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Growth and Yield Responses of Various Nutrient Efficient Maize Lines to Application of Low Doses of Biological Fertilizers and Chemical Fertilizers in Different Growing Seasons

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ABSTRACT

Through the use of low dosages of chemical fertilizers and effective nutrient-corn genotypes that respond to bio-fertilizer type assignments, this study intends to produce rather steady outcomes over the course of several growing seasons. Field tests for this study have been conducted at the ATP Ministry of Research and Technology in South Sumatra. The experiment was run across two growing seasons: the dry season (May through September 2011) and the rainy season (January–April, 2012). The equal split-split plot design is the one used for the study's two separate growing seasons. The central conflict concerns the application of chemical fertilizer at the following rates: P1: 50% standard dose of ATP (200 kg urea, 50 kg SP36, and 25 kg KCl ha-1), and P2: 25% standard dose of ATP (100 kg urea, 25 kg SP36, and 12,5 kg KCl ha-1). Treatment of several biological fertilizer subplots: H0: no biological fertilizer (control); H1: mycorrhiza; H2: bacterial phosphate solvent. The treatment of children plot uses a variety of corn strains with effective nutrient selection outcomes, including strains B41 (G1), L164 (G2), S219 (G3), and variations BISI 816, as the genotype comparison (G4). Three times each were used for each combination of treatments. The results of the two investigations indicate that strain B41 can produce adaptive growth based on the growing season, is more resilient to drought stress, and may be able to produce more at lower doses of chemical fertilizer while being comparatively stable. A combination of chemical fertilizer at the 50% standard dose of ATP and mycorrhizal fertilizer, along with the use of strain B41, has the best impact on the growth and yield of maize on marginal dryland. Mycorrhizae fertilizer at various levels of low doses of chemical fertilizer can increase the growth and yield of maize in two different cropping seasons. All of the examined maize lines generally shown the ability of the bacteria connected to mycorrhizal and phosphate solvents to enhance nutrient absorption.

Keywords : *corn genotype, low doses of chemical fertilizers, bio fertilizers, growing season.*

1. INTRODUCTION

One strategy for increasing the amount of maize produced nationally is to increase the planting area, particularly by making use of the still-plentiful dry ground. According to data from the Center for Research and Development of Soil and Agro-climate (2005), Indonesia has 6.69 million hectares of prospective land for the growth of maize crops, the majority of which is dry, acidic terrain. An solution to combating the low fertility of acid dry land is lime and heavy dosages of artificial fertilization. Due to the high expenses involved, this approach has various restrictions on its ability to be used on vast tracts of land. On the other hand, applying organic fertilizer of 5 to 20 tons ha-1 can increase the production of corn on dry, acidic ground (Syam'aun and Ala, 2010). Due to issues with fertilizer supply, pricing, and delivery, this strategy also has certain restrictions when used on wide tracts of land. Therefore, a technological innovation is required through the creation and application of nutrient-efficient, high-yielding varieties, balanced fertilization, and the use of biological fertilizers that can generate the greatest amount of maize crops.

The ability of a maize genotype to yield more grain in comparison to other genotypes on soils with a limited supply of one or more nutrients is known as nutrient efficient maize (Kant and Kafkafi, 2004). Utilizing corn genotypes that are nutrient-efficient can lower the need for chemical fertilizers while increasing yields. Through numerous steps of selection with Recurrent Half-sib Selection and available 31 nutrient-efficient lines from crossings of selected parents, Hayati et al. (2009) established nutrient-efficient maize genotypes on acid dry land in South Sumatra. Utilizing nutrient-efficient maize varieties can help overcome N and P nutrient limitations on dry, acidic soils. Nutrient availability must be improved, particularly with the use of chemical and biological fertilizers, in order to maximize corn yields. Mycorrhizal fungi and phosphate-solubilizing bacteria are two examples of biological fertilizer technology that can improve plant nutrient uptake (Simanungkalit et al., 2006).

One of the biggest issues with plant growth and development is the drought element. Water, a crucial limiting element for achieving high yields. Drought stress can restrict corn plant development and output on terrain where there is a water scarcity. Compared to plants that receive enough water, plants under drought stress typically have reduced physical sizes.Due to the female flowers/cobs drying out, which occurs in corn plants under drought stress during the generative phase, the process of filling the seeds is delayed. As a result, there are fewer and smaller seeds in the cob (Aqi et al., 2008). In contrast, heavy rain during the planting season during the rainy season induces nutrient leakage from the top soil layer. Nutrient concentrations are reduced as a result of this leaching.

Planting nutrient-efficient corn during the dry season or the rainy season would undoubtedly present challenges, such as the occurrence of excess soil water deficits, the degree of mycorrhiza symbiotic or nonsymbiotic abilities, and the availability of nutrients. When compared to other genotypes, nutrient efficient maize has the capacity to yield more on soils with poor and limited nutrient content (Presterl, et al 2003, and Syafruddin, 2004). In addition to increasing the availability of nutrients, providing biological fertilizers like CMA can also aid corn plants in growing when there is a water deficit (Sasli, 2004). Increased drought stress resistance has also been observed in a variety of plant species that have received the AMF vaccine, including oil palm nurseries, cocoa nurseries, and patchouli trees (Mawardi and Djazuli, 2006). (Widiastuti et al. , 2005). It is envisaged that nutrient-efficient corn, which receives both inorganic and biological fertilizers, will be able to combat the constantly variable groundwater state.

The goal of this project is to develop nutrient-efficient maize lines that yield the most from diverse biological fertilizers while only requiring small amounts of chemical fertilization and are largely stable over the course of two growing seasons. The findings of this study are anticipated to have a positive impact on the program for the development of technological innovations for effective and sustainable corn cultivation that can decrease the use of chemical fertilizers without reducing production and are technically and economically feasible to implement at the scale of individual farmers.

2. MATERIALS AND METHODS

The study was conducted in Bakung Village, North Inderalaya District, Ogan Ilir Regency, South Sumatra, at the Integrated Agro Technology Center's (ATP) research facility. The investigation was conducted throughout the rainy season planting period (May 2020–September 2020) and the dry season planting period (January –April 2021). The Split-Split Plot research design was chosen to account for the two distinct growing seasons. Chemical fertilizers were applied at the fertilization level as the primary plot treatment. P1 received a 50% standard dose of ATP (200 kg of urea, 50 kg of SP36, and 25 kilogram of KCl ha-1) while P2 received a 25% standard dose of ATP (100kg Urea, 25kg SP36 and 12.5kg KCl ha-1).The administration of several biological fertilizer types was the subplot treatment, which included the following: H0: no biological fertilizer application (control), H1: mycorrhizal fertilizers, and H2: phosphate-solubilizing bacterial fertilizers. Various maize lines resulting from nutrient-efficient selection, including lines B41(G1), L164(G2), S219(G3), and BISI 816(G4) varieties as control genotypes, were used to treat kid plots. Three times each of every treatment combination were used. The management of the land is automated. To sow one seed, up to three seed holes with a 75 cm x 20 cm spacing were dug. Each line was divided into two 3 meter-long rows of plants. One plant was left in each planting hole during the first week of plant thinning. Chemical fertilizers are administered in accordance with each dose's therapy. Two-thirds of the urea fertilizer dose was applied at 4 WAP, along with all of the SP36 and KCl fertilizers, and one-third of the urea fertilizer dose was applied at planting. At the time of planting, mycorrhizal fertilizers are applied per planting hole at a dose of 5 g planting hole-1. Phosphate solubilizing bacterial fertilizer (BPF) is applied in accordance with the time and suggested dose. It is sprayed onto the plant's roots once every two weeks, beginning the second week after planting and continuing until the tenth week after planting, at a rate of 400 liters per hectare. The study's variables comprised measurements of plant height and plant-1's number of leaves, each done at 7 WAP. At the conclusion of the study, measurements of N and P nutrient uptake, cob weight, number of cob-1 seeds, 100 seed weights, and hectare-1 yields were made. The SAS program was used to tabulate and statistically analyze the observational data, and the BNJ test was used to test for differences between treatments at a level of 0.05.

3. RESULTS AND DISCUSSION

Conditions of Soil Fertility and Climate

Prior to treatment, the findings of the soil study revealed that the soil had a very acidic (4.22) acidity level with low N nutrient status (1.90 g kg-1), high P (30.45 mg kg-1), low K (0. 13 cmol kg-1) and low C-organic content (10.58 g kg-1). Sand (63.39%), silt (20.92%), and clay (15.69%) fractions make up the majority of the soil texture. This demonstrates that the experimental field's soil fertility is low (Appendix 1).

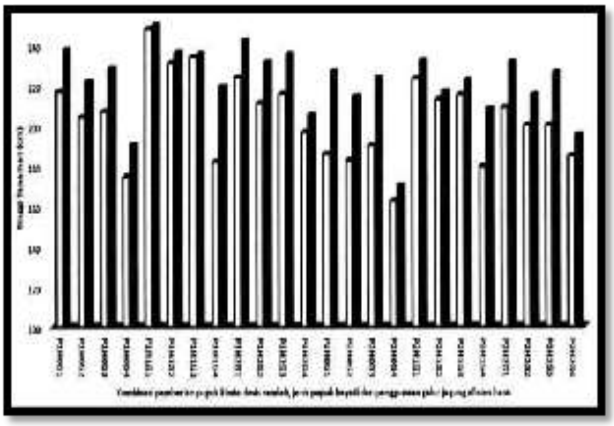
It found out that the amount of rainfall during the dry season planting period was quite low, with an average rainfall of 88.36 mm month-1 and an average number of rainy days only coming to 10.6 days month-1. The average rate of evaporation, however, was 126.16 mm month-1. The value of land water availability had a deficit of 91.10 mm month-1 as a direct result of the decrease in rainfall and rise in the rate of evaporation. The rate of increase in rainfall that occurred was higher than the rate of evaporation, so the land water balance experiences an average surplus of 171.79 mm month-1. During the planting period of the rainy season, the average rainfall reached 280.98 mm month-1. This was followed by an average evaporation rate of 109.18 mm month-1 (Appendix 2).

Growth Response and Plant Yield

The application of low doses of chemical fertilizers, various biological fertilizer types, and the use of nutrient-efficient selection lines had a significant impact on all observed variables, according to the results of an analysis of variance performed at each growing season. There was also a significant interaction between the application of low doses of chemical fertilizers, various biological fertilizer types, and strains. Although corn was nutrient-efficient for all variables measured, it had no discernible impact on plant height or the number of leaves on plant 1. (Appendix 3).

Plant Height and Number of Leaves

There was a tendency for plant height and number of leaves of plant-1 produced during the rainy season planting period to be higher than the plant height and number of plant-1 leaves produced during the dry sea. The combination of chemical fertilizer 50% standard dose of ATP, accompanied by mycorrhizal fertilizer and the use of strain B41 in each growing season produced the highest plant height and number of leaves of plant-1 compared to other treatment combinations (Figure 1).



Picture. 1a. Plant height (cm)

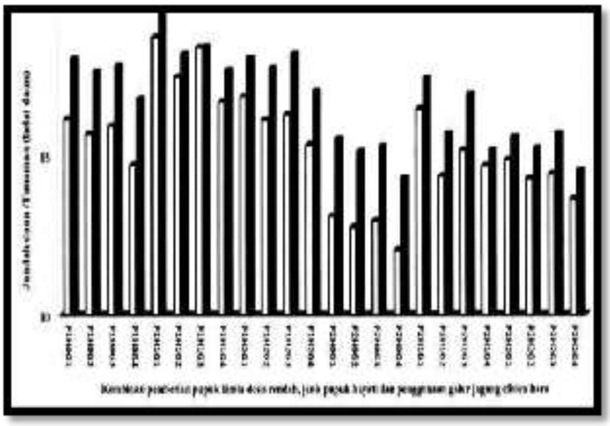


Figure 1b. Number of plant leaves (leaf)

Note

= Dry season planting period

= Rainy season planting period

Figure 1. The effect of the combination of low doses of chemical fertilizers, types of biological fertilizers and the use of nutrient efficient maize lines on plant height and number plant leaves-1

Nutrient Absorption N and P

The highest N and P plant-1 uptake was achieved by the B41 line during each growing season without the use of biological fertilizers, which was significantly different from other chosen maize lines at various doses of low dosage chemical fertilization. While the BISI 816 variety with a chemical fertilization level of 25% standard dose of ATP had the lowest plant-1 absorption of N and P nutrients for each growing season (Tables 1 and 2).

Table 1. The effect of the combination of low-dose chemical fertilizer treatment, type biofertilizers and use of maize lines resulting from nutrient efficient selection of plant N-1 uptake at different growing seasons

Treatment		Nutrient N uptake (g plant -1)									
		Dry Season Planting Period					Rainy Season Planting Period				
		Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	Var BISI 816 (G_4)	Rerata P*H	Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	VarBISI 816 (G_4)	Rerata P*H
P1 (Fertilizer dosage 50% ATP standard)	H0 (Without Biofertilizer)	7,17 A c	6,06 A b	6,38 A b	4,86 A a	6,11 A	8,25 A c	7,63 A b	7,82 A b	7,01 A a	7,68 A
	H1 (Mycorrhiza)	15,60 C c	11,39C a	12,48 C b	10,96 C a	12,61 C	18,21 C d	15,98 C b	16,68 C c	13,52 C a	16,09 C
	H2 (Phosphate Solubilizing Bacteria)	12,64 B c	12,64 B a	10,84 B b	9,19 B a	10,61 B	14,87 B d	11,70 B b	12,98 B c	10,61 B a	12,54 B
Average P*G		11,81 d	9,07 b	9,90 c	8,33 a		13,77d 10,38 a		11,76b	12,94 c	
P2 (25% ATP standard fertilizer dosage)	H0 (Without Biofertilizer)	6,22 A b	5,17 A a	6,11 A b	4,54 A a	5,51 A	6,29 A c	5,55 A b	6,13 A c	4,68 A a	5,66 A
	H1 (Mycorrhiza)	11,72 C d	7,96 C b	9,38 C c	6,77 C a	8,96 C	13,67 C d	11,67 C b	12,71 C c	10,46 C a	12,12 C
	H2 (Phosphate Solubilizing Bacteria)	9,33 B c	6,60 B a	7,95 B b	5,96 B a	7,46 B	11,01 B c	9,16 B a	10,48 B b	9,00 B a	9,91 B
Average P*G		9,09 d	6,58 b	7,81c	5,76 a		10,32d	8,79b	9,77c	8,04a	
BNJ 0,05		P*G=0,43		P*H*G=0,67		P*H=0,46	P*G=0,15		P*H*G=0,42		P*H=0,26

Note: Numbers followed by the same letters in the same column and row are significant not significantly different at the BNJ test level of 0.05. Where: Lowercase letters are read horizontally and capital letters are read vertically.

The highest N and P plant-1 nutrient uptake was produced by the combination of chemical fertilizer application of 50% standard dose of ATP along with the application of mycorrhizal fertilizer and the use of B41 strain for each growing season, and it was noticeably different from the other treatment combinations and plant-1 N and P nutrient uptake produced. Planting occurs more frequently during the wet season than during the dry season. The combination of 25% chemical fertilizer application with a standard dose of ATP, no addition of biological fertilizers, and the use of the BISI 816 (P2H0G4) variety resulted in the lowest plant-1 absorption of N and P nutrients for each growth season.

Table 2. The effect of the combination of low-dose chemical fertilizer treatment, type biofertilizers and use of maize lines resulting from nutrient efficient selection of plant nutrient P-1 uptake at different growing seasons.

Treatment		Nutrient N uptake (g plant -1)									
		Dry Season Planting Period					Rainy Season Planting Period				
		Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	Var BISI 816 (G_4)	Rerata P*H	Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	VarBISI 816 (G_4)	Rerata P*H
P1 (Fertilizer dosage 50% ATP standard)	H0 (Without Biofertilizer)	0,92 A d	0,56 A b	0,67 Ac	0,29 A a	0,61 A	1,19 A d	0,90 A b	1,00 A c	0,71 A a	0,95 A
	H1 (Mycorrhiza)	1,87 C d	1,32 C b	1,52 C c	1,23 C a	1,48 C	2,18 C d	1,85 C b	2,02 C c	1,51 C a	1,89 C
	H2 (Phosphate Solubilizing Bacteria)	1,58 B d	1,21 B b	1,31 B c	1,12 B a	1,30 B	1,86 B d	1,45 B b	1,57 B c	1,29 B a	1,54 B
Average P*G		1,59 d	1,16 b	1,30 c		1,01 a	1,74 d 1,17		1,40 b	1,53 c	
P2 (25% ATP standard fertilizer dosage)	H0 (Without Biofertilizer)	0,42 A c	0,18 A a	0,30 A b	0,16 A a	0,27 A	0,62 A c	0,41 A a	0,50 A b	0,37 A a	0,47 C
	H1 (Mycorrhiza)	1,37 C d	0,92 C b	1,07 C c	0,77 C a	1,03 C	1,59 C d	1,35 C b	1,46 C c	1,19 C a	1,40 A
	H2 (Phosphate Solubilizing Bacteria)	0,99 B d	0,73 B b	0,82 B c	0,62 B a	0,79 B	1,17 B d	1,01 B b	1,08 B c	0,94 B a	1,05 B
Average P*G		0,99 d	0,68 b	0,79 c	0,58 a		1,13 d	0,93 b	1,01 c	0,83 a	
BNJ 0,05		P*G=0,074		P*H*G=0,083		P*H=0,07	P*G=0,029		P*H*G=0,049		P*H=0,04

Note: Numbers followed by the same letters in the same column and row are significant not significantly different at the BNJ test level of 0.05. Where: lowercase letters are read horizontally and capital letters are read vertically.

Cob Weight and Number of Seeds

The study's findings, which are presented in Tables 3 and 4, demonstrate that the B41 line, when used without the use of biological fertilizers during each growing season, produced the highest cob weight and number of cob-1 seeds, and that it differed significantly from other chosen maize lines at different doses of low-dose chemical fertilization. For each growing season, BISI 816 with a chemical fertilization level of 25% standard dose of ATP had the lowest cob weight and cob-1 seed production.

Table 3. The effect of the combination of low-dose chemical fertilizer treatment, type biofertilizers and use of maize lines resulting from nutrient efficient selection of cob weight of plant-1 in different growing season

Treatment		Cob Weight (g plant $^{-1}$)									
		Dry Season Planting Period					Rainy Season Planting Period				
		Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	Var BISI 816 (G_4)	Rerata P*H	Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	VarBISI 816 (G_4)	Rerata P*H
P1 (Fertilizer dosage 50% ATP standard)	H0 (Without Biofertilizer)	103,55 A b	83,33 A ab	86,67 A ab	73,33 A a	86,72 A	106,41 A c	85,81 A ab	90,53 A b	81,05 A a	90,95 A
	H1 (Mycorrhiza)	153,39 B b	103,33 B a	95,00 A a	96,67 B a	112,10 B	201,36 C c	171,79 C b	176,12 C b	146,31 C a	173,90 C
	H2 (Phosphate Solubilizing Bacteria)	121,67 A b	82,22 A a	91,67 A a	96,67 B a	98.06 A	173,32 B c	141,70 B b	146,75 B b	119,17 B a	145,24 B
	Rerata P*G	126,20 b	89,63 a	91,11 a	88,51 a		160,34 c 115,51 a	133,10 b	137,80 c		
P2 (25% ATP standard fertilizer dosage)	H0 (Without Biofertilizer)	69,30 A a	54,00 A a	66,15 A a	50,49 A a	59.98 A	71,001 A b	57,60 A a	68,50 A b	52,00 A a	62,28 A
	H1 (Mycorrhiza)	119,95 B c	82,91 B ab	91,95 B b	65,53 B a	90,08 B	149,19 C c	129,23 C b	134,72 C b	109,70 C a	130,71 C
	H2 (Phosphate Solubilizing Bacteria)	87,69 A b	59,40 A a	70,20 A ab	54,90 A a	68,04 A	125,37 B c	106,66 B b	111,70 B b	97,25 B a	110,25 B
	Rerata P*G	92,31	65,43 ab	76,10 b	56,97 a		115,19 d	97,83 b	104,97 c	86,32 a	
	BNJ 0,05	P*G=13,42		P*H*G=20,60		P*H=13,62	P*G=4,57		P*H*G=6,96		P*H=4,32

Note: Numbers followed by the same letters in the same column and row are significant not significantly different at the BNJ test level of 0.05. Where: lower case is read as horizontally and capital letters read vertically

The highest cob weight and number of cob-1 seeds were produced by the treatment combination of chemical fertilizer with a 50% standard dose of ATP along with mycorrhizal fertilizer and the use of the B41 strain for each growing season. This combination was significantly different from the other treatment combinations in that the cob weight and number of cob-1 seeds were produced during the rainy season planting period rather than the dry season planting period. The combination of 25% chemical fertilizer treatment with a conventional dose of ATP, without the addition of biological fertilizers, and the use of the BISI 816 (P2H0G4) variety resulted in the lowest cob weight and number of cob-1 seeds in each growing season.

Table 4. The effect of the combination of low-dose chemical fertilizer treatment, type biofertilizers and use of maize lines resulting from nutrient efficient selection of the number of cob-1 seeds in different growing seasons

Treatment		Nutrient N uptake (g plant -1)									
		Dry Season Planting Period					Rainy Season Planting Period				
		Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	Var BISI 816 (G_4)	Rerata P*H	Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	VarBISI 816 (G_4)	Rerata P*H
P1 (Fertilizer dosage 50% ATP standard)	H0 (Without Biofertilizer)	4,50 Aa	4,16 A a	4,33 A a	3,67 A a	4,16 A	4,82 A c	4,41 A b	4,52 A bc	4,05 A a	4,45 A
	H1 (Mycorrhiza)	8,57 C c	5,48 B ab	5,84 B b	4,82 B a	6,18 C	10,07 C c	8,59 C b	8,80 C b	7,31 C a	8,69 C
	H2 (Phosphate Solubilizing Bacteria)	6,08 B b	5,17 B ab	5,46 B ab	4,53 AB a	5,31 B	8,66 B c	7,09 B b	7,34 B b	5,96 B a	7,26 B
Average P*G		6,38 c	4,94 ab	5,21 b	4,34 a		7,85 c a	6,69 b	6,89 b	5,77	
P2 (25% ATP standard fertilizer dosage)	H0 (Without Biofertilizer)	3,47 A a	2,70 A a	3,31 A a	2,52 A a	3,00 A	3,55 A b	2,88 A a	3,42 A b	2,60 A a	3,11 A
	H1 (Mycorrhiza)	6,00 B c	4,15 B ab	4,60 B b	3,27 A a	4,50 B	7,46 C c	6,46 C b	6,73 C b	5,48 C a	6,53 C
	H2 (Phosphate Solubilizing Bacteria)	4,38 A b	2,97 A a	3,51 A ab	2,74 A a	3,40 A	6,26 B d	5,33 B b	5,85 B c	4,86 B a	5,51 B
Average P*G		4,61 c	3,27 ab	3,80 b	2,84 a		5,75 d	4,89 b	5,25 c	4,31 a	
BNJ 0,05		P*G=0,60		P*H*G=0,98		P*H=0,57	P*G=0,27		P*H*G=0,35		P*H=0,26

Note: Numbers followed by the same letters in the same column and row are significant not significantly different at the BNJ test level of 0.05. Where: lowercase letters are read horizontally and capital letters are read vertically

Yields

The study's findings, which are presented in Table 5, demonstrate that the B41 line produced the highest hectare-1 yields without the use of biological fertilizers for each growing season and that it was significantly different from other chosen maize lines at various doses of low-dose chemical fertilization. While the BISI 816 variety with a chemical fertilization level of 25% standard dose of ATP had the lowest 1 hectare yield for each growing season.

The highest hectare-1 yields were produced by the combination of chemical fertilizer application of a 50% standard dose of ATP along with the application of mycorrhizal fertilizer and the use of the B41 strain for each growing season. This treatment combination produced yields that were significantly higher than those of the other treatment combinations. Without the use of biological fertilizers and the BISI 816 variety, the lowest hectare-1 yields in each growing season were produced when 25% chemical fertilizer application and a standard dose of ATP were combined (P2H0G4).

Table 5. The effect of the combination of low-dose chemical fertilizer treatment, type biofertilizers and use of maize lines resulting from nutrient efficient selection of yields of hectare-1 in different growing seasons.

Treatment		Nutrient N uptake (g plant -1)									
		Dry Season Planting Period					Rainy Season Planting Period				
		Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	Var BISI 816 (G_4)	Rerata P*H	Galur B41 (G_1)	Galur L164 (G_2)	Galur S219 (G_3)	VarBISI 816 (G_4)	Rerata P*H
P1 (Fertilizer dosage 50% ATP standard)	H0 (Without Biofertilizer)	417,86 A d	312,13 A b	365,97 A c	213,21 A a	327,29 A	458,89 A c	354,99 A ab	418,83 A bc	297,72 A a	382,61 A
	H1 (Mycorrhiza)	665,20 B c	511,73 C b	542,94 B b	449,90 B a	585,15 C	876,24 C d	726,74 C b	800,37 C c	646,07 C a	762,36 C
	H2 (Phosphate Solubilizing Bacteria)	636,07 B c	450,14 B a	514,53 B b	401,93 B a	500,67 B	785,08 B d	553,93 B b	641,80 B c	458,97 B a	609,96 B
Average P*G		573,04 d	424,66 b	474,48 c	355,01 a		706,74 d	545,24 b	620,33	467,59	
P2 (25% ATP standard fertilizer dosage)	H0 (Without Biofertilizer)	170,12 A b	112,90 A a	139,09 A ab	99,48 A a	130,39 A	224,08 Ab	165,96 A ab	193,53 A ab	144,23 A a	181,96 A
	H1 (Mycorrhiza)	533,26 C d	356,96 C b	421,30 C c	304,61 C a	404,03 C	802,43 Cb	705,53 C a	797,30 C b	673,60 C a	744,72 C
	H2 (Phosphate Solubilizing Bacteria)	416,61 B c	259,06 B a	320,53 B b	214,69 B a	302,72 B	577,60 B b	464,50 B a	553,72 B b	444,93 B a	510,18 B
Average P*G		373,33 d	242,97 b	293,63 c	206,25 a		534,71 b	445,33 a	514,84 b	420,92 a	
BNJ 0,05		P*G=28,84		P*H*G=51,35		P*H=43,34	P*G=41,05		P*H*G=71,47		P*H=43,59

Note: Numbers followed by the same letters in the same column and row are significant not significantly different at the BNJ test level of 0.05. Where: lowercase k is read as horizontally and capital letters read vertically.

Discussion

The experimental plots' poor soil fertility had an adverse effect on the yield and growth rate of the harvested maize plants. In order to produce their highest yields, maize plants need a lot of nutrients, specifically 165 kg N/ha, 55 kg P2O5/ha, and 35 kilogram K2O/ha (Agricultural Research and Development, 1997). Due to this, efforts must be made to improve nutrient availability through integrated nutrient management (also known as integrated plant nutrient management), a method that is environmentally friendly and optimizes the use of both inorganic and biological fertilizers at the same time in order to maximize maize yields.

Based on different growing seasons, maize's growth and production increased at the greatest rate during the planting time during the rainy season. This demonstrates that one of the environmental elements that significantly influences the increase in plant growth and production is the growing season. The incidence of variations in air temperature, air humidity, solar radiation strength, solar irradiation length, and the amount of available land water are all influenced by variations in the growing season. The growth rate and yield of maize plants are lower during the dry season due to reduced rainfall than they are during the rainy season planting period. Due to a relatively large land water balance deficit of -90.60 mm month-1 during the dry season planting period, the maize plants endured drought stress that persisted for virtually the entirety of their growth period. Dahlan (2001) asserts that maize plants require a minimum average rainfall of 100 mm month-1 in order to thrive. Lack of water in corn plants can inhibit cell division, enlargement, and development, resulting in stunted root growth and narrow root spread. As a result, absorption of water and nutrients declines, which disrupts the metabolism of carbohydrates, proteins, and growth regulators, ultimately leading to stunted plant growth (Taiz and Zeiger, 1991). According to Banzinger et al. (2000), corn plants under drought stress during the flowering or seed filling phase only produced 30–60% of the yields they would have under normal circumstances. The yield achieved is approximately 15–30% of the crop yield in adequate water circumstances, it is further explained, if drought stress occurs during the blossoming to harvest phase.

The study's findings over two distinct growing seasons revealed that the B41 line outperformed other chosen maize lines in terms of plant growth and yield at varied doses of low-dose chemical fertilization. This is due to the B41 line's ability to modify morphology and its ability to use nutrients more effectively than other selected lines, particularly due to its superior root structure traits. Root elongation, increased root density, an increase in the number of roots and root hairs, and other root morphological adaptations to nutrient-deficient environments are all examples of such adaptations (Costa et al., 2002). Increased root surface area in contact with the soil can boost nutrient absorption through modification of the root morphology. Comparing the BISI 816 variety to other chosen maize lines at various degrees of application of modest doses of chemical fertilizers, however, led to the lowest growth rates and plant yields. This is due to the fact that the BISI 816 variety is a hybrid genotype built with superior characteristics, such as high production and very responsive to fertilization, and it requires high production inputs in order to produce maximum production. However, if planted on marginal dry land without being supported by optimal fertilization, these hybrid varieties will display much lower yields than local varieties.For instance, the C7 hybrid corn variety, which receives fertilizer dosages of up to 5 tons ha-1, 2 tons ha-1 of lime, 400 kg ha-1 of urea, 100 kg ha-1 of SP36, and 50 kg ha-1 of KCl fertilizer, only yields 5 tons of dry shelled seeds annually. This is much less than the 12 tonnes ha-1 production potential. (ATP, 2003). Due to the fact that hybrid varieties are cultivars that are combined with the ability to adapt to extremely specific soil types and climates, they only produce their highest yields when they are able to thrive in those conditions and demand significant inputs throughout production. 1988 (Moentono).

In comparison to other combinations of treatments, the 50% ATP standard dose of chemical fertilizer, along with mycorrhizal fertilizer and the usage of the B41 strain, produced the maximum plant height, number of leaves, N and P nutrient uptake, cob weight, number of seeds, and hectare-1 yield. This demonstrates that the use of mycorrhizal fertilizers along with the application of conventional 50% ATP chemical fertilizers (200 kg Urea, 50 kg SP36, and 25 kg KCl hectare-1) is a fertilization combination that is effective enough to maintain the growth and yield of corn plants on barely dry ground. The amount of nutrients in the planting media can be increased by applying chemical fertilizers at a 50% standard dose of ATP (200 kilogram of urea, 50 kg of SP36, and 25 kg of KCl per hectare). The availability of N nutrients increased from 1.90 g kg-1 before planting to 2.6-2.8 g kg-1 at the end of the study, and the availability of P nutrients increased from 27.45 mg kg-1 to 38.25-40.35 mg kg-1 at the end of the study, as shown by the results of the soil fertility analysis at the end of the study (Soil Lab FP Unsri, 2011/2012). The primary element that significantly influences the success rate of plant growth and production on marginal dry land is the availability of nutrients in adequate and balanced amounts. Plants' ability to access and absorb nutrients will be substantially aided by the provision of mycorrhizal fertilizers. This mycorrhiza's mechanism of action involves infecting the host plant's root system and vigorously forming hyphae so that the roots of plants that have mycorrhizae can boost their ability to absorb nutrients (Iskandar, 2004). Numerous studies have demonstrated that CMA can boost nutritional absorption, including macronutrients and micronutrients. De La Cruz (1981 in Octavitani, 2009) shown that CMA might cut the consumption of phosphate, nitrogen, and potassium by around 50%. Because ACM can alter the root structure of plants, increasing the number of branching roots, elongating secondary roots, stimulating the creation of quaternary roots, and increasing the number of lateral roots in corn plants, there is an increase in nutrient uptake (Kaldorf & Ludwig-Muller 2000). In addition, the growth of mycelium surrounding the roots increases the absorption area of root hairs, which is another function of mycorrhiza for the host plant. When compared to the exporting of roots without mycorrhiza, the amount of soil that can be exported by the external hyphae of AMF increases 5-200 times (Sieverding, 1991)As a result of mycorrhizal mycelium enlarging the root wandering area, more nutrients can be absorbed by the host plant than by plants that are not symbiotic with mycorrhizae. AMF external hyphae can improve the absorption of additional nutrients, such as the mobile nutrients N, K, and Mg, in addition to the P nutrient (Sieverding, 1991; Johansen et al., 1996; Bago et al., 1996; Hapsoh, 2003). Additional micro elements that boost absorption include Zn, Cu, B, and Mo. (Smith and Read, 1997).In addition to creating phosphatase enzymes, which allow AMA hyphae to release bound P elements to soil colloids (Musfal, 2010), AMA external hyphae also produce nitrate reductase enzymes that are capable of absorbing nitrates from the soil (Bago et al., 1996; Hapsoh, 2008).

One of the elements that significantly affects plant development and yield is enhancing plant N and P uptake-1. The nutrients phosphorus and nitrogen have a major impact on the growth and production of maize (Hairiah et al., 2000). An essential nutrient, nitrogen serves as the building block for amino acids, proteins, and leaf chlorophyll, all of which are crucial for the process of photosynthesis as well as the components of cell nuclei. In general, the nutrient N is crucial for the development or vegetative growth of plant parts like stems and leaves. The process of cell division, the production of nucleoproteins, the formation and growth of roots, the development of flowers, fruits, and seeds, and the quickening of fruit ripening all depend on phosphorus, an essential nutrient. According to Rosmarkam and Yuwono (2002), element P is essential for the development of fine roots and root hairs, flowers, and reproductive organs. Element P is also intimately connected to the synthesis of starch, particularly in grains like maize plants. The more N and P that plants absorb, the faster their growth is accelerated. As a result, plants grow taller, have more leaves, have wider leaves, produce more seeds, have greater yields, and have higher crop index-1 values. The amount of yield in the corn growing system is highly influenced by the rise in the yield of each of these components.

The findings demonstrated that, when given at different degrees of low-dose chemical fertilization, mycorrhizal fertilizers resulted in the maximum absorption of N and P nutrients, cob weight, number of seeds, and yields when compared to other biological fertilizers. This demonstrates that using mycorrhizal fertilizers can help plants tolerate dryness in addition to increasing nitrogen intake through their exterior hyphae. This resilience results from plants' ability to mitigate the direct impacts of drought by absorbing more water through a network of roots and mycorrhizae (Sasli, 2004). The area of root uptake of water and nutrients will increase due to AMF external hyphae network that infect plant roots. Additionally, the relatively small size of the hyphae in the root hairs enables AMF hyphae to penetrate the smallest soil pores, allowing the hyphae to continue to take water in extremely low soil moisture levels and spreading widely throughout the soil. in order for plants to absorb comparatively more water than plants without mycorrhizae (Kilham, 1994). Increased water uptake by mycorrhizal plants will also carry nutrients like N, P, and K, resulting in an increase in nutrient uptake by plants. Several theories explain why mycorrhizal plants are more resilient to drought stress, according to Morte et al. (2000). These theories include: (1). Mycorrhizae reduce the roots' resistance to water flow, resulting in an increase in the amount of water that reaches the roots. (2). increasing the P status of plants to boost drought resilience. Plants that lack P are typically more susceptible to drought. (3). Plants can survive in harsh environmental conditions thanks to better development and support provided by the presence of external fungal hyphae that can access water deep inside the soil (4). The indirect effect results from the ability of CMA to aggregate soil grains and increase the soil's capacity to hold water in the presence of external hyphae.

In comparison to the application of mycorrhizal fertilizers at different levels of low dose chemical fertilization, the results showed that the application of phosphate solubilizing bacteria (BPF) for all growing seasons resulted in lower absorption of N and P nutrients, cob weight, number of seeds, and yields. This is because a number of factors, such as the following, have a significant impact on the phosphate solubilizing bacteria's activity in the soil: (1). Temp. of the soil (2). pH, (3). soil hydration (4). amounts of nutrients in the soil (5). (As a source of energy for soil microbial activity), C-organic content, and (6). The quantity of phosphate-dissolving bacterial populations and their capacity for competition with other microbial species (Miller and Donahue, 1990; Goenadi and Sarasswati, 1993; Premono and Widyastuti, 1993; Santosa et al. 1997; and Goenadi et al. 2000). This makes the consistent application of BPF to boost P fertilization efficiency less apparent.

In comparison to other treatment combinations, the results showed that using the BISI 816 hybrid variety with the application of 25% chemical fertilizer at the recommended dose of ATP without the use of biological fertilizers resulted in growth in plant height, number of leaves, absorption of N and P nutrients, cob weight, number of seeds, 100 seed weight, and the lowest yields in each growing season. This shows that the treatment combination is ineffective for promoting maize growth and yield on poor dry land. It is not possible to maintain the growth of corn plants on marginal dry soil with the application of chemical fertilizers at a 25% standard dose of ATP (100 kg of urea, 25 kg of SP36, and 12.5 kg of KCl hectare-1). Considering that maize plants need a significant amount of nutrients during one growth cycle According to the findings of Sirappa and Tandisau's study from 2004, the maximum maize yields were produced on dry ground with low to moderate total N content at the level of chemical fertilization with a dose of 260 kg of urea, 220 kg of SP36, and 130 kg of KCl hectare-1. However, without the use of biological fertilizers, the degree of nutrient uptake by plants in the soil remains low. In addition, the research area's conditions are slightly dry, with low soil fertility, an acidic reaction with a soil pH below 5.5, and a high quantity of the macronutrient N. Low growth rates and crop yield are mostly limited by low levels of P, K, Ca, and Mg. According to Liebig's minimum legal concept, it reads as follows: The smallest factors present in the soil have an impact on crop yield, and 2) The amount of crop production will be reduced by nutrient insufficiency in the soil, and the lowest degree of nutrient deficit will lead to the best production outcomes. In contrast, the lack of biological fertilizers results in a low level of plant nutrient uptake into the soil, and on top of that, the research area's state is slightly dry with low soil fertility, an acidic reaction with a soil pH below 5.5, and a high amount of macro-N nutrients. Low crop output and low growth rates are mostly limited by low levels of P, K, Ca, and Mg. This is consistent with Liebig's minimum legal concept, which reads as follows: The bare minimum elements in the soil have an impact on crop output yield, and 2) Lack of nutrients in the soil will lower crop yield, and the lowest amount of nutrient deficit will lead to the best production outcomes. Contrarily, the level of plant nutrient uptake in the soil remains low in the absence of the application of biological fertilizers, and the study area's conditions are also marginally dry, with low soil fertility, an acidic reaction with a soil pH below 5.5, and a high content of the macronutrient N. The main factors limiting growth rates and crop production are low levels of P, K, Ca, and Mg. This follows Liebig's minimum legal principle, which states: The soil's bare minimum components, as well as factors two and three, affect crop yield. The level of crop production will be reduced by a lack of nutrients in the soil, and the lowest level of nutrient deficiency will produce the best results for production. Genetic and environmental factors interact when a plant responds differently to different environmental situations. The impact of significant interactions will directly affect the contribution of genetic factors in the final appearance of a plant.

4. CONCLUSION

1. The 1.B41 line exhibits adaptive growth, is more resilient to drought stress, has a high output potential at low chemical fertilization dosages, and is generally stable throughout the course of the growing season.
2. Applying mycorrhizal fertilizers at different degrees of low-dose chemical fertilization can boost maize plant growth and yield at different times of the year.
3. The use of the B41 strain of mycorrhizal fungi, along with a standard dose of chemical fertilizer at 50% ATP (200 kg urea, 50 kg SP36, and 25 kg KCl per hectare), had the greatest impact on the growth and yield of maize plants during the growing season. Yields during the wet season planting period reached 10.07 tons of dry cobs hectare-1 while the drought reached 8.57 tons of dry cobs hectare-1.

REFERENCE

Agro Tekno Park. 2003. Pekerjaan Budidaya Tanaman Jagung. Laporan Kerjasama Kementerian Riset dan Teknologi dengan Fakultas Pertanian Universitas Sriwijaya.

Aqil, M., Firmasyah dan M. Akil, 2008. Pengelolaan Air Tanaman Jagung . Balitsereal. \Litbang. Deptan. Go.id/ind//bjagung/duatujuh.pdf.Diakses tgl 23 November 2010.

Banzinger, M., S. Mugo, and G.O. Edmeades. 2000. Breeding for Drought Tolerance in Tropical Maize Convensional Approach and Challenges to Molecular Approaches. In: Ribaut, J. M. and D. Poland (Eds). Molecular Approaches for the Genetic Improvement of Cereals for Stable Production in Water Limited Environments, A Strategic Planning Workshop Held at CIMMYT, El Batan, Mexico, 21-25 June 1999, Mexico DF CIMMYT,

Balai Penelitian dan Pengembangan Departemen Pertanian Republik Indonesia. 1997. Kriteria Kesesuaian Tanah dan Iklim Tanaman Pertanian. Biro Perencanaan. Jakarta.

Bago B, Vierhelig H, Piche y, dan A. C. Aguilar. 1996. Nitrate Depletion and pH Changes Induced by the Exraradical Mycelium of the Arbiscular Mycorrhizal Fungus Glomus Inraradices Grown in Monoxenic Culture. New Phytol. 133:273-280.

Dharmarajan S, and Mahadevan A. 1995. Enymatic Studies of vesicular-Arbuscular Mycorrizae and Their Hosts. Biotrop Spec. Publ.56:75-90.

Costa, C. L.M. Dwyer, X. Zhou, P. Dutilleul. C. Hamel, L.M. Reid. And D.I. Smith. 2002. Root Morphology of Contrasting Maize Genotypes. Agron. J.4:96-101.

Dahlan, M. 2001. Pemuliaan Tanaman untuk Ketahanan Terhadap Kekeringan *dalam* Proc. International Conference on Agricultural Development NTT, Timor Timur dan Maluku Tenggara. Kupang, 11-15 Desember 2001.

Presterl.T. G. Seitz, M. Landbeck. E.M. Thiemt, W. Scimdt, and H.H. Geiger. 2003. Crop Breeding Genetics and Citology Improving Nitrogen-Use Eficiency in European Maize: Estimation of Quatitstive Genetic Parameters. Crop Sci. 43:1259-1265

Goenadi, .H.D and Y.T. Adiwiganda. 1998. Prescribing Fertilizers for Plantation Crops Based on Soil and Plant Nutrient Needs. National Soil Summit, Jakarta,26 Feb 1998.

H.D. dan R. Saraswati. 1993. Kemampuan Melarutkan Fosfat dari Beberapa Isolate Fungi Pelarut Fosfat. Menara Perkebunan 61(3):61-66.

Siswanto, and Y. Sugiarto. 2000. Bioactivation of Poorly Soluble Phosphate Rocks with a Phosphate-Solubilizing Fungus. Soil Sci. Soc. Am.J. 64:

927-932.

Hayati, R. Munandar, and F.K.S. Lestari. 2009. Agronomic Performance of Corn Population Selected For Nutrient Efficiency in Marginal Land. J. Agron. Indonesia 37 (1) : 8–13.

Hairiah, K., Van Noordwijk M dan Cadisch G, 2000. Carbon and Nitrogen Balance of Three Cropping Systems in Lampung. Neth.J. Agric. Sci.48 (2000): 3-17

Hapsoh 2003. Kompatibilitas MVA dan Beberapa Genotipe Kedelai Pada Berbagai Tingkat cekaman Kekeringan Tanah Ultisol: Tanggap Morfofisiologi dan Hasil. (Disertasi). Sekolah Pascasarjana, Institut Pertanian Bogor.

______.2008 Pemanfaatan Fungi Mikoriza Arbuskula pada Budidaya Tanaman kedelai di Lahan Kering. Pidato Pengukuhan Jabatan Guru besar Tetap Dalam Bidang Ilmu Budidaya Pertanian Pada Fakultas Pertanian Universitas Sumatera Utara. 14 Juni 2008.

Iskandar, S.S. 2004. Pupuk Hayati Mikoriza untuk Pertumbuhan dan Adaptasi Tanaman di Lahan Marginal (Online). (http://w.w.w.Iptek. Net.id/Terapan) Diakses tanggal 29 Desember 2009.

Johansen A, RD.Finlay dan PA. Olsson. 1996. Nitrogen Metabolism of External Hyphae of the Arbuscular Mycorrhizal Fungus Glomus Intraradices. New Phytol. 133: 705-712.

Kant.S.and Kafkafi. 2004. Mitigation of Mineral Deficiency Strees. (Online)http://w.w.w. Planstress. Com/articles/min deficieny m/ Mitigation. Htm. Diakses 27 Februari 2009

Kaldrof M, and Lutwing-Muller J. 2000. AM Fungi Might Affect The Root Morfology of Maize by Increasing Indole-3-Butyric Acid biosyntesis. *Physiol. Planta*.109: 58-67.

Kilham, K. 1994. Soil Ecology. Cambridge University Press

Mawardi dan M. Djazuli. 2006. Pemanfaatan Pupuk Hayati untuk Peningkatan Toleransi Kekeringan pada Tanaman Nilam. Jurnal Littri 12(1): 38-41

Miller, R.W. and R.L. Donahue. 1990. Soils. An Introduction to Soils and Plant Growth. 6th ed. Prentice Hall. Englewood Cliffs, NJ 07632.

Moertono, M.D. 1988. Pembentukan dan Produksi Benih Varietas Hibrida. Dalam Subandi, M. Syam, dan Adiwidjaja (Penyunting). Jagung. Puslitbangtan. Bogor.

Morte, A., C. Lavisolo and Scubert, 2000. Effect of Drought Stress on Growth and Water relations of Mycorrhiza association *Helianthemum Almeriense-Tervesia claveryi.* Mycorriza J. 10 (3):115-119

Musfal, 2010. Potensi Cendawan Mikoriza Arbuskula Untuk Meningkatkan Hasil Tanaman Jagung. Jurnal Litbang Pertanian, 29 (4):154-157.

Oktavitani, N.2009.Pemanfaatan Cendawan Mikoriza Arbuskular (CMA) Sebagai Pupuk Hayati Untuk Meningkatkan Produksi Pertanian\ http://uwityangyoyo.wordpress.com/2009/04/05. Diakses 2011.

Pusat Penelitian dan Pengembangan Tanah dan Agroklimat. 2005. Peta Potensi lahan Pengembangan Jagung di Indonesia. Bogor: Puslittan Bogor.

Premono, M.E. dan R. Widyastuti. 1993. Stabilitas *Pseudomonas putida* Dalam Beberapa Bahan Pembawa dan Peranannya Sebagai Pupuk Hayati.Makalah Kongres Nasional Perhimpunan Mikrobiologi Indonesia.Surabaya, 2-4 Desember 1993. Hlm 20.

Rosmarkam, A dan N.W. Yuwono. 2002. Ilmu Kesuburan Tanah. Kanisius. Yogjakarta.

Santosa, E., T. Prihatini, S. Widati, dan Sukristiyonubowo. 1997. Pengaruh Bakteri
Pelarut Fosfat dan Fosfat Alam Terhadap Beberapa Sifat Tanah dan Respon Tanaman Kacang Tanah (*Arachis hypogaea*, L). Hlm 115-122. *Dalam* Prosiding Seminar Nasional Identifikasi Masalah Pupuk Nasional dan Standarisasi Mutu yang Efektif. Bandar Lampung.

Sasli, I. 1999. Tanggap Karakter Morfosiologi Bibit kakao Bermikoriza Arbuskula Terhadap Cekaman Kekeringan. Thesis pascasarjana IPB.

_______. 2004. Peranan Mikoriza Vesikula Arbuskula (MVA) Dalam Meningkatkan Resistensi Tanaman Terhadap Cekaman Kekeringan. Tugas Makalah Pengantar Falsafah Sains. Sekolah Pasca Sarjana/S3 IPB. Bogor.

Sieverding E. 1991. Vesicular Arbuscular Mycorrhiza management in Tropical Agrosytem. Eschborn: Deutshe GTZ Gmbh.

Sirappa, M.P and P. Tandisau. 2004. Critical Values and Corn Yield Response to N, P and K Fertilization in the South Sulawesi Dry land. Jurnal Agrivigor 3 (3): 233-240.

Smith, S.E dan D.J. Read. 1997. Mycorrhizal Symbiosis. New York: Academic Press.

Sujiprihati, M. Syukur dan R. Yunisnti .2006, Analisis Stabilitas Hasil Tujuh Populasi Jagung Manis Menggunakan Metode Additive Main Effect Multicative Interaction (AMMI). Bul. Agron. 34 (2): 93-77.

Simanungkalit, R.D.M., D.A. Suriadikarta, R. Saraswati, D. Setyorini dan W. Hartatik. 2006. Pupuk Organik dan Pupuk Hayati. Balai Besar Litbang Sumber Daya Lahan Pertanian. Balai Penelitian dan Pengembangan Pertanian 2006.

Syam'un, E. dan Ambo Ala. 2010. Produksi Tanaman jagung pada Dua Jenis Pupuk Organik, paket Pemupukan dan Dosis Mikoriza Vasikular Arbuskular (MVA). J. Agrivigor 9(2): 177-190 .

Syafrudin. 2004. Genotipe jagung Efisien hara P. Buletin Plasma Nutfah. No 10(1):17-22.

Taiz, L dan E.Zeiger. 1991. Plant Physiology. The Benyamin Cummings Publishing Company, Inc. California.

Widiastuti, H., N. Sukarno., L.K. Darusman, D.H. Goenadi., S. Smith dan E. Guhardja. 2005. Penggunaan Spora Cendawan Mikoriza Arbuskula Sebagai Inokulum untuk Meningkatkan Pertumbuhan dan Serapan Hara Bibit kelapa sawit. Menara Perkebunan 73(1):26-34.