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Effect of FMA Dose and Cytokinin Concentration on the Growth and Yield of Jatropha Curcas L.)

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Abstract

Jatropha curcas L.) is one of the vegetation that produces energy and is often used as biodiesel in an effort to reduce the use of fossil energy that has limited reserves, cannot be renewed (Unrenewable) and has emissions of combustion gases (pollutants) that cause environmental impacts such as the greenhouse gas effect and affect air quality. This experiment was carried out at the Experimental Garden of the Faculty of Agriculture, Winaya Mukti University, Sumedang Regency. The altitude of the place is 850 m above sea level. The trial time is from September to October 2022. The purpose of the experiment was to study the interaction between FMA dosing and cytokinin concentration against increasing growth of IP-3P cultivar jatropha plants in medium plains and obtain the best FMA dosing treatment and cytokinin concentration on IP-3P cultivar jatropha plant growth in medium plains. The study used a randomized group design (RAK) factorial pattern, which consisted of two factors, namely FMA dose with levels: 0 g, 5 g, 10 g, 15 g, 20 g and cytokinin concentrations with levels: 0 MgL-1, 150 MgL-1, 300 MgL-1, 450 MgL-1, 600 MgL-1. Each treatment factor consists of 5 levels. Each treatment is repeated twice, then the total amount of 5 x 5 x 2 = 50 plots. The results of the experiment showed an interaction between FMA dosing and cytokinin concentration on the constraint parameters of the stomata, the number of leaves and the diameter of the stem. It was found that the treatment of FMA dose level f3 (15 grams) gave the best results on the parameters of mycorrhizal colonization, leaf chlorophyll, plant height, number of leaves, number of lateral branches, and root weight + FMA. In the treatment of cytokinin concentration level s3 gave the best results on the parameters of mycorrhizal colonization, leaf chlorophyll, as well as the number of leaves.

Keywords: AMF, Jatropha curcas L., Cultivar IP-3P, Cytokinin

Abstract

Tujuan dari penelitian ini adalah untuk mempelajari interaksi antara pemberian dosis FMA dan konsentrasi sitokinin terhadap peningkatan pertumbuhan tanaman jarak pagar kultivar IP-3P di dataran medium serta mendapatkan perlakuan pemberian dosis FMA dan konsentrasi sitokinin yang paling baik pada pertumbuhan tanaman jarak pagar kultivar IP-3P di dataran medium.. Percobaan ini dilaksanakan di Kebun Percobaan Fakultas Pertanian Universitas Winaya Mukti Tanjungsari Kabupaten Sumedang. Ketinggian tempat 850 m di atas permukaan laut. Waktu percobaan dari Bulan September sampai dengan Bulan November 2022. Penelitian menggunakan Rancangan Acak Kelompok (RAK) pola faktorial, yang terdiri atas dua faktor yaitu dosis FMA dengan taraf : 0 g, 5 g, 10 g, 15 g, 20 g dan konsentrasi sitokinin dengan taraf :

0 MgL-1, 150 MgL-1, 300 MgL-1, 450 MgL-1, 600 MgL-1. Masing-masing faktor perlakuan terdiri dari 5 taraf. Tiap perlakuan diulang sebanyak dua kali, maka jumlah keseluruhan 5 x 5 x 2 = 50 plot. Hasil percobaan menunjukkan adanya interaksi antara pemberian dosis FMA dan konsentrasi sitokinin pada parameter konduktansi stomata, jumlah daun dan diameter batang. Ditemukan pemberian perlakuan dosis FMA taraf f3 (15 Gram) memberikan hasil terbaik pada parameter kolonisasi mikoriza, klorofil daun, tinggi tanaman, jumlah daun, jumlah cabang lateral, dan bobot akar + FMA. Pada perlakuan konsentrasi sitokinin taraf s3 memberikan hasil terbaik pada parameter kolonisasi mikoriza, klorofil daun, serta jumlah daun.

Key words: FMA, Jarak Pagar, Kultivar IP-3P, Sitokinin.

1. Introduction

Jatropha curcas L.(Husn*a et*al., 2021). Jatropha seeds contain 20% - 40% vegetable oil, while the core of the seed contains 45% - 60% crude oil(Purnomo et al., 2020). Jatropha is considered attractive as a bio-diesel because of its high content of methyl ester sulfonate synthesis in its oil, it does not compete for other uses compared to palm oil or sugar cane and has very attractive agronomic characteristics.(Nugroho & Buchori, 2019).

Jatropha plants easily adapt to their growing environment, can grow well in less fertile soil, drought and soil conditions that are not optimal for plant growth in general.(Pasertiyani, 2013). So the cultivation of Jatropha plants can be carried out on sub-optimal soil such as inceptisol soil. Inceptisol soil is a type of soil that has the potential to be developed for its use because it has a wide distribution, nationally the distribution of inceptisol soil reaches 52.0 million hectares.(Yuniarti et al., 2020). This soil is generally found on dry land which has a cambic horizon and an orchic epipedon, causing the soil to have low levels of soil fertility and organic matter levels.(Khairiyah et al., 2022). This condition is further exacerbated by restrictions on the use of organic fertilizers, especially for several types of food crops(Amalia & Fajri, 2020). Besides that, naturally the levels of organic matter in the soil in tropical areas quickly decrease, ranging from 30% - 60% within 10 years.(Sabaruddin et al., 2013).

To optimize the use of inceptisol soil, efforts need to be made to improve the physical, biological and chemical properties of the soil by utilizing Arbuscular Mycorrhizal Fungi (AMF).(Khairiyah et al., 2022). AMF is a fungus that has a symbiotic relationship with plant roots(Herlina et al., 2017). As a biological agent, AMF is able to increase plant growth through providing more optimal nutrients and water so that it meets the needs of marginal land such as dry land with inceptisol type soil.(Nahak et al., 2022).

In cultivating Jatropha plants, the components of production come from each axillary lateral branch, for this reason it is necessary to increase the multiplication of lateral branches by adding the growth regulator substance cytokinin which is able to regulate the performance of the auxin hormone in cell division in the apical tissue leading to the formation of tissue in the lateral branches.(Indriana, 2020). The aim of this research was to find the best dose of AMF and cytokinin concentration to increase the growth of Jatropha curcas cultivar IP-3P.

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2. Materials and Methods

This experiment was carried out at the Experimental Garden of the Faculty of Agriculture, Winaya Mukti University, Tanjungsari, Sumedang Regency. The height of the place is 850 m above sea level. The trial period was from July to September 2022. The study used a factorial Randomized Block Design (RAK), which consisted of two factors, namely FMA dose with levels: 0 g, 5 g, 10 g, 15 g, 20 g and cytokinin concentration with levels: 0 MgL-1, 150 MgL-1, 300 MgL-1, 450 MgL-1, 600 MgL-1. Each treatment factor consists of 5 levels. Each treatment was repeated twice, so the total number was 5 x 5 x 2 = 50 plots. In order to test the hypothesis, it was analyzed using a linear model of Randomized Block Design (RAK) factorial pattern (Xijk = μ + ri + fj + sk + (fs)jk + eijk). To determine the differences between treatments, a further test was carried out using Duncan's Multiple Range Test. at a real level of 5% with the formula LSR (α, dbg, P) = SSR (α, dbG, P) x sx.

3. Results and Discussion

Mycorrhizal Colonization

The results of the analysis of mycorrhizal colonization at the age of 8 WAP showed that there was no interaction between the combination of FMA dosage and cytokinin concentration on mycorrhizal colonization. The results of the independent test analysis on observations of mycorrhizal colonization are presented in Table 1.

Table 1. Response to FMA Dosing and Cytokinin Concentration on Mycorrhizal Colonization 8 WAP

Treatment	Mycorrhizal Colonization (%)
FMA dosage:	
f0 = 0 g	5.75 a
f1 = 5 g	83.35 b
f2 = 10 g	88.05 c
f3 = 15 g	95.85d
f4 = 20 g	87.75 c
Cytokinin Concentration:	
s0 = 0 MgL-1	72.10 b
s1 = 150 MgL-1	71.30 ab
s2 = 300 MgL-1	71.80 b
s3 = 450 MgL-1	75.60c
s4 = 600 MgL-1	69.95 a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 1 shows that administering the FMA dose showed significantly different results with the highest results being at the f3 level (15 grams) with a mycorrhizal colonization percentage value of 191.7%. The cytokinin concentration treatment showed significantly different results with the highest results being at the s3 level (450 Mg.L-1) with a mycorrhizal colonization percentage value of 151.2%.

Stomatal Conductance

The results of observations of stomatal conductance at the age of 6 WAP showed that there was an interaction between the combination of FMA doses and cytokinin concentration on stomatal conductance. The results of the interaction test analysis on stomatal conductance observations are presented in Table 2.

Table 2.Response to FMA Dosage and Cytokinin Concentration on Stomata Conductance 6 WAP

	Stomatal Conductance (mmol H2O/m-2s-1) Cytokinin (S) Concentration									
	S0		S1		S2		S3		S4	
f0 (0)	38.60 A	a	34.65 A	a	37.05 A	a	56.80 B	b	40.20 A	ab
f1(5)	31.05 A	a	37.35 AB	a	43.45 BC	ab	57.55 D	b	48.55 CD	c
f2 (10)	29.90 A	a	29.40 A	a	41.00 AB	ab	53.45 C	b	44.70 BC	B C
f3 (15)	39.70 AB	a	36.25 A	a	39.55 AB	ab	47.85 B	ab	38.50 AB	ab
f4 (20)	37.73 AB	a	29,20 A	a	47.60 C	b	41.50 BC	a	34.03 AB	a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 2 shows that there is an interaction between the FMA dose and the cytokinin concentration, with the FMA dose levelf1The cytokinin concentration level S3 treatment showed the highest stomatal conductance observations with an average value of 57.55 mmol H2O/m-2s-1. At levels f0, f1, f2, f3, and f4 show significantly different results. In the s3 level cytokinin concentration treatment at the f1 level FMA dose treatment showed the highest results with an average value of 57.55 mmol H2O/m-2s-1. At levelS0, S1, S2, S3, and S4 show significantly different results.

Leaf Chlorophyll

The results of observations of leaf chlorophyll at 6 WAP showed that there was no interaction between the combination of AMF dosage and cytokinin concentration on leaf chlorophyll. The results of the independent test analysis on leaf chlorophyll observations are presented in Table 3.

Table 3.bResponse to FMA Dosage and Cytokinin Concentrations
Leaf Chlorophyll 6 WAP

Treatment	Leaf Chlorophyll (CCI)
FMA dosage:	
f0= 0 g	52.00 b
f1 = 5 g	51.30 ab
f2 = 10 g	52.90 b
f3 = 15 g	64.50c
f4 = 20 g	48.50 a
Cytokinin Concentration:	
s0 = 0 MgL-1	52.20 b

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s1 = 150 MgL-1	51.10 a
s2 = 300 MgL-1	51.60 ab
s3 = 450 MgL-1	65.60c
s4 = 600 MgL-1	48.60 a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 3 shows that the administration of AMF doses showed significantly different results on the leaf chlorophyll index with the highest results at the f3 level (15 grams) with an average value of 64.50 CCI. Likewise, the cytokinin concentration treatment showed significantly different results with the highest results being at the s3 level (450 Mg.L-1) with an average value of 65.60 CCI.

Plant Height

The results of observations of plant height at 2 WAP, 4 WAP, 6 WAP, and 8 WAP showed that there was no interaction between the combination of AMF doses and cytokinin concentration on plant height. The results of the independent test analysis on plant height observations are presented in Table 4.

Table 4. Response to FMA Dosage and Cytokinin Concentrations
Plant height 2 WAP, 4 WAP, 6 WAP, and 8 WAP

Treatment	Plant Height (Cm)			
	2 WAP	4 WAP	6 WAP	8 WAP
FMA dosage:				
f0= 0 g	13.30 BC	19.60 ab	25,20 a	34.90 a
f1 = 5 g	11.30 ab	21.70 BC	31.90 BC	42.70 b
f2 = 10 g	16.20 c	25.40 c	36.50 c	47.40 BC
f3 = 15 g	21.40 d	32.50 d	42.50 d	50.50 c
f4 = 20 g	9.20 a	16.40 a	27.80 ab	36.60 a
Cytokinin Concentration:				
s0 = 0 MgL-1	12.40 a	22.00 a	30.50 a	39.30 a
s1 = 150 MgL-1	13.30 a	20.90 a	30.60 a	37.60 a
s2 = 300 MgL-1	18.50 a	27.40 a	37.10 a	49.80 a
s3 = 450 MgL-1	15.70 a	24.40 a	34.00 a	45.20 a
s4 = 600 MgL-1	11.40 a	20.80 a	31.50 a	40.20 a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 4 shows that administering FMA doses at the ages of 2 WAP, 4 WAP, 6 WAP, and 8 WAP showed significantly different results with the highest results at the s3 level (15 grams). Meanwhile, the cytokinin concentration treatment showed that the results were not significantly different.

Number of Leaves

The results of observing the number of leaves at the age of 2 WAP, 4 WAP, 6 WAP, and 8 WAP showed that there was no interaction between the combination of AMF dosage and cytokinin concentration on the number of leaves at the age of 2 WAP, 4 WAP and 6 WAP. The results of the independent test analysis on observing the number of leaves are presented in Table 5.

Table 5. Response to FMA Dosing and Cytokinin Concentrations
Number of Leaves 2 WAP, 4 WAP, and 6 WAP

Treatment	Number of Leaves (Strands)					
	2 WAP		4 WAP		6 WAP	
FMA dosage:						
f0= 0 g	3.9	a	4.9	a	5.7	a
f1 = 5 g	4.6	a	6.4	a	7.0	e
f2 = 10 g	4.1	a	5.2	c	6.0	b
f3 = 15 g	4.6	a	6.2	c	6,8	d
f4 = 20 g	4.7	a	5,6	ab	6.3	c
Cytokinin Concentration:						
s0 = 0 MgL-1	4.1	b	5.2	a	6.0	a
s1 = 150 MgL-1	4.1	b	5.2	a	5.9	a
s2 = 300 MgL-1	4.5	b	5.8	b	6.5	b
s3 = 450 MgL-1	6.0	c	6,7	c	7.3	c
s4 = 600 MgL-1	3,2	a	5.3	ab	6.1	ab

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 5 shows the results of the independent test analysis on the response of AMF doses to the number of leaves at the plant age of 2 WAP showing that the results were not significantly different, and had a significant effect at the age of 4 WAP, and 6 WAP showed significantly different results, with the highest number of leaves being found. at the f1 level with an average number of leaves of 7.0 pieces. Meanwhile, the cytokinin concentration treatment at plant ages of 2 WAP, 4 WAP, and 6 WAP showed significantly different results on leaf number parameters with the highest leaf number results at the S3 level with an average value of 7.3 leaves.

Meanwhile, at plant age of 8 WAP, it showed that there was an interaction between the combination of AMF dosage and cytokinin concentration on the number of leaves. The results of the interaction test analysis on observing the number of leaves are presented in Table 6.

Table 6. Response to FMA Dosage and Cytokinin Concentration
to the Number of Leaves 8 WAP

FMA dosage (F)	Number of Leaves (Strands) Cytokinin (S) Concentration									
	S0		S1		S2		S3		S4	
f0 (0)	3.16 A	a	3.39 A	a	3.39 A	a	3.80 A	a	2.97 A	ab
f1(5)	3.94 AB	a	3.39 A	a	3.60 A	a	4.00 AB	ab	4.63 B	c
f2 (10)	3.39 AB	a	3.32 AB	a	3.87 B	a	4.03 B	ab	2.79 A	a

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f3 (15)	3.27 A	a	3.54 A	a	4.05 A	a	4.73 AB	b	3.67 B	b
f4 (20)	3.53 A	a	3.53 A	a	3.52 A	a	3.74 A	a	3.71 A	b

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 6 shows the interaction between AMF dosage and cytokinin concentration on leaf number parameters aged 8 WAP. Giving the FMA level f3 dose to the cytokinin S3 treatment showed the highest number of leaves with an average value of 4.73 pieces. The f1, f3, and f4 levels show significantly different results compared to the f0 and f2 levels. Likewise, the s3 level cytokinin concentration treatment at the f3 level AMF dose showed the highest number of leaves. Cytokinin concentrations s2, s3, and s4 showed significantly different results compared to levels s0 and s1.

Bar Diameter

The results of observations of stem diameter at 2 WAP, 4 WAP, 6 WAP, and 8 WAP showed that there was no interaction between the combination of AMF dosage and cytokinin concentration on stem diameter at 2 WAP and 4 WAP. The results of the independent test analysis on stem diameter observations are presented in Table 7.

Table 7 Response to FMA Dosage and Cytokinin Concentration on Diameter Bars 2 MST and 4 MST

Treatment	Bar Diameter (Cm)			
	2 WAP		4 WAP	
FMA dosage:				
f0= 0 g	0.80	a	0.85	a
f1 = 5 g	0.75	a	0.65	a
f2 = 10 g	0.75	a	0.60	a
f3 = 15 g	0.75	a	0.65	a
f4 = 20 g	0.80	a	0.75	a
Cytokinin Concentration:				
s0 = 0 MgL-1	0.80	a	0.75	a
s1 = 150 MgL-1	0.75	a	0.85	a
s2 = 300 MgL-1	0.75	a	0.60	a
s3 = 450 MgL-1	0.75	a	0.70	a
s4 = 600 MgL-1	0.80	a	0.70	a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 7 shows that administering doses of AMF at 2 WAP and 4 WAP showed non-significantly different results, likewise treatment with cytokinin concentrations at 2 WAP and 4 WAP showed non-significantly different results.

Meanwhile, at plant ages of 6 WAP and 8 WAP, it showed that there was an interaction between the combination of AMF dosage and cytokinin concentration on the number of leaves. The

results of the interaction test analysis on observing the number of leaves are presented in Table 8 and Table 9.

Table 8. Response to FMA Dosing and Cytokinin Concentrations
Stem Diameter 6 MST

FMA dosage (F)	Bar Diameter (Cm) Cytokinin (S) Concentration									
	S0		S1		S2		S3		S4	
f0 (0)	1.12 C	c	0.97 AB	ab	0.97 AB	a	1.07 BC	b	0.92 A	ab
f1(5)	0.89 A	a	1.05 B	b	0.92 A	a	0.97 A	a	0.95 AB	ab
f2 (10)	0.97 A	ab	0.92 A	a	0.92 A	a	1.02 A	ab	0.89 A	a
f3 (15)	1.02 A	B C	1.16 B	c	1.02 A	a	1.05 A	ab	1.02 A	B C
f4 (20)	0.95 A	a	0.97 AB	ab	0.95 A	a	1.02 AB	ab	1.07 B	c

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 8 shows the interaction between AMF dose and cytokinin concentration on stem diameter parameters aged 6 WAP. Giving the FMA level f3 dose to the cytokinin concentration level S1 treatment showed the highest stem diameter. At levels f0, f1, f2, f3, and f4 show significantly different results. Likewise, the s1 level of cytokinin treatment at the f3 level of AMF dose showed the highest stem diameter. At levels s0, s1, s3, and s4 show significantly different results compared to level s2.

Table 9. Response to FMA Dosing and Cytokinin Concentrations
Stem Diameter 8 MST

FMA dosage (F)	Bar Diameter (Cm) Cytokinin (S) Concentration									
	S0		S1		S2		S3		S4	
f0 (0)	1.12 C	c	0.97 AB	ab	0.97 AB	a	1.07 BC	a	0.92 A	ab
f1(5)	0.89 A	a	1.05 B	b	0.92 A	a	0.97 AB	a	0.95 AB	ab
f2 (10)	0.97 AB	ab	0.92 AB	a	0.92 AB	a	1.02 B	a	0.89 A	a
f3 (15)	1.02 A	B C	1.16 B	c	1.02 A	a	1.05 A	a	1.02 A	B C
f4 (20)	0.95 A	ab	0.97 AB	ab	0.95 A	a	1.02 AB	a	1.07 B	c

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 9 shows that when administering the FMA level f3 dose to the cytokinin concentration level s1 treatment, the stem diameter was the highest. At levels f0, f1, f2, f3, and f4 show significantly different results. Likewise, the s1 level of cytokinin treatment at the f3 level of AMF dose showed the highest stem diameter. At levels s0, s1, s3, and s4 show significantly different results compared to level s2.

Number of Lateral Branches

The results of observing the number of lateral branches at the age of 2 WAP, 4 WAP, 6 WAP and 8 WAP showed that there was no interaction between the combination of AMF dosage and cytokinin concentration on the number of lateral branches at the age of 2 WAP, 4 WAP, 6 WAP and 8 WAP. The results of the independent test analysis on observing the number of lateral branches are presented in Table 10.

Table 10. Response to FMA Dosage and Cytokinin Concentration on Amount Lateral branches 2 MST, 4 MST, 6 MST, and 8 MST

Treatment	Number of Lateral Branches (Fruits)							
	2 WAP		4 WAP		6 WAP		8 WAP	
FMA dosage:								
f0= 0 g	4.65	a	9.45	a	9.45	a	10.65	a
f1 = 5 g	13.65	a	8.45	a	8.45	a	9.45	a
f2 = 10 g	4.25	a	8.45	a	8.45	a	10.25	a
f3 = 15 g	5.25	a	10.25	a	16.45	a	21.65	b
f4 = 20 g	9.85	a	11.05	a	11.05	a	13.05	a
Cytokinin Concentration:								
s0 = 0 MgL-1	6.05	a	10.45	a	11.45	a	14.25	a
s1 = 150 MgL-1	5.45	a	11.05	a	11.05	a	12.85	a
s2 = 300 MgL-1	5.65	a	6.05	a	6.05	a	8.45	a
s3 = 450 MgL-1	4.45	a	5.65	a	9.45	a	14.65	a
s4 = 600 MgL-1	16.05	a	14.45	a	15.85	a	15.85	a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 10 shows that administering FMA doses at 2 WAP, 4 WAP, and 6 WAP showed no significant different results. Meanwhile, at the age of 8 WAP, the AMF treatment dose gave significantly different results with the highest number of lateral branches at the f3 level which had an average value of 21.65. The cytokinin concentration treatment at 2 WAP, 4 WAP, 6 WAP and 8 WAP showed no significant different results.

Root Weight + FMA

The results of observations of root weight and AMF at 8 WAP showed that there was no interaction between the combination of AMF dosage and cytokinin concentration on root weight and AMF at 8 WAP. The results of the independent test analysis on observing root weight and AMF are presented in Table 11.

Table 11. Response to FMA Dosage and Cytokinin Concentrations Root Weight and FMA 8 MST

Treatment	Root Weight + FMA (Grams)	
FMA dosage:		
f0= 0 g	10.5	a

f1 = 5 g	12.8	b
f2 = 10 g	12.4	ab
f3 = 15 g	18.7	c
f4 = 20 g	12.7	b
Cytokinin Concentration:		
s0 = 0 MgL-1	15.0	a
s1 = 150 MgL-1	12.8	a
s2 = 300 MgL-1	12.2	a
s3 = 450 MgL-1	14.8	a
s4 = 600 MgL-1	12.7	a

Note: Average numbers followed by the same letter in the same column are not significantly different based on Duncan's Multiple Range Test at a 5% significance level.

Table 11 shows that the AMF dose treatment had significant differences in root weight parameters and the AMF with the highest weight was at the f3 level with an average value of 18.7 grams. Meanwhile, the cytokinin concentration treatment showed insignificantly different results on root weight and AMF parameters. In general, the application of AMF to inceptisol soil can improve the quality of the soil thereby providing better plant growth compared to the growth of plants that are not given AMF.(Christofer et al., 2022). Several growth indicators such as mycorrhizal colonization parameters, stomatal conductance, leaf chlorophyll, plant height, number of leaves, stem diameter, number of lateral branches, as well as root and AMF weights were significantly influenced by the AMF dose. The optimal dose of FMA based on the regression test ranges from 13.64 grams - 13.67 grams. So at the f3 level (15 grams) several parameters show the highest values.

This significant influence cannot be separated from the role of mycorrhiza as soil saprophytic microorganisms that can increase the availability of nutrients and water that can be absorbed by Jatropha plants.(Nursidiq, 2019). AMF colonizes the roots, increasing the plant's absorption area so that the plant is able to absorb more nutrients to increase its growth(Agustiyanto, 2018).

Apart from increasing nutrient availability, mycorrhiza can also produce various hormones such as auxin, gibberellins and cytokinins as well as other hormones.(Juwita et al., 2022). Therefore, treatment with cytokinin concentrations that are too large will not make a significant difference. This is because plants have different needs for nutrients and growth regulating hormones. In general, plants need relatively little hormones, not to mention that plants themselves are capable of producing hormones naturally(Karmaita & Taufiq, 2019). In the experiment of Khofiyya et.al(2021)This shows that providing higher levels of nutrition does not guarantee increased growth, on the contrary, providing nutrients or hormones that are not in accordance with the needs of the plant will reduce the efficiency of the treatment. Plant growth will also be disrupted and what is worse can result in poisoning and death of Jatropha plants.

4. Conclusion

The conclusion obtained from this research is that the experiment shows that there is an interaction between AMF dosage and cytokinin concentration on the parameters of stomatal conductance, number of leaves and stem diameter. It was found that treatment with an FMA dose of f3 level (15 grams) gave the best results on the parameters of

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mycorrhizal colonization, leaf chlorophyll, plant height, number of leaves, number of lateral branches, and root weight + AMF. The S3 level of cytokinin concentration treatment gave the best results on the parameters of mycorrhizal colonization, leaf chlorophyll and number of leaves.

From the results of observations and hypothesis testing on the growth parameters of Jatropha plants, it cannot be said to be optimal, because the research results have not achieved the expected results. This can be influenced by various factors, both internal and external factors. Internal factors include genetic characteristics, morphology, physiology and plant age. Meanwhile, external factors can include altitude, climate, temperature, humidity, intensity of sunlight, wind, and other living creatures. It is necessary to ensure that these problems are addressed so that the expected experimental results are obtained. To maximize the experiment, it is necessary to use planting materials that are certified, high quality and guaranteed to be homogeneous. The environment sought must also be optimized for the growth requirements of the Jatropha curcas cultivar IP-3P.

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