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Effect of *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application on Soil Fertility under Nutrient Supply in Ultisol Soil

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Abstract

The application of *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. liquid green manure in Ultisol Soil media causes soil fertility to be better and more fertile. Ultisol soil, known as Red-Yellow Podzolic, has minimal nutrients, so plants are less developed and grow in the Soil. *Crotalaria mucronata* Desv. *Crotalaria juncea* L. is a plant that can provide nutrients to the Soil in an organic form that can be applied to nutrients fertilizer 12.12.17.2, which will make soil nutrients more available and make plants thrive and develop and produce production. This research was conducted at the Soil and Soil Fertility Laboratory Research Practice Farm, University of Sumatera Utara, Medan. This research used a Randomized Group Design (RGD). The results showed that the application of liquid green manure *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. as much as 300 ml. polybag^{-1} and fertilizer 12.12.17.2 as much as 10 g. polybag^{-1} was the highest treatment to improve Ultisol Soil fertility both in Soil Chemistry and Physics.

Keywords: Competence, Participation, Leadership, Pro-Social, Accountability
Crotalaria mucronata, Crotalaria juncea, Ultisol, Liquid Green Manure, Fertilizer

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INTRODUCTION

The contribution of liquid green manure is a source of nutrients containing organic matter that has been widely researched and has become a method of improving degraded soils. *Crotalaria mucronata* Desv. It is a plant with a fairly good nutrient content and is very beneficial as a source of organic matter. It can produce high biomass and increase the content of N-total (Nitrogen) and can grow on marginal land as well as *Crotalaria juncea* L., which has a high level of organic matter content and is very beneficial as a source of soil organic matter that is deficient (Marsha, 2014).

Crotalaria juncea L. plants are plants with *Crotalaria* species used as green manure. The type of *Crotalaria* spp. has better potential as a green manure. *Crotalaria* spp. Plants are a family of plants that can help land problems and nutrient deficiencies in the soil and help soils that experience nutrient deficiencies (Nisaa et al., 2016).

Low organic matter content causes soil fertility to be damaged or reduced; this causes crop production, which will experience crop failure due to low organic matter in the Soil. Increasing organic matter in the Soil is done by adding ameliorants to the Soil. Ameliorant is a material that can increase soil fertility by improving the physical and chemical properties of the Soil. Green Manure is an ameliorant that can increase soil organic matter (Nisaa et al., 2016).

The application of both solid and liquid green manure in a short period will not necessarily be able to increase plant productivity, so it is necessary to carry out integrated management, which combines the application of both solid and liquid green manure with inorganic fertilizers (Nisaa et al., 2016) *in* (Sumarni, 2008).

According to Uratani et al., (2004) that the potential content of N (Nitrogen) contained in *Crotalaria mucronata* Desv. Plants are higher by 3.90% than *Crotalaria juncea* L, in Cardoso et al. (2013) and Marsha's (2014) research that *Crotalaria mucronata* Desv. Plants at 3 weeks contain N (Nitrogen) of 3.12%, and this green manure can increase N (Nitrogen) in the coffee plant area.

Natural fertility in Ultisol soil is the presence of a thin A horizon with low organic matter (BO) content. Macronutrients such as phosphorus (P) and potassium (K) are deficient, so the soil reaction is acidic to very acidic, and the occurrence of aluminium saturation causes Ultisol soil to inhibit plant growth (Subagyo et al., 2004) in (Prasetyo & Suriadikarta, 2006). According to Lubis (2020), Ultisol soil is referred to as Red-Yellow Podzolic soil, which lacks nutrients, so the plants that grow on the land will not be fertile, and the production will experience crop failure.

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According to Damanik et al. (2011), ultisol soil is classified as marginal land with a low level of productivity and low nutrient content due to incentive base leaching and soil acidity (pH). Available nutrients are very low, such as the availability of P (Phosphorus) and K (Potassium) potential, which varies very low to low in the layer (Fitriatin et al., 2014).

Lycopersicum esculentum Mill. It is a vegetable and fruit that is classified as a seasonal crop. The problem with the agricultural business of *Lycopersicum esculentum* Mill. Is that production still low compared to its production potential? Most of the land in Indonesia is with Ultisol soil so Ultisol land must be utilized so that plants can be fertile and production and productivity can support (Lubis, 2020). This is done to increase the production of *Lycopersicum esculentum* Mill. This can be done by improving technology and soil fertility. Cultivation such as this plant must be improved in terms of varieties, fertilization, pest and disease control and improvement of planting land and post-harvest handling of *Lycopersicum esculentum* Mill. (Fadel et al., 2017).

In this study, *Lycopersicum esculentum* Mill. Plants were used as experimental plants to see the growing power of applying liquid green manure *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. given and the provision of inorganic nutrients 12.12.17.2 fertilizer on Ultisol soil media.

METHODS

This study uses a 2 Factorial Randomised Group Design, with 2 parts in compiling this study. Part 1 consists of factorial 1, where factor 1 is Liquid Green Manure *Crotalaria mucronata* Desv. There 3 treatment levels, namely level 1, namely 100 ml. polybag^{-1}; level 2, namely 200 ml. polybag^{-1}; level 3, namely 300 ml. polybag^{-1}. In factor 2 part 1, inorganic fertilizer 12.12.17.2 consists of 3 treatment levels, level 1, namely 5 g. polybag^{-1}, level 2, namely 10 g. polybag^{-1}, level 3, namely 15 g. polybag^{-1}.

Part 2 consists of factorial 2 where factor 1 is Liquid Green Manure *Crotalaria junce* L. which consists of 3 treatment levels, namely level 1, which is 100 ml. polybag^{-1}, level 2, which is 200 ml. polybag^{-1}, level 3, which is 300 ml. polybag^{-1}. Factor 2 part 2, namely inorganic fertilizer 12.12.17.2, consists of 3 levels, level 1, namely 5 g. polybag^{-1}, level 2, namely 10 g. polybag^{-1}, level 3, namely 15 g. polybag^{-1}.

This research was conducted for six months, from August 2024 to January 2025, at the Soil and Environment Laboratory Research Practice Farm, University of Sumatera Utara, Medan.

Soil analysis and experiments were conducted at the Soil Laboratory, Indonesian Oil Palm Research Institute (IOPRI or PPKS) Medan, and the Soil, Plant, Fertilizer and Water Laboratory at the Institute for Agricultural Technology (IAT or BPTP) Johor, Medan, North Sumatera.

In *Lycopersicum esculentum* Mill. The plants used in this study were seedlings of the Fiesta F1 variety (Bintang Asia). The seedlings used in the experiments were two months old, and their roots and stems were strong and able to accept changes in the growing medium.

Observation parameters and indicators are Plant Height (cm), Number of Leaves (Strands), Root Wet Weight (g), Root Dry Weight (g), Saturated Soil Moisture Water Content (%), Soil Moisture Water Content Field Capacity (%), Weight of Soil Content (g.cm^{-3}), Cation Exchange Capacity (CEC) (me.100 g^{-1}), Soil Porosity (%), Soil Plasticity Index (%), Calcium exchangeable Soil (Ca-dd) (me.100 g^{-1}), Electrical Conductivity of Soil (µS.cm^{-1}), Soil H_2O pH Value, Soil C-Organic Analysis (%), Soil N-Total Analysis (%), P_2O_5-Soil Available (ppm P), and K_2O-Soil Exchange (me.100 g^{-1}).

RESULT AND DISCUSSION

Results of Analysis of Physical and Chemical Properties of Ultisol Soil

a. Saturated Soil Moisture Water Content

From the Results of Saturated Soil Moisture Water Content, the Resulting Data Obtained in Table 1 follows.

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Table 1. Saturated Soil Moisture Water Content under Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	Saturated Soil Moisture Water Content	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			
ml.polybag^{-1}		g. polybag^{-1}	%	
100		5	43,10 a	43,00 a
		10	44,70 a	44,30 a
		15	44,20 a	44,10 a
200		5	44,36 a	44,10 a
		10	45,50 b	46,00 c
		15	45,30 b	45,20 b
300		5	46,44 c	45,88 b
		10	46,90 d	46,90 c
		15	45,90 c	46,00 c

Description: The number followed by the same index in the same row or column showed no significant difference according to the DMRT test (Duncan's Multiple Range Test) 95% confidence level (α = 0,05).

The data of the research results on Saturated Soil Moisture Water Content (%) can be seen in Table 1, where in Table 1 it is obtained that the measurement results of Saturated Soil Moisture Water Content in Liquid Green Manure *Crotalaria mucronata* Desv. With a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} is 46.90%, while in Liquid Green Manure *Crotalaria juncea* L. with a dose of 300 ml. polybag^{-1} and nutrient fertilizer with 10 g. polybag^{-1} is 46.90%. This indicates the provision of Liquid Green Manure at 300 ml. polybag^{-1} and nutrient fertilizers 12.12.17.2 at a dose of 10 g. polybag^{-1}, the Soil can be filled with nutrients, and the fertility of the Soil has been maximally fulfilled without leaching nutrients by watering.

This is conveyed by (Nisaa et al., 2016) that the provision of nutrients that are right on target and the right dose will make plant growth more fertile, and the application of the right planting media will make soil fertility better, and the Soil will be healthy as a place for plant growth and development.

Excessive application of nutrient fertilizers causes the Soil to become intolerant, causing nutrient leaching or nutrients to be wasted during watering and not accepted by plants (Lubis, 2025a).

b. Soil Moisture Water Content Field Capacity

From the Results of Soil Moisture Water Content Field Capacity, the Resulting Data has been Obtained in Table 2.

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Table 2. Soil Moisture Water Content Field Capacity in Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure				
***Crotalaria mucronata* Desv.**	***Crotalaria juncea* L.**	**Fertilizer 12.12.17.2**	**Soil Moisture Water Content Field Capacity**	
ml.polybag^{-1}		**g. polybag^{-1}**	**%**	
100		5	17,00 a	17,10 a
		10	21,10 b	19,98 b
		15	21,88 b	21,00 c
200		5	25,10 c	23,70 d
		10	25,40 c	25,10 e
		15	26,30 d	26,00 f
300		5	26,70 d	26,72 f
		10	**28,10 f**	**27,89 g**
		15	27,89 e	27,00 g

Description: The number followed by the same index in the same row or column showed no significant difference according to the DMRT test (Duncan's Multiple Range Test)95% confidence level (α = 0,05)

The study results can be seen in Table 2, where there is a reaction in the Soil so that the test on Soil Moisture Water Content Field Capacity (%) to the application of liquid green manure and nutrient fertilizer has a significant effect on soil testing. The application of liquid green manure *Crotalaria mucronata* Desv. At a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 at 10 g. polybag^{-1} showed a result of 28.10% higher than the nutrient fertilizer dose above, which was only 27.89%. The application of liquid green manure *Crotalaria juncea* L. dose of 300 ml. polybag^{-1} and nutrient fertilizer dose of 10 g. polybag^{-1} was not significantly different but gave a higher effect of 27.89%, higher than the dose of nutrient fertilizer above, which was 27.00%.

This shows that the dose level of fertilizer gives better results than more; this will make the Soil and plants experience over-absorption so that plants will easily stress excess nutrients and die, and the Soil will experience damage so that the Soil will easily experience Leached Nutrients (Nisaa et al., 2016).

In accordance with Lubis et al. (2023), the problematic Ultisol and Inceptisol soils lack Phosphorus and Potassium nutrients, which support plant growth. Soils need to be applied, but according to their needs. If they are applied in excess, they will damage the Soil, and the Soil will become unhealthy due to excess nutrients.

c. Weight of Soil Content

From the Results of Soil Content Weight, the Resulting Data has been Obtained in Table 3.

Table 3. Weight of Soil Content in Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. Liquid Green Manure Application

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Liquid Green Manure		Fertilizer 12.12.17.2	Weight of Soil Content	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			
ml.polybag^{-1}		g. polybag^{-1}	g.cm^{-3}	
100		5	1,27 a	1,25 a
		10	1,33 a	1,27 a
		15	1,35 a	1,32 a
200		5	1,30 a	1,28 a
		10	1,35 a	1,33 a
		15	1,37 a	1,37 a
300		5	1,35 a	1,32 a
		10	**1,38 a**	**1,37 a**
		15	1,38 a	1,36 a

Description: The number followed by the same index in the same row or column showed no significant difference according to the DMRT test (Duncan's Multiple Range Test) 95% confidence level (α = 0,05)

In the research results in Table 3, it is stated that the application of *Crotalaria mucronata* Desv. Liquid Green Manure in a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 in 10 g. polybag^{-1} produces 1.38 g.cm^{-3}, and the result is the same as the application of nutrient fertilizer in a dose of 15 g. polybag^{-1}, which is 1.38 g.cm^{-3}. The application of *Crotalaria juncea* L. Liquid Green Manure at 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 at a dose of 10 g. polybag^{-1} produced 1.37 g.cm^{-3} higher than the application of nutrient fertilizer at a dose of 15 g. polybag^{-1}, which is 1.36 g.cm^{-3}. So, the soil content's weight was heavier when applying nutrient fertilizer 12.12.17.2. and liquid green manure *Crotalaria mucronata* Desv. This is due to the absorption of nutrients in liquid green manure and nutrient fertilizer stored in the soil bysoil particles and available in the Soil and used by plants.

d. Electrical Conductivity of Soil

From the Soil Electrical Conductivity Results, the Resulting Data Obtained in Table 4 is as follows.

Table 4. Soil Electrical Conductivity under Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	Electrical Conductivity of Soil	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			
ml.polybag^{-1}		g. polybag^{-1}	µS.cm^{-1}	
100		5	177,80	177,00

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	10	179,60	178,50
	15	179,90	182,10
	5	189,80	187,90
200	10	210,20	210,00
	15	213,80	213,50
	5	231,50	228,80
300	**10**	**245,90**	**240,80**
	15	243,60	237,50

Table 4 shows the Electrical Conductivity (DHL) in the application of Liquid Green Manure *Crotalaria mucronata* Desv. With a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} shows a Soil Electrical Conductivity of 245.90 µS.cm^{-1}. The application of liquid green manure *Crotalaria juncea* L. with a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} showed a soil electrical conductivity of 240.80 µS.cm^{-1}.

e. Soil Porosity

From the Results of Soil Porosity, the Resulting Data has been obtained in Table 5.

Table 5. Soil Porosity under the Application of Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure

Liquid Green Manure		**Fertilizer 12.12.17.2**	**Soil Porosity**	
***Crotalaria mucronata* Desv.**	***Crotalaria juncea* L.**			
ml.polybag^{-1}		***f.*** **polybag^{-1}**	**%**	
		5	43,00 a	44,00 a
100		10	44,30 a	45,20 a
		15	45,00 ab	46,00 a
		5	45,50 b	46,80 ab
200		10	45,80 b	46,90 b
		15	48,00 c	49,20 c
		5	48,50 c	49,60 c
300		**10**	**55,70 d**	**54,10 d**
		15	55,20 d	53,20 cd

Description: The number followed by the same index in the same row or column showed no significant difference according to the DMRT test (Duncan's Multiple Range Test) 95% confidence level (α = 0,05)

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In the research results can be seen in Table 5, that there are differences in soil porosity due to the application of Liquid Green Manure and Nutrient Fertilizer 12.12.17.2. The application of liquid green manure *Crotalaria mucronata* Desv. With a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} resulted in soil porosity of 55.70%, not significantly different from the dose of nutrient fertilizer 15 g. polybag^{-1} with a result of 55.20%. The application of *Crotalaria juncea* L. Liquid Green Manure with a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} resulted in soil porosity of 54.10%; this was not significantly different from the dose of nutrient fertilizer 12.12.17.2 of 15 g. polybag^{-1}, which was 53.20%.

This indicates that the application of Liquid Green Manure from *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. makes the porosity of Ultisol soil, which was initially hard and coarse, smooth and crumbly so that plant roots can penetrate the Soil in their growth and water is easily absorbed by the Soil and available to plants (Lubis et al., 2023; Lubis, 2025).

f. Soil Plasticity Index

From the Results of the Soil Plasticity Index Research, the Resulting Data Obtained in Table 6 follows.

Table 6. Soil Plastisity Index under Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	Soil Plasticity Index	
***Crotalaria mucronata* Desv.**	***Crotalaria juncea* L.**			
ml.polybag^{-1}		**g. polybag^{-1}**	**%**	
100		5	46,50 d	45,90 d
		10	45,30 c	43,10 b
		15	43,20 b	42,10 b
200		5	44,70 d	43,00 d
		10	43,20 b	41,10 c
		15	39,30 a	39,00 b
300		5	44,30 d	44,70 d
		10	42,10 b	41,00 b
		15	38,80 a	37,90 a

Description: The number followed by the same index in the same row or column showed no significant difference according to the DMRT test (Duncan's Multiple Range Test) 95% confidence level (α = 0,05)

The research results can be seen in Table 6 as follows, the application of liquid green manure *Crotalaria mucronata* Desv. With a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 15 g. polybag^{-1} became the lowest soil plasticity index on Ultisol soil at 38.80% and on *Crotalaria*

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juncea L. Liquid Green Manure at a dose of 300 ml. polybag^{-1} and 12.12.17.2 nutrient fertilizer at a dose of 15 g. polybag^{-1} made the smallest soil plasticity index of 37.90%. While the application of nutrient fertilizer at a dose of 10 g. polybag^{-1} with a medium Plasticity Index (IP) of 42.10% on *Crotalaria mucronata* Desv. Liquid Green Manure and *Crotalaria juncea* L. Liquid Green Manure resulted in a 41.00% Plasticity Index.

This indicates that a plant with a low plasticity index (IP) is more likely to become easily dry and waterlogged when watering occurs, and the water content decreases when the plant begins to absorb water in the Soil (Lubis, 2025).

g. Cation Exchange Capacity (CEC)

From the Cation Exchange Capacity Results, the Resulting Data Obtained in Table 7 is as follows.

Table 7. Cation Exchange Capacity under Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	Cation Exchange Capacity	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			
ml.polybag^{-1}		g. polybag^{-1}	me.100 g^{-1}	
100		5	32,12	33,20
		10	33,41	34,30
		15	35,60	35,00
200		5	35,17	35,20
		10	36,80	36,30
		15	37,99	35,30
300		5	37,90	36,40
		10	44,10	42,00
		15	42,70	43,20

Table 7 shows that Cation Exchange Capacity (CEC) in Ultisol Soil changes when applying Liquid Green Manure and Nutrient Fertilizer. The application of liquid green manure *Crotalaria mucronata* Desv. At a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2, as much as 10 g. polybag^{-1} gave results on cation exchange capacity (CEC) of 44.10 me.100 g^{-1}, while applying liquid green manure *Crotalaria juncea* L. at 300 ml of polybag^{-1} and nutrient fertilizer 10 g. polybag^{-1} gave CEC results of 42.00 me.100 g^{-1}.

h. Calcium exchangeable Soil (Ca-dd)

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The Results can be Calsium exchanged Soil. The Resulting Data Obtained in Table 8 is as follows.

Table 8. Calcium exchangeability on Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	Calcium exchangeable Soil	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			
ml.polybag^{-1}		h. polybag^{-1}	me.100 g^{-1}	
100		5	100,00 a	101,10 a
		10	110,10 b	114,20 b
		15	114,30 b	115,00 b
200		5	114,90 b	115,60 b
		10	115,80 b	117,20 b
		15	117,90 b	117,90 b
300		5	121,20 c	122,25 c
		10	**128,90 e**	**125,70 d**
		15	126,60 d	125,40 d

Description: The number followed by the same index in the same row or column showed no significant difference according to the DMRT test (*Duncan's Multiple Range Test*) 95% confidence level (α = 0,05)

Table 8 shows the results of the Calcium exchangeable (Ca-dd) analysis, which must be analyzed due to the application of Liquid Green Manure and Nutrient Fertilizer. The application of liquid green manure *Crotalaria mucronata* Desv. At a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 at a dose of 10 g. polybag^{-1} is the highest result in the exchangeable Calcium (Ca-dd) analysis of 128.90 me.100 g^{-1}. Applying *Crotalaria juncea* L. Liquid Green Manure at a dose of 300 ml. polybag^{-1} produced an exchangeable calcium value of 125.70 me.100 g^{-1}. This makes calcium nutrients exchangeable with phosphorus or other organic materials and can be used by microorganisms that are interrelated in preparing plant growth.

In Lubis's opinion (2025b), exchangeable Calcium is Calcium that is available in the Soil, can interact with other organic matter and can be used by soil microbes.

i. Soil H_2O pH Value

From the Results Soil Analysis H_2O pH Value Conducted in the Laboratory, the Resulting Data Obtained in Table 9 follows.

Table 9. Soil H_2O pH Value on Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

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Liquid Green Manure		Fertilizer 12.12.17.2	Soil H_2O pH Value	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			
ml.polybag^{-1}		g. polybag^{-1}	------	
100		5	5,10	5,10
		10	5,29	5,15
		15	5,27	5,30
200		5	5,44	5,17
		10	5,90	5,25
		15	5,99	6,00
300		5	6,10	6,10
		10	6,25	6,25
		15	6,20	6,14

Table 9 shows that soil acidity (pH) refers to whether plants can thrive due to high or low soil acidity. The application of liquid green manure *Crotalaria mucronata* Desv. With a dose of 300 ml. polybag^{-1} and nutrient element fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} has soil acidity (pH) with slightly acidic criteria, namely a value of 6.25. This soil acidity (pH) is the same as the application of *Crotalaria juncea* L. Liquid Green Manure with a fertilizer dose of 300 ml. polybag^{-1} has a slightly acidic criterion, namely a value of 6.25.

According to Lubis (2025b), soils that are too acidic experience serious land degradation problems and impact agricultural land. Soils that are too acidic will reduce the availability of nutrients and can increase the risk of heavy metal poisoning, such as Aluminium (Al) and Magnesium (Mg).

j. Soil C-Organic and Soil N-Total Analysis

From the Results of the Soil C-organic and Soil N-total analysis Conducted in the Laboratory, the Resulting Data in Table 10 are as follows.

Table 10. Soil C-Organic and Soil N-Total Analysis on Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	C-Organic Soil	Soil N-Total
Crotalaria mucronata Desv.	*Crotalaria juncea* L.			

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ml.polybag^{-1}	g. polybag^{-1}	%		%	
	5	3,00 m	3,11 m	0,22 l	0,31 m
100	10	3,20 m	3,20 m	0,25 l	0,30 l
	15	2,29 m	3,27 m	0,27 l	0,30 l
	5	3,10 m	3,21 m	0,33 m	0,31 m
200	10	3,19 m	3,40 m	0,37 m	0,33 m
	15	3,29 m	3,47 m	0,40 m	0 41 m
	5	3,30 m	3,80 m	0,43 m	0,44 m
300	10	4,29 h	4,27 h	0,47 m	0,49 m
	15	4,15 h	4,25 h	0,45 m	0,48 m

Description: Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh = Very High

In Table 10 are the results of laboratory analyses where soil Organic Carbon (%) and Soil Total Nitrogen (%) levels are tested. In the Soil C-Organic test carried out by applying *Crotalaria mucronata* Desv. Liquid Green Manure at a dose of 300 ml. polybag^{-1} and 12.12.17.2 nutrient fertilizer at 10 g. polybag^{-1} in Ultisol soil, the analysis result is 4.29% with high criteria. Likewise, with the application of *Crotalaria juncea* L. Liquid Green Manure at 300 ml. polybag^{-1} and 12.12.17.2 nutrient fertilizer at a dose of 10 g. polybag^{-1}, the analysis result was 4.27% with high criteria.

The same thing happened in Ultisol soil analysis testing, namely analyzing the Total Soil Nitrogen (N-Total) level by applying *Crotalaria mucronata* Desv. Liquid Green Manure at a dose of 300 ml. polybag^{-1} and nutrient fertilizer at 10 g. polybag^{-1}, the analysis result is 0.47% with moderate criteria. Tests on Liquid Green Manure *Crotalaria Juncea* L. at a 300 ml polybag^{-1} dose and nutrient fertilizer at 10 g. polybag^{-1}, the analysis result was 0.49% with moderate criteria.

This becomes the basis for applying liquid green manure from *Crotalaria mucronata* Desv. *Crotalaria juncea* L. plants can make Ultisol soil with no organic matter available so that organic carbon becomes available and can be used by *Lycopersicum esculentum* Mill. Plants and other plants. According to Josephine et al. (2020) *in* Havlin et al. (2016), the complement of organic matter in the Soil, if available, will make the Soil healthier, and the carrying capacity of carbon will be available to make plants grow well, as well as the provision of green manure as organic matter that supports soil lack of organic matter.

The application of liquid green manure *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. can replace mineral nutrients that are deficient in Ultisol soil to be available. Using inorganic fertilizers to provide plant nutrients can also make plants grow better (Nisaa et al., 2016).

The improvement of nutrient availability in the Soil will be known from the organic matter content, which can be seen from the laboratory analysis results of 4.29% with high criteria. In addition, the application of either solid or liquid green manure into the Soil will improve its physical and biological

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properties. The decomposition process from applying liquid green manure *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. will produce organic acids to increase organic compounds characterized by increased levels of organic carbon (C-Organic) in the Soil.

According to Marsha (2014) in Nisaa et al. (2016), the provision of organic matter in the form of green manure, both solid and liquid, into the Soil will increase other nutrients, one of which is the nutrient Nitrogen (N) Total Soil, where soil N-Total becomes 0.47% and 0.49% with moderate criteria. This supports the addition of inorganic fertilizers so that nitrogen nutrient levels are met for plant growth.

As explained by Lubis et al. (2023), the N-total content is relatively low to moderate due to absorption activities by plants or microbes. Nitrogen levels in the form of ammonium (NH_4^+) can be bound by clay minerals so that they will be available to plants in their growth, and nitrogen in the form of nitrate (NO_3^-) is easily washed away by rainwater or watering.

k. P_2O_5- Soil Available and K_2O-Soil Exchange Analysis

From the Results of Soil P_2O_5-Soil Available and K_2O-Soil Exchange Analysis Conducted in the Laboratory, the Resulting Data has been Obtained in Table 11 as follows.

Table 11. Soil P_2O_5-Available and K_2O-Exchange Analysis on Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

Liquid Green Manure		Fertilizer 12.12.17.2	P_2O_5- Soil Available		K_2O-Soil Exchange	
Crotalaria mucronata Desv.	*Crotalaria juncea* L.					
ml.polybag^{-1}		g. polybag^{-1}	ppm P		me.100 g^{-1}	
100		5	39,10 h	39,00 h	0,98 h	0,89 h
		10	39,55 h	39,35 h	0,99 h	0,97 h
		15	39,60 h	39,88 h	1,20 vh	1,00 h
200		5	39,99 h	40,25 h	1,27 vh	1,25 vh
		10	40,22 h	40,40 h	2,13 vh	1,89 vh
		15	40,47 h	40,50 h	2,22 vh	2,15 vh
300		5	41,00 vh	41,50 vh	2,98 vh	2,87 vh
		10	42,30 vh	43,20 vh	3,28 vh	3,27 vh
		15	43,10 vh	43,35 vh	3,10 vh	3,00 vh

Description: Criteria for Planting Media, h = High, l = Low, m = Medium, sl = Slightly Low, vl = Very Low, vh = Very High

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Table 11 shows the results of Ultisol soil analysis with the application of liquid green manure of *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. plants with nutrient fertilizer 12.12.17.2. on soil tests of soil P_2O_5-available (ppm P) and soil K_2O-exchange (me.100 g^{-1}). The application of *Crotalaria mucronata* Desv. Liquid Green Manure at a dose of 300 ml. polybag^{-1} and nutrient fertilizer at 10 g. polybag^{-1} produced soil analysis on P_2O_5-Soil Available of 42.30 ppm P, with very high criteria, and at a dose of nutrient fertilizer of 15 g. polybag^{-1} also produced 43.10 ppm P with very high criteria. The application of liquid green manure *Crotalaria juncea* L. at 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 at a dose of 10 g. polybag^{-1} resulted in soil analysis of P_2O_5-Soil Available of 43.20 ppm P, with very high criteria, and at a dose of nutrient fertilizer of 15 g. polybag^{-1} also produced 43.35 ppm P, with very high criteria.

In the Potassium Exchange (K_2O-Soil Exchange) test in Ultisol Soil, the application of *Crotalaria mucronata* Desv. Liquid Green Manure at a dose of 300 ml. polybag^{-1} and 12.12.17.2 nutrient fertilizer at 10 g. polybag^{-1} produced 3.28 me.100 g^{-1} Soil, with very high criteria, while the fertilizer dose of 15 g. polybag^{-1} produced 3.10 me.100 g^{-1} Soil, with very high criteria. The application of liquid green manure *Crotalaria juncea* L. at a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 produced 3.27 me.100 g^{-1} of Soil, with very high criteria, while the fertilizer dose of 15 g. polybag^{-1} produced 3.00 me.100 g^{-1} of Soil, with very high criteria.

The application of liquid green manure *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. in the nutrient fertilizer mixture 12.12.17.2; this makes the Ultisol soil, which is experiencing a lack of phosphorus and potassium nutrients that are not available, become available. Available phosphorus testing (P_2O_5-Soil Available) where the application of 10 g. polybag^{-1}, with 42.30 ppm P, makes Ultisol soil to P nutrients available. This is due to the role of inorganic nutrients applied and fulfilled in the Soil. While the application of only nutrient fertilizers applied to Ultisol soil will not be able to meet the needs of nutrients in Ultisol soil.

Organic matter is one indicator that causes the availability of nutrients in the Soil. The application of liquid or solid green manure into the Soil can increase the availability of nutrients needed by Soil and plants. Soil compaction can inhibit root growth of *Lycopersicum esculentum* Mill. With the addition of green manure, *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. will be able to weaken the porosity, and soil pores will be formed so that plant roots will easily penetrate and search for mineral nutrients in the Soil.

The nutrient p (Phosphor) in the Soil is in the form of organic and inorganic compounds. The increase in phosphorus nutrient levels in the Soil is due to adding organic matter. According to Sumarni (2008), the application of *Crotalaria mucronata* Desv. *Crotalaria juncea* L. The Soil will show the addition of organic matter into the Soil and Nitrogen (N) and Phosphorus (P) nutrients in the Soil.

Vegetative Observation Results

From the Results of Research on Vegetative Plant Growth, the Resulting Data has been Obtained in Table12 as follows.

Table 12. Observation of Vegetative Growth of Plants on Fertilizer 12.12.17.2 and *Crotalaria mucronata* Desv. and *Crotalaria juncea* L. Liquid Green Manure Application

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Liquid Green Manure	Fertilizer	*Lycopersicum esculentum* Mill. Plant Growth			
Crotalaria mucronata Desv.	12.12.17.2	Plant Height	Number of Leaves	Root Wet Weight	Root Dry Weight
ml.polybag^{-1}	g. polybag^{-1}	cm	Twigs	g	g
100	5	58 a	11 a	131 a	22 a
	10	60 a	14 a	133 a	25 a
	15	67 a	16 a	145 b	32 b
200	5	68 a	17 a	158 c	39 b
	10	77 b	20 b	172 d	42 c
	15	89 c	24 b	198 e	55 d
300	5	94 d	23 b	247 f	62 e
	10	112 e	39 c	272 h	75 f
	15	110 e	40 c	268 g	68 e
Crotalaria juncea L.	12.12.17.2	*Lycopersicum esculentum* Mill. Plant Growth			
ml.polybag^{-1}	g. polybag^{-1}	cm	Twigs	g	g
100	5	53 a	12 a	129 a	29 a
	10	58 a	14 a	132 b	35 a
	15	66 b	17 a	140 c	39 a
200	5	69 b	19 a	148 c	47 a
	10	75 c	20 a	155 d	52 a
	15	86 d	27 b	163 d	62 a
300	5	91 d	29 b	201 e	67 a
	10	111 e	42 c	275 f	77 a
	15	107 e	43 c	270 f	70 a

Description: A number followed by the same index in the same row or column showed not the significant difference according to the DMRT test (Duncan's Multiple Range Test) 95% confidence level (α = 0,05)

In the observation results in Table 12, the results of plant growth of *Lycopersicum esculentum* Mill. in Ultisol soil media on the application of liquid green manure *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. and nutrient fertilizer mixture 12.12.17.2. In observing plant height (cm) in applying *Crotalaria mucronata* Desv. Liquid Green Manure at a dose of 300 ml. polybag^{-1} and 12.12.17.2 nutrient fertilizer at 10 g. polybag^{-1}, it was seen that the height of *Lycopersicum esculentum* Mill. plants had a height of 112 cm, which was higher than the application of nutrient fertilizer at a dose of 15 g. polybag^{-}

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$^{-1}$, which was 110 cm. In applying liquid green manure, *Crotalaria juncea* L. with a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 with a dose of 10 g. polybag^{-1} has a height of 111 cm and is higher than the application of nutrient fertilizer dose of 15 g. polybag^{-1}, which is 107 cm.

On the observation of twigs of *Lycopersicum esculentum* Mill. Plants to the application of liquid green manure of *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. plants with nutrient fertilizer 12.12.17.2. In Ultisol soil media. The application of liquid green manure *Crotalaria mucronata* Desv. At a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 at a dose of 10 g. polybag^{-1} had 39 twigs, not significantly different from the application of nutrient fertilizer 12.12.17.2 at a dose of 15 g. polybag^{-1} at 40 twigs. In applying Liquid Green Manure, *Crotalaria juncea* L. plants with a dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 at 10 g. polybag^{-1} had 42 twigs, not significantly different from nutrient fertilizer 15 g. polybag^{-1} with 107 twigs.

In the observation of root fresh weight and root dry weight of *Lycopersicum esculentum* Mill. Plants on the application of Liquid Green Manure *Crotalaria mucronata* Desv. And *Crotalaria juncea* L. with nutrient fertilizers 12.12.17.2. In the observation of fresh weight of roots in *Lycopersicum esculentum* Mill. Plants with the application of Liquid Green Manure *Crotalaria mucronata* Desv. Dose of 300 ml. polybag^{-1} and nutrient fertilizer dose of 10 g. polybag^{-1} with a weight of 272 g, while in the application of *Crotalaria juncea* L. dose of 300 ml. polybag^{-1} and nutrient fertilizer 12.12.17.2 dose of 10 g. polybag^{-1} with a weight of 151 g. At the same time, observing the dry weight of the roots of *Lycopersicum esculentum* Mill. the application of Liquid Green Manure *Crotalaria mucronata* Desv. Dosage of 300 ml. polybag^{-1} and nutrient fertilizer dosage of 10 g. polybag^{-1} became the highest root dry weight of 75 g and Liquid Green Manure *Crotalaria juncea* L. dosage of 300 ml. polybag^{-1} with nutrient fertilizer dosage of 10 g. polybag^{-1} also became the highest root dry weight at 77 g.

The occurrence of high growth is due to the supply of nutrients suitable for the needs of *Lycopersicum esculentum* Mill. in the provision of organic matter, such as the provision of Liquid Green Manure *Crotalaria mucronata* Desv. *Crotalaria juncea* L. has added organic matter in Ultisol soil, which experiences a lack of organic matter and is marked by organic carbon (C-Organic) in Ultisol soil. According to (Lubis, 2025b), the application of organic matter into the Soil will make the Soil healthier and more fertile, microorganisms in Ultisol soil will occur, and plants will thrive in the application of nutrient fertilizer 12.12.17.2 where nitrogen nutrients with levels of 12%, phosphorus nutrients with levels of 12%, high potassium levels with levels of 17% and magnesium levels of 2%. This makes the plants grow well because many levels of potassium nutrients already exist in Liquid Green Manure and the addition of nutrient fertilizers.

According to Ayuningtyas et al. (2020), phosphorus increases production in flowers and fruit in *Lycopersicum esculentum* Mill plants. According to Aziez et al. (2021), adding inorganic fertilizers with fast soluble phosphorus can help increase fruit production in long red chilli plants (*Capsicum annum* var. Longum). According to Wibisana & Anggara (2024), the application of treatments of various types of Plant Growth Promoting Rhizobacteria (PGPR) and Liquid Green Manure provides a significant increase in the growth of tomato plants (*Lycopersicum esculentum* Mill.).

CONCLUSION

The conclusion of the Ultisol soil research on the application of Liquid Green Manure *Crotalaria mucronata* Desv. *Crotalaria juncea* L. with the addition of nutrient *fertilizer* 12.12.17.2 in testing the physical and chemical properties of the Soil changes in Ultisol soil, which was originally hard Ultisol soil,

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and clay now becomes crumbly, healthy and nutrient levels are available in testing the vegetative growth of *Lycopersicum esculentum* Mill. Plants showed very good growth due to fertile planting media, and this showed by the content of heavy root fresh weight and heavy root dry weight due to the available nutrients in the roots left behind. For further research, other soil media and other plants should be used.

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