STUDY ON THE USE OF ARBUSCULAR MYCORRHIZA FUNGI FOR IMPROVING CROP PRODUCTIVITY IN AGROFORESTRY SYSTEM IN GUNUNG WALAT EDUCATIONAL FOREST

By

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Abstract

Previous study showed that agroforestry site in Gunung Walat had soils that were not so fertile and comprise areas that were covered and those not covered with tree crown. Beside that, there had been identified, the presence of Arbuscular Mycorrhizal Fungi from the genus Gigaspora, Glomus, Gigaspora and Acaulospora. This fungi had potential to increase crop productivity in agroforestry system in Gunung Walat.

The objective of this study was to learn the effectiveness of AMF in increasing the productivity of corns planted in sites that are open and sites shaded with tree crown in Gunung Walat. Research results showed that the use of AMF could increase the production of corn in open sites, whereas in shaded sites, there had been no significant results. This use of AMF is equal with the use of 2 g NPK per plant.

Keywords : arbuscular mycorrhizae fungi, crop productivity, agroforestry

Introduction

Gunung Walat is an educational forest managed by Faculty of Forestry Bogor Agricultural University. Due to the Indonesian economic crises since 1997, the forest was encroached by farmers, who live around the forest. Consequently, the forest became degraded. Rehabilitation of the degraded sites is not an easy task due to several major constrains, which are related to unfavorable environmental *conditions* existing at the degraded sites. Edhapic factors (low nutrients, acidic soils), climatic factors (high level of solar radiation and high temperatures) and biological factors and low soil microbial activities) are unfavorable to plants, and hampered the performance of planted tree.

The application of beneficial microbial technology such as mycorrhizal fungi as alternative strategy should be attemped and developed in order to increase the survival, quality and growth rate of seedling and plant productivity in the field.

Arbuscular mycorrhizal fungi (AMF) belong to the Glomales (Zygomycetes), and about 130 species in the genera Glomus, Sclerocystis, Gigaspora, Enthtropospora, Scutellospora and Acaulospora have up to now been rezognized as forming symbiotic associations with plants (Schenk and Perez, 1990). These fungi are extremely widespread. They are not limited to any one plant family and have an exceptionally wide range of host and habitat (Smith and Read, 1997). The novel function of this fungi as biological agent for plant productivity as well as for bioremidiation of heavy metal contaminated soil (Setiadi, 1998, Hashem, 1995), and as helping agent in early seedling establishment on degraded sites are recognized. Arbuscular mycorrhizal fungi (AMF) have also been employed to increase resistance to plant pathogens (Liu, 1995) and salinity (Azcon and El-Atrash, 1997).

Previous study showed that in agroforestry site of Gunung Walat, there were Arbuscular Mycorrhiza Fungi from genera Glomus, Gigaspora and Acaulospora. These fungi had the potential to increase crop productivity in agroforestry system of Gunung Walat.

The objective of this study was to learn the effectiveness of AMF in increasing the productivity of corn planted in areas that are open and areas shaded with tree crown in Gunung Walat.

Materials and Methods

Research was conducted in agroforestry areas that are open site and shaded site. In each site, there were treatments in the form of control, inoculation with mycorrhiza, fertilizer application with 2 g NPK per crop, and fertilizer 100 g compost per crop. Each treatment consisted of 12 replications.

The data obtained were subjected to Analysis of Variance and Duncan range test. The variables observed were height and fruit production of corn at three months after planting.

Results And Discussion

A. Open Site

1. Height increment

Results of Analysis of Variance showed that there were no difference between treatments in terms of variables of height increment and number of leaves (Table .1).

Table 1 Results of analysis of variance for the effect of treatment on height

Source of variation	Degree of freedom	Sum of Square	Mean Square	F	Significance (P value)
Among treatments	3	5878.062	1959.354	2.657^{ns}	0.060
Within treatment	44	32450.250	737.506		
Total	48	492875.000			
Corrected total	47	38328.313			

Note: ns = no significant effect

Average height at three months after planting for treatments of control, NPK fertilizer, composts, and mycorrhiza were consecutively 81 cm, 101 cm, 95.83 cm, and 111 cm. Although there were no statistical differences between treatments, but the use of fertilizers, chemical, organic or biological fertilizer had the tendency to increase the height growth of corn in open site. If compared with all treatments, the use of mycorrhiza is the best.

2. Fruit production

Results of analysis of variance showed that there was significant difference in the variable of corn fruit production (Table .2).

Table .2 Results of analysis of variance for the effect of treatment on fruit weight

Source of variation	Degree of freedom	Sum of Square	Mean Square	F	Significance (P value)
Among treatments	3	48772.917	16257.639	9.836**	0.000
Within treatment	44	72725.000	1652.841		
Total	48	1347100.000			
Corrected total	47	121497.917			

**Highly significant at 0.05 level.

Result of further test with Duncan showed that NPK fertilizer treatment could significantly increase the production of corn fruit (Table 3).

Table 3 Result of Duncan-test for the effect of treatment on fruit weight

Treatment	N	Fruit Weight	% of increase compared to control
Control	12	125.00^{b}	
Compos	12	148.33^{b}	16
Mycorrhizae	12	154.17^{b}	19
NPK	12	211.67^{a}	41

Note: ***Numbers followed by the same letter are not significantly different**

The highest percentage of increase for fruit production was by using NPK fertilizer followed by mycorrhiza biological fertilizer, and compost. Although the use of NPK fertilizer produced the highest yield, for agroforestry farmers, these constitute an additional cost that should be expended for buying fertilizers. With the use of mycorrhiza whose inoculum could be produced by the farmers themselves, then the production increase of 19 % is considerably good. However, study on economic analysis for fertilizer use, either chemical, compost or biological fertilizer is necessary to be conducted.

B. Shaded site.

1. Height increment

Results of analysis of variance (Table 4) showed highly significant effect from the treatment on the height of corn plant.

Table 4 Results of analysis of variance from the effect of treament on height

Source of variation	Degree of freedom	Sum of Square	Mean Square	F	Significance (P value)
Among treatments	3	10698.667	3563.222	6.139**	0.001
Within treatment	44	25538.333	580.417		
Total	48	451380.000			
Corrected total	47	36228.000			

Note: ****Highly significant at 0.05 levels**

Further Duncan test showed that control is the best treatment and was highly significant in difference with other treatments. On the other hand, fertilizer treatment, chemical, organic or biological fertilizers were not significant (Table 5).

Table 5 Results of Duncan test for the effect of treatment on height

Treatment	N	Height
Control	12	81.25^{b}
Compos	12	83.58^{b}
Mycorrhizae	12	88.75^{b}
NPK	12	118.42^{a}

Note: ***Numbers followed by the same letter are not significantly different**

2. Fruit production

Results of analysis of variance showed that there was highly significant effect from the treatment on the production of corn fruit (Table 6).

Further analysis with Duncan showed that control treatment was the best and was significantly different with other treatments, whereas fertilizer

treatment, either chemical, compost or biological fertilizer did not exhibit significant difference (Table 7).

Table 6 Results of analysis of variance for the effect of treatment on fruit weight

Source of variation	Degree of freedom	Sum of Square	Mean Square	F	Significance (P value)
Among treatments	3	26156.250	8718.750	6.733**	0.001
Within treatment	44	56975.000	1294.886		
Total	48	871100.000			
Corrected total	47	83131.250			

Note: ****Highly significant at 0.05 level**

Results in Table 6 and Table 7 as described above, showed considerably interesting phenomenon where the control treatment produced the best treatment for height growth or fruit production. Whether this phenomenon constitutes the effect of interaction between light and fertilizer application or other factors, still require further investigation.

Table 7 Results of Duncan test for the effect of treatment on fruit weight.

Treatment	**N**	**Fruit Weight**
Control	12	110.83[b]
Compos	12	115.83[b]
Mycorrhizae	12	117.50[b]
NPK	12	168.33[a]

Note: *Numbers followed by the same letter are not significantly different

Comparison of corn fruit production in open and shaded sites with various treatments is presented in Table 8.

If comparison is made between open condition and shaded condition (Table .8) in terms of corn fruit production, in shaded condition, those of control are higher than other treatment. On the other hand, in open condition, fertilizer treatment, either chemical, compost or biological fertilizer produced higher fruit production than those of control. There was

possibility that in shaded condition, nutrients given could not be optimally absorbed due to lack of nutrients that results in impeded process of photosynthesis.

Results of this research need to be verified further in larger scale, and if there is consistency of results in open areas and shaded areas, then the application of mycorhiza will be effective in open area.

Table .8 Comparison of corn fruit production in open and shaded sites

Treatments	Fruit weight	
	Open area	Shaded area
Control	125.00	168.33
Compos	148.33	110.83
Mycorrhizae	154.17	115.83
NPK	211.67	117.50

Conclusion

1. Biological fertilizer of mycorrhiza could increase production of corn fruit in open areas, by 19 %.

2. Application of fertilizers, chemical, organic or biological fertilizers in shaded sites did not produce significant results, but this phenomenon should be verified further through further research.

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