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Research Article

Effect of Sesbania rostrata Liquid Green Manure and Gypsum at Water Content in Sodic Soil and Plant Growth of Solanum torvum

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Abstract
Sesbania rostrata is a plant classified as *leguminoceae* which has nodules on the roots. Nodules on the roots contain *Rhizobium* bacteria that can tether N_2 from the air and are able to convert large amounts of atmospheric nitrogen into plant-available nitrogen. Gypsum fertilizer is a fertilizer containing calcium (Ca) and sulfur (S) derived from the mineral gypsum and the benefits of gypsum can increase plant growth, improve soil physical and chemical properties, and improve plant roots. This study aims to determine the effect of liquid green manure from *Sesbania rostrata* and gypsum on the growth of *Solanum torvum* plants on the physical and chemical properties of the soil, as well as the provision of water content in sodic soil that accumulates gypsum and *Sesbania rostrata* liquid green manure. This research used Randomised Group Design (RGD) with 4 repetitions. This research was conducted for 4 months. The experimental parameters observed consisted of saturated soil moisture content, field capacity moisture content, soil content weight, soil cation exchange capacity (CEC), soil porosity, soil plasticity index, soil electrical conductivity, and exchangeable calcium. The application of gypsum and *Sesbania rostrata* liquid green manure significantly affected saturated water content, field capacity water content, soil content weight, soil electrical conductivity, and vegetative plants but not significantly different on cation exchange capacity (CEC) and soil porosity.

Keywords: Chemical Properties, Gypsum, Moisture Content, Physical Properties, Sodicity

1. Introduction

The successes and failures that occur in agricultural endeavours are related to the superior quality of soil resources, one of which is an important factor in agriculture. Low soil quality can be a measure of low success to enable farmers to fail in achieving crop production. Eggplant takokak or rimbang (*Solanum torvum*) is a plant whose life has potential in fertile soil in sub-tropical and tropical climates spread throughout Indonesia. *Solanum torvum* is a buni fruit that has the characteristics of ovoid leaves, small green fruit, ripe brownish yellow colour, many seeds, little pulp. The seeds are flat brown in colour, 1.5-2.0 mm long, smell like pepper, and have a sharp taste (Helilusiatiningsih & Irawati, 2021).

Lime application is one of the efforts in improving some soil chemical properties, such as increasing soil pH, reducing dissolved Fe (Felium), Mn (Manganese), and Al (Aluminium), and increasing the availability of P (Phosphor) and Mo (Molebdinum) as well as Ca (Calcium) and Mg (Magnesium) (Dent (1986) in Mukmin et al. (2016)).

Sesbania rostrata is a plant classified as *leguminoceae* which has nodules on the roots. Nodules on the roots contain *Rhizobium* bacteria that can tether N_2 from the air and are able to convert large amounts of atmospheric nitrogen into plant-available nitrogen. Gypsum fertilizer is a fertilizer containing calcium (Ca) and sulfur (S) derived from the mineral gypsum and the benefits of gypsum can increase plant growth, improve soil physical and chemical properties, and improve plant rooting (Lubis et al., 2023).

Sodic soils are soils that contain high amounts of sodium (Na). Sodic soils can cause ion poisoning in certain plants (Yu et al., 2014). The characteristics of sodic soils are that they contain exchangeable Na (Na-dd) more than 6%, acidity (pH) > 8.5, excess sodium carbonate (Na_2CO_3), low oxygen levels, unstable soil structure and easily eroded, and difficult to penetrate by roots.

This study aims to evaluate the impact of *Sesbania rostrata* liquid green manure and gypsum on the growth of *Solanum torvum*, as well as their effects on the physical and chemical properties of sodic soil, particularly its water content. Understanding these effects is crucial, as sodic soils often suffer from poor structure, low fertility, and inadequate water retention, which hinder plant growth and agricultural productivity. By investigating the combined influence of organic and mineral amendments, this research provides valuable insights into sustainable soil management practices that can improve soil quality and enhance plant growth in degraded lands. The findings may contribute to more effective soil rehabilitation strategies, supporting long-term agricultural sustainability and food security.

2. Methods

This research conducted in the nursery area of the Soil Management Field Laboratory, Institut Teknologi Sawit Indonesia (ITSI) Medan. Soil sampling location in Tanjung Morawa, North Sumatra. In this study, *Solanum torvum* seedlings were used in the *Solanum chrysotrichum* var. *pleilotonum* variety planted at the age of 2 months.

Soil analysis and experiments 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 Sumatra.

Sesbania rostrata liquid green manure was given to polybags with 3 treatment levels, namely 100 $ml.polybag^{-1}$, 150 $ml.polybag^{-1}$, and 200 $ml.polybag^{-1}$, gypsum was given to polybags with 2 treatment levels namely 100 $g.polybag^{-1}$, and 200 $g.polybag^{-1}$.

Soil moisture content determined using the gravimetric method, on soil content weight and soil porosity using a ring. Soil plasticity index using Atterberg method, cation exchange capacity (CEC) using 1M Ammonium Acetate solution method and 0.5 N HCl titration, exchangeable calcium (Ca-dd) using leaching extraction method and measured using *Atomic Absorption Spectrophotometer* (AAS).

Observation parameters and indicators are Plant Height (cm), Number of Leaves (Strands), Root Wet Weight (g), Root Dry Weight (g), Saturated Soil Water Content (%), Field Capacity Soil Water Content (%), Soil Content Weight ($g.cm^{-3}$), Cation Exchange Capacity (CEC) (me.100 g^{-1}), Soil Porosity (%), Soil Plasticity Index, Calcium Exchangeable (Ca-dd) (me.100 g^{-1}), and Soil Electrical Conductivity ($\mu S.cm^{-1}$).

3. Results and Discussion

3.1. Results of Analysis of Physical and Chemical Properties of Sodic Soil

3.1.1. Saturated Soil Water Content

Based on the research results for saturated soil moisture content, the data obtained in Table 1 is as follows.

Table 1. Saturated Soil Moisture Content under Gypsum and Sesbania rostrata Liquid Green Manure Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Saturated Water Content (%)
100	100	**42,10 a**
	200	**43,22 a**
150	100	**44,58 b**
	200	**45,20 b**
200	100	**47,15 c**
	200	**48,20 c**
Average		**270,45**

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

Table 1 shows the average produced on the parameter of saturated soil moisture content where the average is 270.45 g.polybag^{-1}. In general, it can be seen that the application of gypsum and liquid green manure with appropriate levels will be able to increase the saturated soil moisture content. It can be seen in Table 1, that *Sesbania rostrata* liquid green manure levels of 100 ml.polybag^{-1} and gypsum levels of 100 g.polybag^{-1} only get an average of 42.10% saturated soil moisture content, not significantly different from gypsum 200 g.polybag^{-1} of 43.22%, but still provide an increase in soil moisture content, thus, significantly different at doses of *Sesbania rostrata* liquid green manure 200 ml.polybag^{-1} and gypsum 100 g.polybag^{-1} with an average of 31.10% and the highest at gypsum levels 200 g.polybag^{-1} of 33.71%.

3.1.2. Soil Water Content Field Capacity

Based on the research results for soil moisture content at field capacity, the data obtained in Table 2 is as follows.

Table 2. Soil Moisture Content Field Capacity on Gypsum and Sesbania rostrata Liquid Green Manure Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Moisture Content Field Capacity (%)
100	100	**17,33 a**
	200	**22,21 b**
150	100	**24,40 bc**
	200	**28,55 d**
200	100	**31,10 e**
	200	**33,12 f**
Average		**156,71**

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

The results in Table 2 show that the average field capacity soil moisture content of Sodic soil. The field capacity soil moisture content, obtained on average on liquid green manure *Sesbania rostrata* 100 ml.polybag^{-1} and gypsum 100 g.polybag^{-1} is 17.33%, significantly different from the dose of gypsum 200 g.polybag^{-1} 22.21%. Gypsum ameliorant on sodic soil with the addition of *Sesbania rostrata* liquid green manure increased until the level of *Sesbania rostrata* liquid green manure 200 ml.polybag^{-1} and the dose of gypsum 100 g.polybag^{-1} was 31.10%, significantly different from the dose of gypsum 200 g.polybag^{-1} which was 33.12%. The addition of gypsum and the addition of *Sesbania rostrata* liquid green manure can increase the increase in field capacity soil moisture content so that it is suitable for soil and plants.

3.1.3. Weight of Soil Content

Based on the research results for soil content weight, the data obtained in Table 3 is as follows.

Table 3. Weight of Soil Content in Gypsum and Sesbania rostrata Liquid Green Manure Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Weight of Soil Content (g.cm^{-3})
100	100	**1,33 a**
	200	**1,31 ab**
150	100	**1,27 c**
	200	**1,24 d**
200	100	**1,20 e**
	200	**1,18 e**
Average		**7,53**

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

The soil content weight at various doses of *Sesbania rostrata* liquid green manure and gypsum showed notable differences. The lowest weight was observed at a *Sesbania rostrata* liquid green manure dose of 200 ml per polybag and a gypsum dose of 200 g per polybag, with an average of 1.18 g/cm^3. In contrast, the highest weight occurred with a *Sesbania rostrata* dose of 100 ml per polybag and a gypsum dose of 100 g per polybag, yielding an average of 1.33 g/cm^3.

3.1.4. Electrical Conductivity of Soil

Based on the research results for soil electrical conductivity, the data obtained in Table 4 is as follows.

Table 4. Soil Electrical Conductivity under Gypsum and *Sesbania rostrata* Liquid Green Manure

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Electrical Conductivity of Soil (μS.cm^{-1})
100	100	179,60
	200	185,00
150	100	187,80
	200	532,21
200	100	521,70
	200	500,30
Average		**2.106,61**

Table 4 shows that the treatment of *Sesbania rostrata* liquid green manure with a gypsum dose of 100 g.polybag^{-1} showed a DHL (*Electrical Conductivity*) of 179.60 µS.cm^{-1} which then increased when the gypsum dose became 200 g.polybag^{-1} and the dose of *Sesbania rostrata* liquid green manure as much as 100 ml.polybag^{-1} of 521.70 µS.cm^{-1} but, the gypsum dose of 200 g.polybag^{-1} decreased by 500.30 µS.cm^{-1}.

3.1.5. Soil Porosity

Based on the research results for soil porosity, the data obtained in Table 5 is as follows.

Table 5. Soil Porosity under the Application of Gypsum and *Sesbania rostrata* Liquid Green Manure

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Soil Porosity (%)
100	100	44,00 a
	200	46,55 a
150	100	49,80 b
	200	50,20 b
200	100	53,10 c
	200	54,10 c
Average		**297,75**

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

Table 5 shows that the porosity of soil given the application of gypsum and the addition of *Sesbania rostrata* liquid green manure on Sodic soil tends to increase soil porosity. The porosity of Sodic soil does not increase in the research table due to the role of gypsum applied to Sodic soil and the addition of *Sesbania rostrata* liquid green manure. At the application of liquid green manure *Sesbania rostrata* 100 ml.polybag^{-1} and gypsum 100 g.polybag^{-1}, the porosity average was 44.00%, increasing even though it was not significant until the dose of liquid green manure *Sesbania rostrata* 200 ml.polybag^{-1} and the dose of gypsum 200 g.polybag^{-1} averaged 54.10%.

3.1.6. Soil Plasticity Index

Based on the research results for the soil plasticity index, the data obtained in Table 6 is as follows.

Table 6. Soil Plasticity Index under Gypsum and *Sesbania rostrata* Liquid Green Manure Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Soil Plasticity Index
100	100	44,35 a
	200	39,12 b
150	100	38,44 b
	200	36,89 c
200	100	33,70 d
	200	31,55 d
Average		**224,05**

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

In Table 6, it is found that there is a decrease in soil plasticity towards the soil plasticity index obtained after the application of higher gypsum to the application of *Sesbania rostrata* liquid green manure with higher doses as well. The highest plasticity index occurs at the effect of gypsum 100 g.polybag^{-1} and the application of liquid green manure *Sesbania rostrata* as much as 100 ml.polybag^{-1} which is 44.35, and the lowest occurs at the dose of gypsum 200 g.polybag^{-1} with the application dose of liquid green manure *Sesbania rostrata* 200 ml.polybag^{-1} which is 31.55. The decrease occurred 12.80% after being given a lot of gypsum and the application of *Sesbania rostrata* liquid green manure at high doses.

3.1.7. Cation Exchange Capacity (CEC)

Based on the research results for cation exchange capacity, the data obtained in Table 7 is as follows.

Table 7. Cation Exchange Capacity under Gypsum and *Sesbania rostrata* Liquid Green Manure Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Cation Exchange Capacity (me.100 g^{-1})
100	100	35,44
	200	35,10
150	100	35,78
	200	34,10
200	100	34,51
	200	34,10
Average		**209,03**

In Table 7 it can be seen that, there is no significant difference in the application of gypsum, and the greater the dose of *Sesbania rostrata* liquid green manure given, the change in the exchangeable cations in sodic soil there is no effect that occurs, but a decrease is seen from the results of the analysis, but there is no significant decrease in sodic soil given gypsum and *Sesbania rostrata* liquid green manure (Lubis *et al*., 2023).

3.1.8. Calcium exchangeable Soil (Ca-dd)

Based on the research results for exchangeable calcium, the data obtained in Table 8 is as follows.

Table 8. Calcium exchangeability on Gypsum and *Sesbania rostrata* Liquid Green Manure Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Calcium is exchangeable (me.100 g^{-1})
100	100	100,66 a
	200	114,70 a
150	100	119,33 a
	200	122,20 b
200	100	125,70 b
	200	129,50 b
Average		**712,09**

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

In the results in Table 8, it shows that the average value of Ca-dd increases due to high gypsum and the effect of *Sesbania rostrata* liquid green manure. The effect of gypsum on sodic soil where calcium is very low becomes available in the soil. The provision of gypsum in sodic soil where 100 g.polybag^{-1} is 100.66 me.100 g^{-1} soil becomes high in the provision of gypsum 200 g.polybag^{-1} soil at 114.70 me.100 g^{-1}. In the application of liquid green manure with a higher dose of 200 ml.polybag^{-1} with a gypsum dose of 100 g.polybag^{-1} to 125.70 me.100 g^{-1} and 200 g.polybag^{-1} to 129.50 me.100 g^{-1} and the results are significantly different from the results of data analysis shown in the observation table.

3.2. Vegetative Observation Results

Based on the research results for plant vegetative growth, the data obtained in Table 9 is as follows.

Table 9. Observation of Vegetative Growth of Plants on Gypsum and Liquid Green Manure *Sesbania rostrata* Application

Liquid Green Manure *Sesbania rostrata* (ml.polybag^{-1})	Gypsum (g.polybag^{-1})	Plant Height (cm)	Number of Leaves (twigs)	Root Wet Weight (g)	Root Dry Weight (g)
100	100	44 a	9 a	120 a	21 a
	200	47 a	12 a	147 b	22 a
150	100	52 a	14 a	217 c	25 a
	200	58 b	16 a	221 c	27 a
200	100	66 b	20 b	234 d	28 a
	200	79 c	26 b	237 d	28 a
Average		**346**	**97**	**1176**	**151**

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

In Table 9, data on observations of vegetative growth of *Solanum torvum* plants are produced, where the vegetative observations are plant height, number of leaves, root fresh weight and root dry weight of *Solanum torvum* plants.

In the observation of plant height, the application of liquid green manure *Sesbania rostrata* 100 ml.polybag^{-1} and gypsum 100 g.polybag^{-1} average growth of 44 cm and the application of gypsum 200 g.polybag^{-1} which is 47 cm, this is not significantly different, but the application of liquid green manure *Sesbania rostrata* with a large dose of 200 ml.polybag^{-1} with gypsum 100 g.polybag^{-1} as high as 66 cm is significantly different from the application of gypsum 200 g.polybag^{-1} which is 79 cm.

In the observation of the number of leaves or twigs on *Solanum torvum* plants, namely the application of liquid green manure 100 ml.polybag^{-1} with the application of gypsum 100 g.polybag^{-1}, the number of leaves is an average of 9 twigs, not significantly different from gypsum 200 g.polybag^{-1} which is 12 twigs, significantly different from the provision of increasing doses of liquid green manure *Sesbania rostrata* 200 ml.polybag^{-1} and gypsum 100 g.polybag^{-1} with an average of 20 twigs but not significantly different from gypsum 200 g.polybag^{-1} with an average of 26 twigs.

In the observation of root fresh weight and root dry weight, it is known that the fresh weight of roots with the application of *Sesbania rostrata* liquid green manure 100 ml.polybag^{-1} with gypsum 100 g.polybag^{-1} gets an average of 120 g, but is significantly different from the application of gypsum 200 g.polybag^{-1} which is 147 g. with the highest average in the application of *Sesbania rostrata* liquid green manure 200 ml.polybag^{-1} and gypsum 100 g.polybag^{-1} which is 234 g, not significantly different from the application of gypsum 200 g. dry weight of roots on the application of liquid green manure *Sesbania rostrata* 100 ml.polybag^{-1} and the application of gypsum 100 g.polybag^{-1} get an average of 21 g, but not significantly different from the application of gypsum 200 g.polybag^{-1} with an average of 22 g, while the highest dose of liquid green manure *Sesbania rostrata* 200 ml.polybag^{-1} on the application of gypsum

100 g.polybag^{-1} get an average of 28 g, not significantly different from the application of gypsum 200 g.polybag^{-1} average of 28g.

3.3. Discussion in Effect of Gypsum application and *Sesbania rostrata* Liquid Green Manure on Soil Physical and Chemical Properties

In general, the addition of liquid green manure from *Sesbania rostrata* plants is very good for soil and plants where this green fertilizer can tether N_2 from the atmosphere which is not available to plants to become available to plants. and in general also, that the application of gypsum to soils that have problems with very little calcium or almost no calcium, or the soil begins to be contaminated with toxins, gypsum is able to increase calcium that is lacking to be available (Yosephine et al., 2022).

The application of gypsum and *Sesbania rostrata* liquid green manure will be able to improve soil physical properties, one of which is the improvement of saturated soil moisture content, field capacity soil moisture content, and soil porosity and can increase the weight of the soil content in sodic soil. The increase in soil porosity due to the application of gypsum is a good increase, where the pore size is >0.034 mm in macro, meso and micro pores (Yu et al., 2014 in Mukmin et al. (2016)). Gypsum given to sodic soils that are very poor in nutrients and poor in calcium, is able to provide and improve the soil from solid to open (Lubis et al., 2023).

This is also as seen in the decrease in soil content weight which is one indication that can be used as an indicator of changes in soil density. Changes in soil weight without gypsum application, only the application of *Sesbania rostrata* liquid green manure, was able to decrease, but not significantly due to more liquid green manure nutrients leached (Lubis et al., 2023). Changes in soil content weight are also very important, and can affect plants because plant roots will be able to penetrate the soil (Hillel, 2013).

The provision of gypsum and the addition of *Sesbania rostrata* liquid green manure will be able to increase the exchangeable calcium in sodic soil. Calcium is a basic ingredient in gypsum, and with the addition of gypsum to sodic soil, it will be able to improve the quality of sodic soil which is deficient in calcium and can increase the electrolyte content in the soil (Mukmin et al., 2016).

4. Conclusion

Based on the results of the research that has been studied, the effect of the application of liquid green manure *Sesbania rostrata* and the application of gypsum on Sodic soil on the growth of *Solanum torvum* plants is that the application of gypsum can increase and be able to improve soil properties which improve the physical and chemical properties of the soil. And the function of *Sesbania rostrata* liquid green manure can fertilizer *Solanum torvum* plants and be able to increase plant vegetative growth.

5. References

Dent, D. L. (1986). *Acid sulphate soils: a baseline for research and development* (Issue 39). ILRI.

Helilusiatiningsih, N., & Irawati, T. (2021). Pengaruh Lokasi Tumbuh Terhadap Senyawa Fitokimia Pada Buah, Biji, Daun, Kulit Buah Tanaman Takokak (Solanum torvum). *BUANA SAINS*, *21*(1), 29–38.

Hillel, D. (2013). *Introduction to soil physics*. Academic press.

Lubis, E. J., Rauf, A., & Sarifuddin, S. (2023). Effectiveness of Fertilization Techniques on Growth Two Varieties of Palm Oil Seeds (Elaeis guineensis Jacq.) in Main Nursery. *Journal of Social Research*, *2*(8), 2759–2772.

Mukmin, M., Widjajanto, D., & Hasanah, U. (2016). Pengaruh Pemberian Gipsum Terhadap Perubahan Beberapa Sifat Fisik Dan Kimia Entisols Lembah Palu. *Agrotekbis: Jurnal Ilmu Pertanian (e-*

Journal), *4*(3), 252–257.

Yosephine, I. O., Wijaya, H., & Lubis, E. J. (2022). *Effect of market waste compost and compound fertilizer application on the vegetative growth of oil palm seedling (Elaeis guineensis Jacq) in Ultisol growing media.*

Yu, H., Yang, P., Lin, H., Ren, S., & He, X. (2014). Effects of sodic soil reclamation using flue gas desulphurization gypsum on soil pore characteristics, bulk density, and saturated hydraulic conductivity. *Soil Science Society of America Journal*, *78*(4), 1201–1213.