growth is food security, where healthier and more productive plants can boost food production and availability for the population.

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