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The Response of Two Maize Genotypes Inoculated with Mycorrhizae on Dry Land North Lombok, Indonesia

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Abstract:- This study aims to determine the effect of arbuscular mycorrhizal fungi (AMF) doses in increasing growth and yield of two varieties of maize in a dry land. This research has been carried out in Akar-Akar Village, Bayan District, North Lombok Regency, from July to December 2018. A field experiment was designed with Randomized Complete Block Design conducted in Split Plot Design with two factors. The first factor as the main plot is the variety (V) of maize consisting of two races, namely Srikandi and "Galur C2 Unram" varieties. The second factor as a subplot is mycorrhizal dose (AMF) consisting of m_0= without mycorrhizal administration, m_1 = 250 kg/ha mycorrhizal, m_2 = 300 kg/ha mycorrhizal, m_3= 350 kg/ha mycorrhizal, m_4 = 400 kg/ha mycorrhizal, m_5 = 450 kg/ha mycorrhiza. Each treatment was repeated three times. Data collected were analyzed by analysis of variance of 5% and further tests with the test of Honestly Significant Difference (HSD) at the 5% level. A dose of 450 kg/ha AMF can increase the wet weights of dry maize in the dry land of North Lombok. The use of Srikandi varieties can increase the dry weights of maize in North Lombok and the percentage of colonization and the numbers of spore of Galur C2 UNRAM. The dose of 450 kg/ha AMF can increase the numbers of spore and the percentage of colonization in both Srikandi and Galur C2 Unram.

Keywords: *Genotype, Maize, Mycorrhiza*

I. INTRODUCTION

The agricultural sector is still one of the mainstay sectors of development in the province of West Nusa Tenggara (NTB). Construction of dryland agriculture is a mainstay of the future featured and NTB because 84% of the area of value-added of around 1.8 million ha a dry land that has the potential to be developed into productive agricultural land of various farm commodities of food crops and horticulture (Suwardji, 2007).

The limiting factors such as water availability, deficient nutrient, and soil organic matter are the root of the problems to increase maize yield on the dryland area. It is necessary to manage maize in an integrated manner, namely, by using technology that provides a synergistic effect, namely by using mycorrhizae. Many have reported that the soil fungi, in symbiosis with their host plants, can help plants to improve water retention and make their host plants more tolerant to drought. AMF colonization also increases nutrient uptake from soils and enhances the growth and yield of the host plants, although it depends on the species of AMF colonizing the host plants (Bintoro, 2000).

Mycorrhizal plant roots will be protected from attack by root pathogens because the plants with mycorrhizal roots will become harder, so it is more difficult to be penetrated by pathogens (Fakura and Setiadi, 1986). Mycorrhizal plant roots are more resistant to drought in the dry season than without mycorrhiza, in addition to the presence of mycorrhiza can increase plant tolerance to drought (Manan, 1976; Nuhamara, 1980). With mycorrhizae, plant growth becomes faster (Fakura and Setiadi, 1986).

From various studies that have been done to prove that the weight tomato (Hasbi, 2003) and chili (Hilman, 2002) in Eri Farda Hussein et al. (2008), were inoculated with the fungi mycorrhizae can be increased respectively by 76, 1% and 85% compared to those who did not use mycorrhizae. Similarly, the results of the study of Astiko et al. (2012) and Astiko et al. (2013) showed that the inoculation of arbuscular mycorrhizal fungi (AMF) was able to increase soybean and maize yields far higher than with no mycorrhizae. Also, the results of Rahman and Husin's research (2000) in Eti Farda Husein et al. (2008) that oil palm, which is given mycorrhiza, is more resistant to disease. The positive effects of mycorrhizae on food crops, horticulture, and estate crops are also expected to increase leaf production for Madura tobacco plants.

This study aims to determine the effect of MA dose in increasing growth and yield of two varieties of maize in a dry land.

II. MATERIALS & METHODS

A field experiment was designed with Randomized Complete Block Design conducted in Split Plot Design with two factors. Main plot: Maize Genotype (V), consisting of 2 levels, namely v_1 = Srikandi Variety, v_2 = ‘‘Galur C2 Unram”. Subplot: AMF application, consisting of 6 levels of treatment namely m_0 = without mycorrhizal administration, m_1 = 250 kg/ha mycorrhiza, m_2 = 300 kg/ha mycorrhiza, m_3 = 350 kg/ha mycorrhiza, m_4 = 400 kg/ha

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mycorrhiza, m_5 = 450 kg/ha mycorrhiza. The treatment is the result of a combination of maize genotype (V) with the mycorrhizal application (M) is 12 treatments. Each treatment was repeated three times so that there were 36 experimental units.

This research was conducted in the Village of Akar-Akar, Bayan District, North Lombok Regency, from July to December 2018.

The tools used in this study are hoes, buckets, big gun sprinkles, analytical scales, rulers or gauges, spray tools, and writing instruments.

The variety of Srikandi and Galur C2 Unram and AMF were used in this research.

Processing is done by leveling the ground to make a 2 x 2.5-meter plot of each treatment plot, and the treatment plot is made close to the big gun sprinkler to facilitate watering.

Planting is carried out with a torch, by placing three seeds in each hole and thinning after the plants are one week old by leaving two plants that grow healthy, the maize planting bar used is 20 x 70 cm.

We are watering for trial in the village of Akar-Akar done using a big sprinkler gun. Irrigation is done twice a week.

Fertilization using 150 kg/ha Phonska compound fertilizer (given three times, i.e., when planting 50 kg planted 10 cm apart from plant holes, age two weeks after planting 50 kg and age five weeks after planting 50 kg, Urea fertilizer with a dose of 150 kg/ha, which is applied two times, which is 50% at the age of 2 weeks after planting and 50% at the period of 5 weeks after planting.

Applications a dose AMF with five treatments with different dosages. With the application of AMF applications, a planting hole. A dose is 2625 grams AMF and weighed as much as 450 plastic bags known doses needed in each treatment include m_1: 125 g/plot or 4.17 g/plant hole, m_2: 150 g/plot or 5.00 g/plant hole, m_3: 175 g/plot or 5.83 g/plant hole, m_4: 400 g/plot or 6.67 g/plant hole, m_5: 225 g/plot or 7.50 g/plant hole. AMF required : 2625 g or 2 kg for 18 plots ie : 125 g x 3 plots or 4.17 g x 90 planting holes : 150 g x 3 plots or 5 g x 90 planting holes : 175 g x 3 plots or 5.85 g x 90 holes planting : 200 g x 3 plot or 6.67 g x 90 planting hole : 225 g x 3 plot or 7.5 g x 90 planting hole.

In pest control, there are monkey pests by providing fences and guarded by gardeners so that they do not enter the maize plant.

Plant growth observations made were plant height, especially on vegetative growth by measuring plants in the plant population each plot by observing three plants randomly at the age of 2 weeks after seeding (was), four was, six was. Observations were carried out on the wet biomass weight of the plant (g) weighed all parts of the plant that were still in a fresh state, dry crop trimming (g) weighed all parts of the plant at the age of 60 days after planting.

III. RESULTS AND DISCUSSION

- *Plant height*

The results of observations and analyses of the diversity of the effect of varieties and dosages of AMF applications on plant height growth can be seen in the Table 1. The results of the diversity analysis showed that the AMF application dose and the interaction of the two factors, namely variety, and AMF dose application, were not significantly different from plant height.

Observation	Plant Height (cm)*	
	Srikandi	C2 Unram
2 was	16.50a	12,00a
4 was	34.95a	32,56a
6 was	100.17a	82,33a
8 was	180.44a	143,22a

Table 1:- Effect of maize varieties on plant height at observations of 2 was to 8 was (*The numbers followed by the same numbers in the same row and column are not significantly different at P 0.05)

Based on Table 1 it can be seen that varieties Srikandimenunjukkan plant height equal to "Galur C2 Unram ". High maize crop varieties heroine at the age of 2-8 was is 16.50 cm; 34.95 cm; 100.17 cm and 180.45 cm; then high crop "Galur C2 Unram" at age 2-8 was is 12 cm; 32.56 cm; 82.33 cm and 143.22 cm. This shows that the Srikandi variety gives the same high growth as "Galur C2 Unram" in maize cultivation in the dry land of North Lombok. Still, the plant height in each observation phase shows higher yields in the Srikandi variety compared to "Galur C2 Unram". The phenomenon is caused by different genetic factors in the two varieties, in which Srikandi varieties are better able to adapt to drought-strained conditions (Baon, 1996).

Furthermore, in terms of AMF dose, plant height at each observation week after the plant can be seen in Table 2.

Observation	AMF dose (kg/ha)*					
	0	250	300	350	400	450
2 was	14.67 a	11.00 a	13.17 a	15.34 a	16.33 a	15.00 a
4 was	32.34a	30.34 a	29.00 a	37.17 a	35.34a	38.34 a
6 was	85.33a	94.50 a	83.67 a	99.33a	80.00 a	104.67 a
8 was	146.00 a	152.00 a	155.5 a	161.17 a	173.79 a	182.5 a

Table 2:- Effect of AMF dose on plant height at observation of 2 was to 8 was (*The numbers followed by the same numbers in the same row and column are not significantly different at P 0.05)

Table 2 shows that the AMF inoculation dose cannot increase plant height at two was to 8 was. In this experiment, the AMF dose of inoculation did not play a role in increasing plant height. This relates to the AMF species inoculated with *Acaulospora tuberculate* species that are not suitable for local conditions. AMF species generally develop effectively at a temperature of 34^0C, but in the Village of Roots, the temperature reaches 35^0C even above 35^0C (BMKG Bayan, 2014). This is consistent with the opinion of Mosse (1981), who said that some gigaspores from the subtropical region experienced the best germination at 34^0C so that this was the reason AMF was less effective in increasing the height of maize plants in the North Lombok Roots Village.

- *Wet Biomass Weight*

The results of the observation and analysis of variance of the wet biomass weight of the plant maize showed that the use of varieties, inoculation doses of AMF, and the interaction between the factors of varieties and dosage AMF effect which does not differ real effect on the weight of wet maize biomass. Further tests were carried out with an HSD test at a 5% level on the wet weight of maize (Table 3 and 4).

Varieties	Wet Biomass Weight (kg)*
Srikandi	1.88a
Galur C2 Unram	1.57a

Table 3:- The average weight of wet biomass per plot in two varieties of maize. (*The numbers followed by the same letters in the same column and row are not significantly different at P 0.05).

Table 3 shows that the weights of wet maize biomass have higher yields in Srikandi variety (1.80) than "Galur C2 Unram" (1.57), although statistically not significantly different. H al that allegedly caused Heroine varieties is high yielding varieties developed with the growth rate and high yield in the gripped state. In contrast, the "Galur C2 Unram" power yields are lower on the land seized for not being able to adapt to the village roots.

Adaptability was allegedly related to the genetic nature of each variety of maize; it is in line with the results reported by Darjanto and Satifah (1990), which states that the factors affecting crop yield are hereditary genetic factors in addition to the temperature, light, and water. Arifin (2015) also reports that different varieties of maize give different results.

MA dose (kg / ha)	Wet Biomass Weight (kg)*
0	1.57a
250	1.55a
300	1.67a
350	1.75a
400	1.90a
450	1.96a

Table 4:- Effect of AMF dose on the weight of wet maize biomass per plot. (*The numbers followed by the same letters in the same column and row are not significantly different at P 0.05).

Table 4 shows that the AMF dose did not increase the weights of wet maize biomass. This relates to the MA species inoculated with *Acaulospora tuberculate* species that do not match local conditions. AMF species generally develop effectively at a temperature of 34^0C, but in the Village of Roots, the temperature reaches 35^0C even above 35^0C (BMKG Bayan, 2014).

- *Dry Biomass Weight*

The results of observations and analysis of the dry biomass weight can be seen in Tables 5 and 6, showing that the use of varieties gives a significantly different effect, whereas AMF dose and interaction between various factors and AMF dose give no significant effect on dry biomass weight on maize plant.

Varieties	Dry Biomass Weight (g)*
Srikandi	430.605a
Galur C2 Unram	270.673b

Table 5:- The effect of varieties toward AMF inoculation dose on dry biomass weight of maize per plot. (*The numbers followed by the same letters in the same column and row are not significantly different at P 0.05).

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Table 5 shows that the dry biomass weights of Srikandi maize varieties (430.605 g) are significantly different than "Galur C2 Unram" (270.673 g). This is thought to be due to Srikandi varieties are superior varieties developed with high yield quality, whereas "Galur C2 Unram" yield quality lower because they are unable to adapt in a state gripped by drought. This is consistent with the results reported by Handoo et al. (1970), who concluded that the inheritance pattern of maize is controlled by minor genes and is additive.

AMF dose (kg / ha)	Dry Biomass Weight (g)*
0	247.5a
250	339.42a
300	355.49a
350	357.14a
400	386.22a
450	418.41a

Table 6:- Effect of AMF dose on dry biomass weight of maize per plot. (*The numbers followed by the same letter in the same column are not significantly different at P 0.05).

Table 6 shows that the dry biomass weight due to the application of AMF doses also increased with increasing AMF doses, although not statistically significantly different. The role is related to the function of AMF in increasing nutrient availability for plants. However, in this study, the increase in dry anchor weight is still low so that in future studies, it is necessary to consider the type of AMF inoculated concerning pH and temperature suitable for local conditions.

This is consistent with Mosse's (1981) opinion that changes in soil pH through liming usually have a detrimental effect on the development of native AMF so that the AMF inoculation action must take into account the appropriate type of AMF to guarantee AMF formation. Astiko (2013) also reported that AMF isolates were different and came from different regions, so their effectiveness was also changed.

➢ *Weight of Cob and Weight of 100 Maize Seeds*

The results of observations and analysis of variance on the weight of cob and weight of 100 seeds can be seen the Table 7. This Table shows that the use of varieties, AMF dose, and interaction between varieties and AMF dose have no significant effect. In contrast, AMF dose and interaction between various factors and AMF dose gave no significant effect on the dry weight of maize biomass. Further tests were carried out with an HSD test at a 5% level on the wet weight of maize (Tables 6 and 7).

Varieties	Cob Weight (g)*	Weight of 100 seeds (g)*
Srikandi	380.25a	22.41a
Galur C2 Unram	252.91b	21.91a

Table 7:- The average weight of maize cobs and weight of 100 maize per plant in two varieties of maize. (*The numbers followed by the same letter in the same column and row are not significantly different at P 0.05).

The data in Table 7 shows that the weight of cobs per plant showed different results in the two varieties, where Srikandi varieties gave higher yields than "Galur C2 Unram ". The difference in the weight of cob between Srikandi varieties and "Galur C2 Unram" is caused by genetic and environmental factors. If supporting environmental factors such as soil, water, CO_2, O_2, nutrients, and light are sufficient, the plants will grow and develop according to their genetic characteristics. This is in line with the opinion of Darjanto and Satifah (1990), which states that the factors affecting crop yields are genetic and hereditary. The weight of 100 seeds in the two varieties, Srikandi varieties, was not significantly different from "Galur C2 Unram ". This means that both varieties have the same ability to produce the weight of cob and seeds.

AMF dose (kg / ha)	Cob Weight (g) *)	Weight of 100 Seeds (g)*
0	253.74a	21.14a
250	269.23a	21.99a
300	326.93a	22.14a
350	339.67a	22.48a
400	348.41a	22.56a
450	361.51a	22.66a

Table 8:- The average weight of maize cobs and weight of 100 maize seeds per plant due to the influence of AMF doses. (*The numbers followed by the same letter in the same column are not significantly different at P 0.05.

Table 8 shows that cob weight per plant and weight of 100 maize kernels have the same results in AMF inoculation and without AMF. The type of AMF inoculated in this experiment was not suitable for soil pH at the test site. Also, the temperature at the experimental site reached 35^0C, so the AMF inoculation in this experiment was less effective in increasing the weight of cob and seed weight. This result is by the opinion of Corcidi et al. (2005) and Astiko (2013) which say that the selection of AMF types is essential when performing inoculation actions because different species and isolates from different regions will cause different effects on plant growth and yield.

➢ *Number of Spores and Percentage of AMF Colonization*

Table 9 shows that the use of varieties provides a significantly different effect in increasing the number of spores but do not give a significantly different effect on the percentage of colonization AMF. In contrast, the treatment dosage of AMF application has a significantly different effect on the number of spores as well as on the percentage of AMF colonization. Furthermore, the interaction of the two factors gave a significantly different effect on the number of AMF spores but did not significantly affect the percentage of colonization. HSD further test results at the 5% significance level are listed in Tables 8 and 9.

AMF dose (kg/ha)	Srikandi*	C2 Unram*
0	127.33a	220.00a
250	130.00a	231.00a
300	345.00ab	445.33b
350	496.00ab	481.33b
400	528.33bc	568.33b
450	593.33c	616.00b

Table 9:- The average number of spores in two maize varieties due to AMF inoculation (*The numbers followed by the same letters in the same column are not significantly different at P 0.05.

Table 9 shows that the average number of spores was higher in the "Galur C2 Unram" compared to Srikandi varieties at all dosage levels. This is thought to be caused because "Galur C2 Unram" is a local variety, so the inoculated AMF prefers it compared to Srikandi varieties but based on the interaction effect of varieties and AMF doses it is known that the effective MA dose used to increase the number of spores in Srikandi varieties is the highest dose of 450 kg/ha, whereas in "Galur C2 Unram" is a dose of 300-450 kg/ha. Because doses of 300-450 kg/ha show the same results on the number of spores, a dose of 300 kg/ha is an effective dose to be applied to maize plants in the dry land of North Lombok.

From the AMF application dosage, the highest number of spores in both varieties was at 450 mg/ha and the lowest AMF application in the treatment without AMF inoculation. But in this study found AMF spores in the dick plants suspected of being a type of AMF species that were inoculated in previous studies a namely Glomus sp. Related to the increasing number of spores due to increased dosage of inoculation, but it is less useful to increase the growth and yield of maize because it is based on the development of AMF that is suspected to be Glomus sp., Whereas *Acaulospora tuberculata is* less able to adapt in the Root-Village due to pH and temperature different from the area of origin of isolates namely Serpong Tangerang

Varieties	% Colonization*
Srikandi	57.78a
Galur C2 Unram	64.44a

Table 10:- The average percentage of colonization in two varieties of maize. (*The numbers followed by the same letters in the same column are not significantly different at P 0.05).

The data in Table 10 shows that the percentage of colonization of the two varieties, namely Srikandi varieties, was not significantly different from "Galur C2 Unram". This means that the percentage of colonization in the two varieties is the same.

AMF dose (kg/ha)	% Colonization*
0	23.33d
250	30.00cd
300	53.33bc
350	76.67ab
400	93.33a
450	90.00a

Table 11:- The Average of colonization rates (% colonization) on several AMF doses. (*The numbers followed by the same letters in the same column and row are not significantly different at P 0.05.

Table 11 shows that the treatment dose of AMF applications significantly influences the percentage of AMF colonization. The average percentage of colonization highest dose applications AMF 400 kg/ha and the lowest at treatment without AMF. AMF applications can increase the percentage of AMF colonization in plant roots from 23.33% to 30% - 93.33%. This will increase soil health and fertility to increase plant growth and productivity.

The association between AMF and host plants is exciting. However, the fungus is obligate but has more than one host, such as mycorrhizae *Glomus* sp. can infect soybeans, string beans, onions, cassava, oranges, and tobacco. Antagonistic fungi which are inoculated in liquid form (soaking seeds), then coated with mycorrhizae, provide the best results in suppressing soybean seedling attacks. This can be suspected because by soaking, both the antagonistic fungus colonies and antifungal substances contained therein will enter (penetrate) the seed layer. The inner part coincides with the germination power of the seed itself, which is stimulated by the ingress of water (Mosse, 1981).

IV. CONCLUSION

AMF dose of 450 kg/ha can increase the wet weights of dry maize in the dry land of North Lombok. The use of Srikandi varieties can increase the dry weights of maize in North Lombok and "Galur C2 Unram" percentage of colonization and number of spores. A dose of 450 kg/ha AMF can increase the number of spores and both in the Srikandi variety and "Galur C2 Unram".

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