STUDY ON THE IMPROVEMENT OF PEAT SOIL STRENGTH USING GROUND MAGNESIUM LIMESTONE FOR FARM MECHANIZATION

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ABSTRACT

Limestone is commonly employed for soil treatment, serving as both a component in fertilizers and a means of reducing soil acidity. However, the utilization of ground magnesium limestone on peat soil for agricultural purposes remains relatively uncharted territory, particularly in relation to its impact on soil strength. Consequently, this project seeks to investigate the influence of ground magnesium limestone on peat soil strength under various application rates. Traditionally, soil strength research has leaned heavily on laboratory experiments and subsequent data analysis. In contrast, our project diverges by acquiring peat soil strength data directly in the field using specialized equipment. All data collected during fieldwork have undergone systematic analysis, considering diverse treatment protocols and an array of parameters over a specified timeframe. The treatments administered in these experiments vary according to the rate of magnesium limestone applied to the soil. Key parameters under scrutiny encompass soil strength, moisture content, soil bulk density, and pH levels. The application of ground magnesium limestone to peat soil yields a substantial improvement in soil strength over time. Following 30 and 60 days of application, we observed increases of 0.01 and 0.05 MPa, respectively. This observation underscores the significance of comprehending how ground magnesium limestone influences peat soil strength, as it holds the potential to yield valuable insights for agricultural mechanization and guide future research in related fields. The ramifications of ground magnesium limestone on peat soil strength are of paramount importance, potentially reshaping agricultural practices and informing research endeavors in the foreseeable future.

Keywords: ground magnesium limestone, soil strength, peat soil, mechanization

INTRODUCTION

Soil strength improvement is a process to improve the performance of soils mixed with some materials for use as construction material or any other related purposes. This process frequently involves the use of one or more admixtures to achieve better results and more reliable end product/process. The research will focus on Ground Magnesium Limestone (GML) as experiment material to improve peat soil strength at study area. The use of hydrated lime has immediate effects whereas it is obtained quickly after the addition process (and mixing) of the lime into the soil and also resulting in long-term effects (un-estimated time) after applying the mixture (Bernardo Celauro et al, 2012). The hydration process of MgO into Mg (OH) is naturally hydraulic and the strengthening of MgO in dolomitic monohydrate lime is quite faster than other lime content which it is tested to be contributing to a major part of the early soil strength improvement in soil-lime stabilization (Jerry Wen-Hann Wang, 1964). The experiment will be divided into a few treatments according to the desire parameter that have been chosen for the research. The equipment used is soil penetrologger. It is obtained from Malaysia Agricultural and Research Institute (MARDI) based at Saratok to do the field test at the required study area. The available experiment area is 1-3 meters deep peat soil and has been planted with various short-term crops such as local potatoes, sweet corn and vegetables.

The peat soil area for the research is currently well maintained in terms of water table, controlled by existing water gates built for irrigation and drainage system. Land clearing on peat soil area will contribute to faster oxidative peat decomposition process and the natural soil moisture content will be less (Liza Nuriati Lim Kim Choo, 2017). Peat soil contains higher than 75 % organic materials, which caused major difficulties in construction works or any other related purposes. The properties of the soil will definitely changes in the presence of water with soil-lime reactions (Bell, 1996). This research will be based on the field experiments of the selected soil improvement materials to determine the soil strength effects after application Lime stabilization commonly used for controlling shrink-swell behaviour of expansive soil because of various factors such as weather conditions. The objectives of this study are to determine the effects of Ground Magnesium Limestone on peat soil strength and to determine peat strength obtained under different treatment and parameters using the equipment currently available for the experiment.

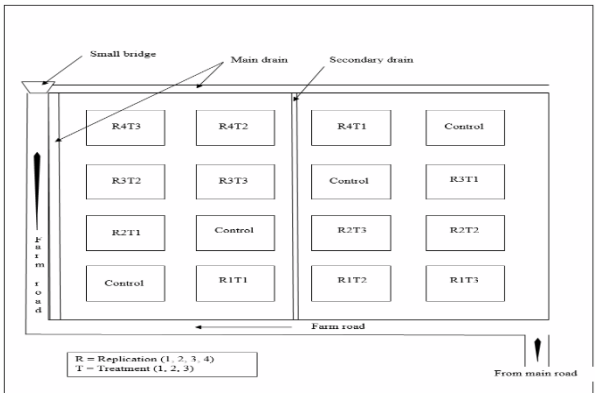
MATERIALS AND METHODS

Peat soil Treatment and Experiment

The size of the plot is 1 Ha (100 m x 100 m) and divided into 16 small points (1 m x 1 m) where the ratio of GML application will be 1:10000. The experiment layout plan is shown in Figure 1. There are 4 replication and 4 types of treatment (including control) for the experiment. The treatments are:

- Treatment 1 (T1): 300 g of GML
- Treatment 2 (T2): 500 g of GML
- Treatment 3 (T3): 700 g of GML
- Treatment 4 (Control): No GML

Figure 1. Experiment layout plan



The amount of GML chooses for the treatment is based on standard agriculture practices considering the peat soil acidity. The application of 500 g of GML per 1 meter square is the recommended practice for treating acidic peat soil (3.4 - 4.5 PH). The plot is near to the main drainage and has 1 secondary small drainage inside (middle) of the plot. For the experiment at each point, several data parameters have been determined to be recorded along the experiment. They are:

I. Soil Strength (MPa)
II. Soil Moisture Content (%)
III. Soil Bulk Density (g)
IV. Soil pH

All these parameters will be observed and recorded for 3-month duration at the site (Total 3 set of data). The GML application technique is fix using the manual spreading method on top of the peat soil. The manual spreading on top of the peat soil is the conventional method in agriculture practices because there are no machineries can operate on the deep peat soil surface. So, the spreading uniformity depends on the human labor and is not considered in this experiment. Schematic layout of the whole experimental design was as illustrated as in Figure 2.

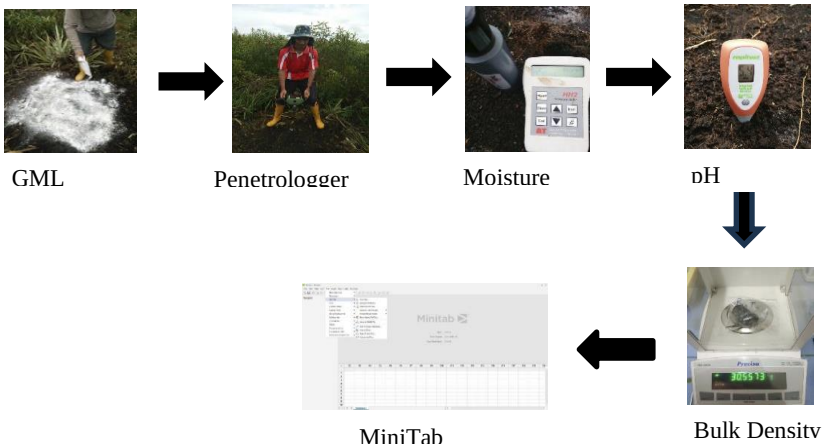


Figure 2. A schematic diagram of soil sampling and data acquisition on site. Data analysis was done by statistical analysis software (Minitab 19).

RESULTS AND DISCUSSION

Experiment data and analysis summary

The preliminary data for this study were taken 3 times or cycle by 24 hour and 1 month duration for each set of data. For the analysis, the treatments are divided into: Treatment A is Control, Treatment B is 3 ton/Ha, Treatment C is 5 ton/Ha and Treatment D is 7 ton/Ha. All the samples were taken started at 9 am in the morning with a good weather condition (no raining) at the site.

The sampling point has been applied with ground magnesium limestone according to the treatment parameters. The sampling point has already been marked and listed according to the layout plan. The soil strength data is taken at 80 cm depth while the other parameters are taken at the peat soil surface. Table 1 shows the summary of all the data collected during the experiments and analysed using statistical analysis software (Minitab 19).

Table 1. Summarize all data from statistical analysis software

Cycle	1				2				3			
Treatment	A	B	C	D	A	B	C	D	A	B	C	D
Parameter												
Moisture Content	59.10 ± 3.91	55.95 ± 1.26	55.25 ± 4.57	60.85 ± 5.32	43.88 ± 5.41	51.70 ± 3.40	41.10 ± 7.24	44.77 ± 5.85	38.92 ± 2.42	49.90 ± 3.58	43.90 ± 2.01	46.60 ± 1.79
Soil Strength	0.1430 ± 0.0122	0.1467 ± 0.0252	0.1517 ± 0.0070	0.1440 ± 0.0333	0.1618 ± 0.0188	0.1583 ± 0.0252	0.1492 ± 0.0189	0.1593 ± 0.0261	0.1935 ± 0.0090	0.2450 ± 0.0173	0.2283 ± 0.0288	0.1845 ± 0.0149
Bulk Density	0.5410 ± 0.0548	0.5177 ± 0.0159	0.4913 ± 0.0672	0.5607 ± 0.0660	0.3555 ± 0.0763	0.4728 ± 0.0486	0.3297 ± 0.0679	0.3830 ± 0.0873	0.2582 ± 0.0240	0.3885 ± 0.0467	0.3093 ± 0.0217	0.3435 ± 0.0181
pH	4.325 ± 0.202	5.775 ± 0.144	6.300 ± 0.040	6.375 ± 0.025	5.200 ± 0.122	5.550 ± 0.290	5.325 ± 0.325	5.775 ± 0.217	5.000 ± 0.070	5.450 ± 0.176	5.725 ± 0.189	6.150 ± 0.050

The value of soil strength is increasing over time that is 30 days between each cycle. This is possibly due to the peat soil compacted by the natural grass grows at the sampling site after 60 days of treatment or experiment. The grass roots will hold the peat soil structure and increase the soil strength on top. The possibility of the appropriate amount of ground magnesium limestone applied for the treatment to be fully react with the peat soil structure after 60 days also contribute to the sudden increased in soil strength. The significant difference between soil strength and cycle time in different treatment is shown in Figure 3.

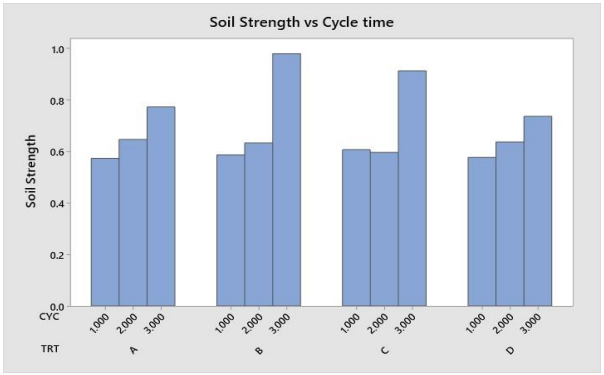


Figure 3. Soil strength vs Cycle time in different treatment

The summary of relationship between all parameters in this experiment will be done using the descriptive statistic technique available inside the Minitab 19 software. Figure 4 shows the descriptive statistic of all parameters over cycle time. From the figure, we can see that the soil strength (PL) is significantly increasing with time (with mean value of 0.2127 MPa). The other parameters have also significant differences but mostly governs by outside factor such as weather condition and soil condition during sampling at site.

Figure 5 shows the descriptive statistic of all parameters over treatments. From the figure, we can see that the soil strength (PL) is maximum at treatment B (with mean value of 0.1833 Mpa) that is the application of minimum ground magnesium limestone (300 g). All the parameters show no significant differences except for the soil pH.

Statistics

Variable	CYC	Total Count	Mean	SE Mean	StDev
MC	1.000	16	57.79	1.91	7.65
	2.000	16	45.36	2.72	10.88
	3.000	16	44.83	1.54	6.16
PL	1.000	16	0.14646	0.00992	0.03967
	2.000	16	0.1571	0.0101	0.0405
	3.000	16	0.2127	0.0106	0.0425
BD	1.000	16	0.5277	0.0255	0.1020
	2.000	16	0.3858	0.0348	0.1394
	3.000	16	0.3250	0.0182	0.0726
PH	1.000	16	5.694	0.220	0.880
	2.000	16	5.463	0.126	0.503
	3.000	16	5.581	0.124	0.496

Figure 4: Descriptive statistic for all over treatments

Statistics

Variable	TRT	Total Count	Mean	SE Mean	StDev
MC	A	12	47.30	3.36	11.64
	B	12	52.52	1.72	5.95
	C	12	46.75	3.23	11.20
	D	12	50.74	3.27	11.32
PL	A	12	0.16611	0.00958	0.03318
	B	12	0.1833	0.0178	0.0617
	C	12	0.1764	0.0153	0.0532
	D	12	0.1625	0.0144	0.0499
BD	A	12	0.3850	0.0459	0.1589
	B	12	0.4597	0.0264	0.0916
	C	12	0.3768	0.0384	0.1329
	D	12	0.4297	0.0438	0.1519
PH	A	12	4.842	0.135	0.468
	B	12	5.592	0.118	0.410
	C	12	5.783	0.166	0.575
	D	12	6.100	0.101	0.349

Figure 5: Descriptive statistic for all parameters parameters over cycle time

CONCLUSION

The major findings of this study were that the application of ground magnesium limestone on peat soil increases the soil strength significantly over time. However, the soil strength shows inconsistent differences value prior to the treatments. This is because all the data were obtained directly from the field in a period by using field equipment's under natural environment (such as weather condition and peat soil contents/properties).

Another finding is that the spreading technique for ground magnesium limestone application is not very suitable for the purpose of improving the soil strength. Although this technique is widely use in conventional agricultural practices, the absorption of the ground magnesium limestone on top of the peat soil may be disturbed due to the water content from rain. For future research, the long-term effect of ground magnesium limestone under various peat soil depth should be explored further in order to investigate how long the effect of ground magnesium limestone can last in terms of soil strength. Laboratory experiments should also be recommended for future research for data comparison considering control condition versus natural environment.

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