Journal of Tropical Mycorrhiza
https://journal.ami-ri.org/index.php/JTM
E-ISSN 2829-467X
Vol. 1 No. 2 October 2022

Impact Of Arbuscular Mycorrhizae And Gogo Rice Interaction Against Rice Blas Disease (*Prycularia oryzae*)

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ABSTRACT. Gogo rice productivity is lower than lowland rice because one of the factors of the production gap is the control of plant-disturbing organisms. One of the diseases that attack rice plants is Blast disease, it is necessary to control efforts by utilizing micro organisms such as mycorrhizae vesicular-arbuscular (MVA). The purpose is to study the role of MVA on the growth and development of three gogo rice varieties and the level of infection intensity of blast disease (Pyricularia oryzae CAF). This research used a Randomized Block Design with the treatments were No MVA with Varieties IR-64, MVA Inoculation with Varieties IR-64, No MVA with Membrano, MVA Inoculation with Membranos, No MVA with Pelita I-1, Inoculation of MVA with Varieties of lamp I-1. The mycorrhizae treatment increased the uptake of P nutrients which was seen in plant height, dry weight yield, percentage of root associations and speed of flower formation. The mycorrhizae treatment showed a relatively low intensity of blast disease. In relation to plant resistance, mycorrhizae can suppress pathogens that cause Pyricularia oryzae CAF so that these plants have low disease intensity. Conclusion: Mycorrhizae increased the plant height, trunk and time of flower formation and P nutrient uptake, an average of 0.26 percent in leaf tissue. Mycorrhizae increased the resistance of gogo rice plants from Pyricularia oryzae CAF attack. The membramo variety showed the best growth and yields.

Keywords: *Mycorrhizae vesicular-arbuscular (MVA), Blast disease.*

INTRODUCTION

Rice production in Indonesia is only 1-1.5 tons/ha on average. The low rice production causes a low ratio between food availability and food needs so that hunger often occurs which is fatal (Suparyono and Agus Setyono, 1993). Efforts to increase rice production have been carried out through intensification and extensification programs, but productivity and production have not yet reached the planned target. To overcome this, the government took efforts to accelerate the increase in rice production through the main efforts to increase productivity and expand the area. Rice is a semi-equatic plant that is suitable for planting in flooded land. However, rice is also good for planting in two types of land, namely rice fields and fields (dry land). Upland rice productivity is usually lower than lowland rice. Several factors that influence the production gap are variety, availability of water, weeds, fertilization and pest and disease management.

In Indonesia, upland rice is always planted by farmers who work in a subsystem. Managed land is marginal land because of the same land limitations as dry land. Upland rice farmers also rarely use fertilizers, both nitrogen, phosphorus, and potassium fertilizers

(Suparyono and Agus Setyono, 1993). Relatively low soil fertility is an obstacle in increasing upland rice production. Fertilization has been proven to increase land productivity, but on the other hand the use of fertilizers will increase the cost of rice production and until now fertilizer production still requires substantial subsidies from the government. One of the diseases that attack rice plants is Blast disease. Blast attacks almost all parts of the rice plant. This disease is caused by the fungus Pyricularia oryzae CAF or also called the fungus Pyricularia grisea CKE. This fungus defends itself with conidia on seeds and hay.

Several attempts to control pests and diseases have been carried out. Controls that have been widely carried out include the use of resistant varieties and pesticides. However, the use of these pesticides can cause unfavorable impacts such as the occurrence of resurgence, resistance, environmental pollution and the killing of non-target organisms (Kasumbogo Untung, 1993). In this regard, control efforts are diverted to the use of micro-organisms that play a role in efforts to suppress pest and disease attacks. One of these groups of organisms is vesicular-arbuscular mycorrhizae (MVA). Mycorrhizae play a role in helping the absorption of nutrients and water in the soil, besides that it can increase resistance to pathogens, especially to soil pathogens because of the interwoven hyphae of mycorrhizal fungi that can function as a barrier to the entry of pathogenic soil fungi in plants (Moose, 1981).

MVA fungus is one of the biological factors responsible for plant productivity. Several reports state that MVA is the ability to provide phosphate (especially on nutrient-poor soils), increase plant tolerance to certain elemental contaminants and suppress disease development, especially those caused by soil-borne pathogens.The influence of mycorrhizae occurs indirectly through 1) The process of forming thick hyphal sheaths, hartig nets and increasing root surface area due to hypertrophy allowing the root system to take in more nutrients (increased absorption surface). 2) The metabolic activity of mycorrhizal roots is higher as reported by Hatch (1973) in Yadi Setiadi (1989) that the oxygen consumption of mycorrhizal roots is 2-4 times higher than that of non-mycorrhizal roots, thus mycorrhizal roots can increase the distribution of mineral salts by supplying exchangeable Hydrogen ions. 3) Mycorrhizal fungi have phosphate enzymes that can help the absorption of phosphorus for plants. Mycorrhizal plants are usually more drought tolerant than non-mycorrhizal plants. Drought that causes damage to the cortical tissue, then the death of the roots will not have a permanent effect on the roots of mycorrhizal plants. Mycorrhizal roots will recover quickly after a period of lack of water, because the fungal hyphae are still able to absorb water. In addition, the spread of hyphae in the soil is very wide so it can take relatively more water.

MATERIAL AND METHODS

This research was conducted at the Agricultural Cultivation Laboratory and Green House Faculty of Agriculture , Hasanuddin University, from late August 2016 to early January 2017. This experiment was arranged according to a Randomized Block Design with the following treatments:

P1 = No MVA with Varieties IR-64
P2 = MVA Inoculation with Varieties IR-64
P3 = No MVA with Membrano Varieties
P4 = MVA Inoculation with Membrano Varieties,
P5 = No MVA with Pelita I-1,
P6 = Inoculation of MVA with Varieties of lamp I-1

Each treatment consisted of 5 (five) plants and 3 (three) times replication, so the total number of experimental units was 108 units.

Spores isolated by wet filtering method through filter of various sizes. Wilarso (1990). gogo rice seeds were disinfected with a 2% disinfectant solution for 3 minutes, then 95% alcohol for one minute, and then washed with sterile water 3 (three) times. In each polybag, 10 (ten) grain seeds were planted and after growing, they were removed by leaving 5 (five) plants with uniform growth. Planting is done according to the treatment.

MVA inoculation was carried out at the same time as seed planting. Inoculation is done by making a box on the surface of the media as deep as 4-5 cm, then the inoculum is inserted and covered again with soil. Inoculation was carried out when the soil was wet at field capacity. Basic fertilization with Urea 1 g, TSP 1 g, KCl 0.5 g/polybag. To see resistance to Blast disease, the fungus that causes the disease is infected with malt media which was bred by a disease laboratory when the plant was 4 weeks old. Infection was carried out by spraying aquadest containing spores of the fungus that causes blast, namely Pyricularia oryzae CAF.

Parameters observation and measurment: Plant height (cm), dry weight of the plant, the percentage of root association (%), Phosphorus concentration in leaves, days of the flower is formed, grain weight at harvest.

Growth Analysis: Leaf Area Index, Leaf Area Ratio (LAR),Net Assimilation Rate (NAR), Relative Growth Rate (RGR).

Severity damage of rice blas disease (RBD) : The measurment of severity damage rate of RBD (%) was commenced when the plant was at 60-days after planting. Percentage of severity damage is determined by following formula:

$$I = \frac{\sum_i^k vi\ x\ ni}{N\ x\ V} x\ 100\%$$

Information :
I = Severity damage (%)
n = Number of infected leaves in each category(i= 1,2,3…9)
v = Scale value on each infected leaf
V = The highest scale of category
N = Total observed leaves

Table 1. Lesion Scale of Rice Blas Disease on Leaves is Categorized According to IRRI as Follows

Scale	Information	Scale	Information
0	Healty leaf or clump	5	4-10% lesion development and covering leaf surface
1	One or two tiny spot lesion development on a leaf	6	11-25% lesion development and covering leaf surface
2	Initial development of circular brown spot lesion in the leaf margin	7	26-50% lesion development and covering leaf surfce
3	Circular brown spot lesion spread out on leaf surface	8	51-75% lesion development andn covering leaf surface
4	4% lesion spread and covering on leaf surface	9	>75% lesion development on leaf surface

Data analysis: Data obtained from observation were analyzed by analysis of variance (ANOVA), correlation, path analysis and Least-Squares Distance (LSD) test at 5% error.

RESULT AND DISCUSSION

Mycorrhizal had a significant effect on plant height at 30 days , but had no significant effect at 60 and 90 days (Table 2; Figure 1). The P5 treatment without MVA with the Pelita I-1 variety gave the highest plant height and was significantly different from other treatments at the age of 30 days. Mycorrhizae had a significant effect on plant dry weight., the P4 treatment (MVA inoculation with the membramo variety) gave the highest plant dry weight and was significantly different from other treatments. Analysis of plant roor association showed that mycorrhizal had a significant effect on the percentage of plant root associations. Meanwhile analysis of plant dry weight showed that mycorrhizae had a significant effect on plant dry weight and the P4 treatment (MVA inoculation with the membramo variety) gave the highest plant dry weight and was significantly different from other treatments.

Table 2. Analysis of Plant Growth and Production of Gogo Rice

Treatments	Plant height (cm)/ day			Dry Weight	Root Association	Phosphorus Con.	Flower Form.	Grain Weight
	30	60	90	(g)	(%)	(%)	(days)	(g)
No MVA with IR-64	25,50a	34.37a	90.21a	42.39a	0.00a	0.187b	88.33ab	10.17b
MVA inoculation with IR-64	28,15ab	35.87a	98.01a	63.89c	53.00b	0.160a	86.67a	10,13b
No MVA with Membrano	32.39b	38.67a	92.77a	40.81a	5.00a	0.260c	88.33ab	10.03b
MVA inoculation with Membrano	23.41a	35,40a	87.36a	67.96d	80.33c	0.267c	90,30ab	8.60a
No MVA Pelit-1	37,00ab	35.27a	89.77a	42.03a	0.00a	0.380c	93.67c	10, 03b
inoculatio MVA with lamp I-1	23.76a	31.07a	83.98a	55.68b	80.33c	0.303d	102.67d	9.51ab

Analysis between growth and treatments is shown in Table 2. Growth analysis of 6 treatments is focused on four main characters; leaf area index, leaf area ratio, Net assimilation rate, and Relative growth rate. The highest LAI was found in treatment P1 (without MVA with IR-64 variety) which was significantly different from treatment P2, P3, P4, and P5 but not significantly different from treatment P6 (MVA inoculation with Pelita 1-1). Futher analysis of the first 30 day observation interval to the third 30 day observation interval, mycorrhizal and non-mycorrhizal treatment had no significant effect on the average LAR of gogo rice plants. The treatment with mycorrhizae and without mycorrhizae had no significant effect on the average NAR of gogo rice plants in the second 30-day observation interval. For the first 30-day observation interval, treatments P2 and P4 showed the highest average NAR and significantly different from treatment P3 but not significantly different from treatments P1, P5 and P6. Meanwhile, in the third 30-day observation interval, treatment P2 showed the highest average NAR which was significantly different from treatments P1, P3 and P5 but not significantly different from treatments P4 and P6. The results of statistical analysis shows that the treatment of giving mycorrhizae and without mycorrhizae did not significantly affect the average RGR of gogo rice plants in the second 30-day observation interval, treatment P4 (MVA inoculation with the membramo variety) showed the highest average RGR and was significantly different from treatment P2, P6. Meanwhile, in the third 30-day observation interval, treatment P4 showed the highest average NAR which was significantly different from treatments P3 and P5 but not significantly different from treatments P2 and P6.

Table 2. Growth Analysis

Treat-ments	LAI (cm2/g)			LAR (cm2/g)			NAR (g/cm2/day)			RGR (g/cm2/day)		
	30	60	90	30	60	90	30	60	90	30	60	90
P1	2.10a	3.19a	7.21b	5.10947a	3.01567a	1.85460a	0.00610a	0.01043a	0.02647a	0.03437a	0.03100a	0.04897a
P2	1.99a	2.65a	4.78a	4.09267a	1.95407a	0.87947a	0.00807a	0.01847a	0.06317b	0.03300a	0.03503bc	0.05203bc
P3	2.22a	3.12a	5.26a	9.02420a	3.11433a	2.73397a	0.00423a	0.01070a	0.02790a	0.03047a	0.03057a	0.05003ab
P4	2.12a	3.06a	4.80a	4.37710a	3,21763a	1.05400a	0.00813a	0.00813a	0.05310a	0.03140a	0.03763c	0.05300c
P5	2.27a	3.19a	5.23b	5,30847a	3.12270a	1.42827a	0.00567a	0.00567a	0.03537a	0.03000a	0.03007a	0.05000ab
P6	2.11a	2.68a	6.06ab	4.50263a	2.16503a	1.18957a	0.00733a	0.00733a	0.04353a	0.03200a	0.03300ab	0.05100abc

Table 3. Effect of Treatment Against RBD

Treatments	Severity damage (%)
P1	25.687bc
P2	17,290ab
P3	31,867c
P4	11,867c
P5	30,857c
P6	19.020ab

Table 3 show that the treatment of mycorrhiza on gogo rice plants significantly affected the severity damage of RBD. Treatment P4 showed a significantly different attack intensity of blast disease with treatments P1, P3 and P5, but not significantly different from treatments P4 and P6.

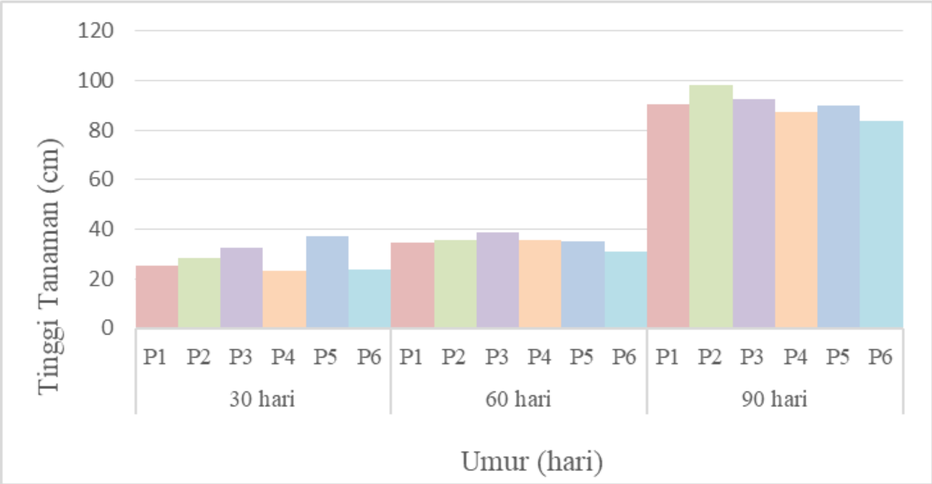

Figure 1. The Development of the Average Height of Gogo Rice Plants with Treatment Administration of Mycorrhizae and Without Mycorrhizae Until the Age of 90 Days

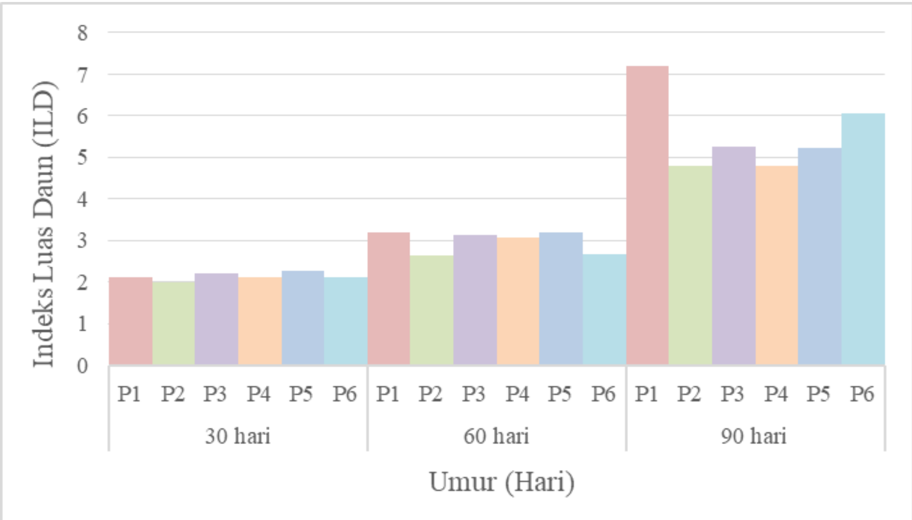

Figure 2. Development of Leaf Area Index of Gogo Rice Plants with Treatment

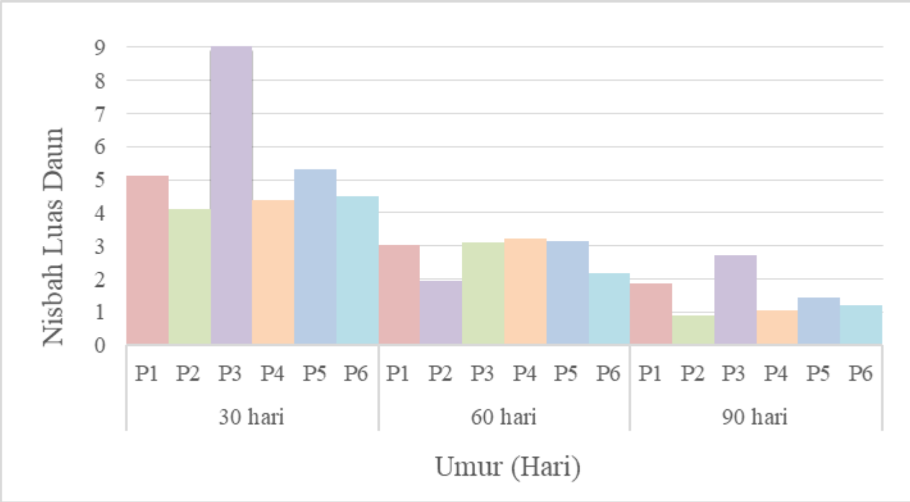

Figure 3. Development of Leaf Area Ratio (LAR) of Gogo Rice Plants in Treatment with Mycorrhizal and Non-Mycorrhizal Treatment Until the Age of 90 Days

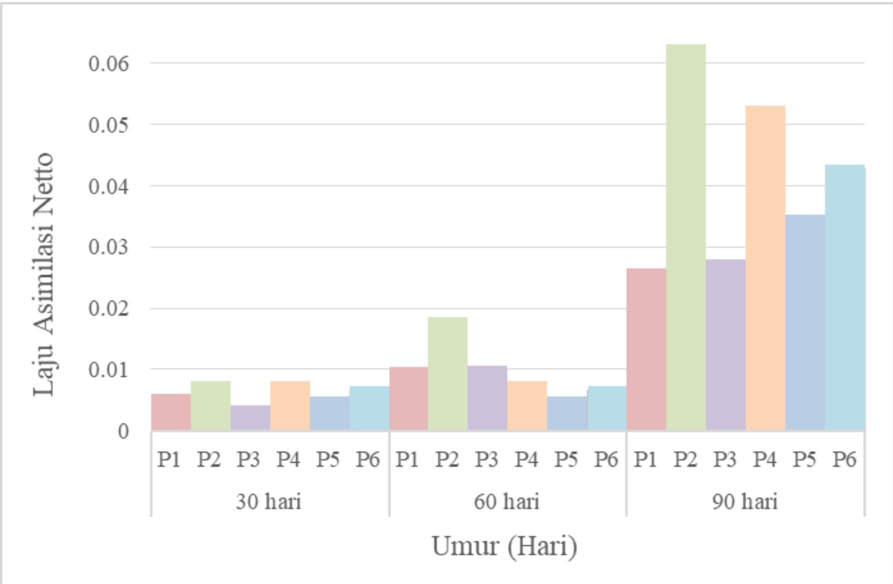

Figure 4. Development of the Net Assimilation Rate (NAR) of Gogo Rice Plants Up to 90 Days Old

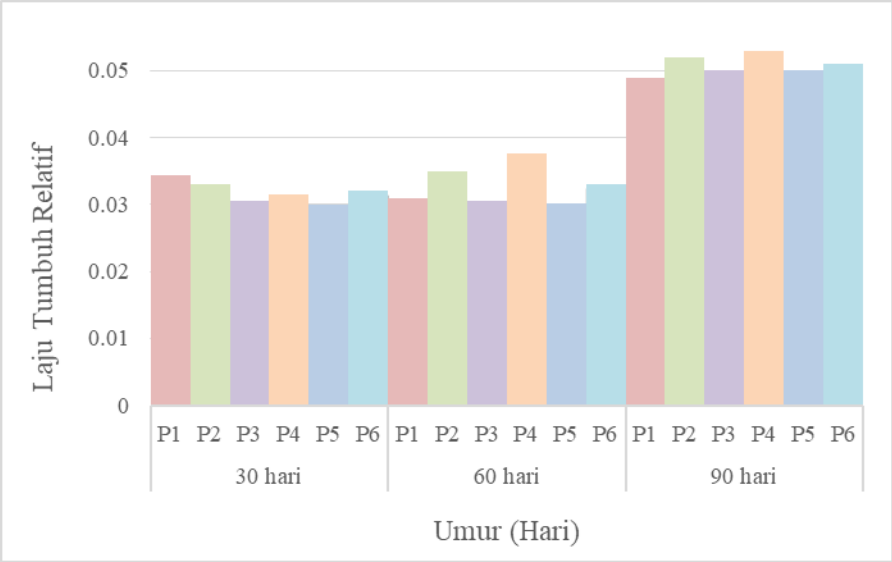

Figure 5. Development of the Relative Growth Rate of Gogo Rice Plants to Age 90 Days

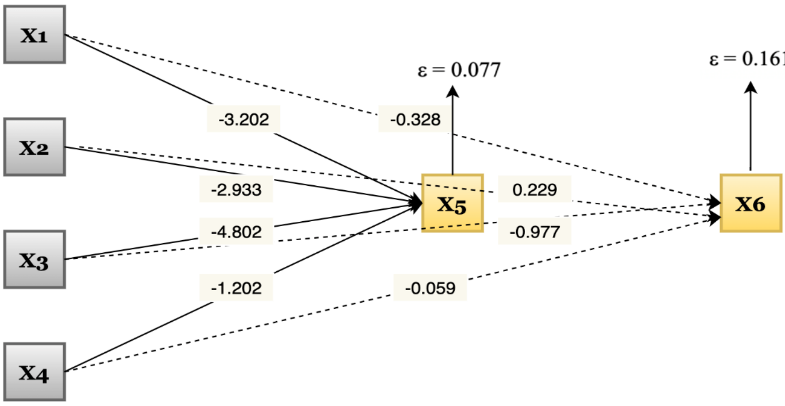

Figure 6. Structural Relationship between Leaf Area Index, Leaf Area Ratio, Net Assimilation Rate and Relative Growth Rate.

Table 4. Coefficient of Direct and Indirect Correlation between Leaf Area Index, Leaf Area Ratio, Net Assimilation Rate and Relative Growth Rate.

Direct Coefficient:

Coefficient Name	Coefficient Symbol	Coefficient Value
Leaf Area Index Path Coefficient	φX_1X_5	-3.202
Path Coefficient Leaf Area Ratio	φX_2X_5	-2.933
Path Coefficient Net Assimilation Rate	φX_3X_5	-4.802
Relative Growth Rate Path Coefficient	φX_4X_5	-1.202

Journal of Tropical Mycorrhiza
https://journal.ami-ri.org/index.php/JTM
E-ISSN 2829-467X
Vol. 1 No. 2 October 2022

Indirect Coefficient:

Coefficient Name	Coefficient Symbol	Coefficient Value
Correlation Coefficient between Leaf Area Index with Area Ratio	rX_1X_2	-0.328
Correlation Coefficient between Leaf Area Index with Net Assimilation Rate	rX_1X_3	-0.977
Correlation Coefficient between Net Assimilation Rate with Relative Growth Rate	rX_3X_4	-0.059
Correlation Coefficient between Leaf Area Ratio with Relative Growth Rate	rX_2X_4	0.229

Table 5. Summary of Correlation to Plant Height Intensity (rX1Y), Direct Effect to Plant Height Intensity (φX1Y) and the Total Contribution of Agronomic Traits to Plant Height Intensity.

No.	Agronomic Properties	Indirect Coefficient rX1Y	Indirect Coefficient φX1Y	Total Donation
1.	Leaf Area Index	-0.328	-3.202	1.050256
2.	Leaf Area Ratio	-0.977	-2.933	2.865541
3.	Net Assimilation Rate	-0.059	-4.802	0.283318
4.	Relative Growth Rate	0.229	-1.202	-0.275258

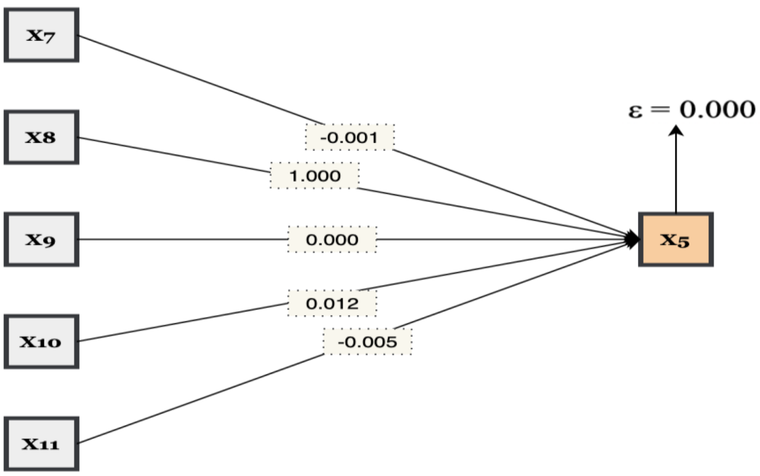

Figure 7. Structural Relationship between Plant Height, Plant Dry Weight, Root Assimilation Percentage, Phospor Concentration, Flower Formation and Grain Weight.

Table 6. Direct Coefficient of Correlation between Plant Height, Plant Dry Weight, Root Assimilation Percentage, Phosphorus Concentration, Flower Formation and Grain Weight.

Coefficient Name	Coefficient Symbol	Coefficient Value
Plant Height Line Coefficient	$\varphi X_7 X_5$	-0.001
Leaf Plant Dry Weight Jalur Path Coefficient	$\varphi X_8 X_5$	-1.000
Path Coefficient of Root Assimilation Percentage	$\varphi X_9 X_5$	0.000
Phosphor Concentration Path Coefficient	$\varphi X_{10} X_5$	0.012
Flower Formation Path Coefficient	$\varphi X_{11} X_5$	-0.005

CONCLUSION

Mycorrhizae increased the uptake of P nutrients which was seen in plant height, trunk and time of flower formation and mycorrhizae increased P nutrient uptake, an average of 0.26 percent in leaf tissue. Mycorrhizae trigerred the rise of the resistance of gogo rice against Pyricularia oryzae causing rice blas disease. The membramo variety showed the best growth and yields.

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