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Study on Physical and Chemical Properties of Soil at Kalay University Campus

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Abstract

Five soil samples were taken from Kalay University campus. Next, five soil samples were grounded with mortar for 1hr and then sieved by a 0.01cm sieve. Then, each sample was weighed 600 grams. To obtain more samples, 100 grams of each from five samples were re-weighed, mixed, and grounded by agate mortar. Finally, a total of six fine soil samples were obtained. Potential Hydrogen (pH) of all soil samples was measured to consider soil acidity or alkalinity. Electrical conductivities of soil samples were tested to investigate the amounts of salts in the soil. Measurements of soil content of Nitrogen(N), Phosphorus(P), and Potassium(K) of two fine samples were analyzed. Energy Dispersive of X-ray Fluorescence (EDXRF) measurements of two fine samples were carried out to determine the elemental contents of soils.

Keywords: re-weighed, Potential Hydrogen, NPK, EDXRF.

Introduction

Soil

Soil supports the richest biodiversity on earth and functions as a filter for, and a buffer of inorganic and organic contaminants as well as pathogenic microorganisms and viruses. Soil is very important and useful for growing crops. It can be categorized into sand, clay, silt, peat, chalk and loam types of soil based on the dominating size of the particles within a soil.

Heavy Metals

Heavy metals occur naturally in soils and in source materials. Metal pollutants in soil may be absorbed by the plants through their roots and vascular systems. Heavy metals are important environmental pollutants that cause toxic effects on plants, thus lessening productivity and posing dangerous threats to the agro-ecosystems. There are numerous essential heavy metals like Copper, Iron, Magnesium, Cobalt, Zinc, and Nickel required by plants as they form cofactors that are structurally and functionally vital for enzymes and other proteins. Nevertheless, when they exceed their threshold concentrations, their actions are considered toxic to plant development.

Sample Preparation and Experimental Techanics

Descript of the Study Area

This study was carried out in Kalay University Campus, Kalay Township, Sagaing Region at $23^{\circ}12'23''$ North and $93^{\circ}58'9''$ East, in December, 2022.

Sample Collection and Preparation

Soil sampling was used by a zone-based method. Each of the five soil samples was taken from Kalay University campus. Each soil sample was dug to a depth of 6 inches and was measured 20 feet between each other. Each soil sample was grounded with mortar for 1hr and

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sieved by using a 0.01cm sieve. Then, each sample was weighed at 600 grams. To obtain a fine sample, 100 grams of each five samples with 600 grams were re-weighed, mixed and grounded by agate mortar. And then, 500 grams of fine sample was obtained as sample 6. All soil samples were dried at room temperature 25°C.

Figure 1 Photographs of soil samples with the depth of 6 inches

Figure 2 Photographs of grounding by mortar and sieving by 0.01cm sieve

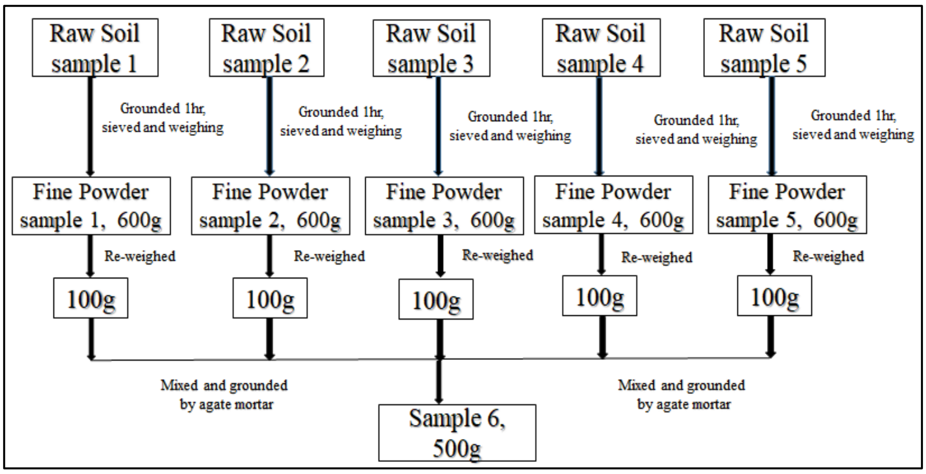

Figure 3 Flow chart of sample preparation for Kalay University campus

Figure 4 Photograph of weighing soil samples with 100grams and the collection and preparation of fine soil samples.

Calibration Procedure of pH Meter

To measure the pH level and the amount of water in the soil, the Kelway Soil Acidity and Moisture Tester was used.

1. The top dial on the tester must be look and make sure that the top of the needle points to the number 7. If not, it must calibrate the device.
2. The top of the tester was rotated two to three times to clean the tip.
3. The white bottom on the side of the tester was pressed to measure the soil moisture.
4. The bottom of the needle stabilizes and is continuously held for two to three minutes.
5. It is necessary to see the top dial where the top of the needle is pointing to determine the pH level of the soil.

The pH of soil samples was measured three times at room temperature, one week apart.

Figure 5 Photographs of Kelway Soil Acidity and Moisture Tester

Figure 6 Photographs of measured the pH (potential hydrogen) of soil sample.

Calibration Procedure of HI 8633 Conductivity Meter

HI 8633 Conductivity Meter was used to measure the amount of salts in soil samples. Conductivity is measured by taking a soil sample, making a saturated paste of soil and deionized water, extracting the water, and then measuring the electrical conductivity of the extracted solution.

1. The conductivity probe to the meter was switched on and then, immersed in the calibration solution and the temperature was checked.
2. The temperature of the buffer solution was recorded at 25˚ C and the 19.99mS/cm range was selected by pressing the appropriate key.
3. While measuring, the probe was shaken into the soil sample solution, and then, in the electrical conductivity meter, the result was kept stable and monitored.

Figure 7 Photograph of HI 8633 Conductivity Meter

Figure 8 Photographs measuring the conductivity of Kalay University's soil sample

NPK (Nitrogen, Phosphorus, and Potassium)

The letters NPK stand for the three major nutrients that plants need to live and grow- nitrogen, phosphorus, and potassium.

Test Procedure of Soil Nitrogen

1. Deionized water was filled to the 50ml mark in the sample container.
2. One level scoop of Extract N was added to the deionized water.
3. One 2ml scoop of soil was added to the deionized water / Extract N solution, replaced the lid, and shaken for one minute.
4. One level spoonful of $Nitratest^{TM}$ powder was added to the soil using the scoop contained within $Nitratest^{TM}$.
5. A filter paper was folded into quarters and inserted into the filter funnel and then Extract N solution was poured into the filter paper and allowed the extraction filtrate to collect in the second container.
6. Once 10ml of the filtrate was available to the 10ml mark and blanked the soil-test 10 photometer.
7. The soil Nitrogen result was displayed by photometer as mg/l N.

Figure 9 Photographs of Soiltest 10 photometer and Chemical box

Figure 10 Procedure of N (Nitrogen Test)

Test Procedure of Soil Phosphorus

1. The sample container was filled to the 50ml mark with deionized water.
2. Five Extract P tablets was added to the deionized water, replaced the lid and shaken gently to dissolve.
3. One 2ml scoop of soil was added to the deionized water/ Extract P solution, replaced the lid and shaken for one minute.
4. A filter paper was folded into quarters and inserted into the filter funnel.
5. One acidifying S tablet was added, crushed and mixed gently to dissolve fully.
6. The soil test 10 photometer was blanked and then one phosphate P tablet was added, crushed and mixed to dissolve fully.
7. The sample solution was inserted into the soil test 10 photometer for ten minutes. Finally, the soil phosphorus result was displayed by soil test 10 photometer as mg/ l P.

Figure 11 Procedure of P (Phosphorus Test)

Test Procedure of Soil Potassium

1. The sample container was filled to the 50ml mark with deionized water.
2. One level scoop of Extract K was added to the deionized water and shaken.
3. Further, 2 ml of soil was added to the solution and shaken for one minute.
4. A filter paper was folded into quarters and inserted into the filter funnel.
5. 10 ml of filtered sample was placed into the tube and then blanked.
6. After blanking, one potassium K tablet was added to the filtered sample and the soil sample solution was inserted into soil test 10 photometer for ten minutes.
7. The soil potassium result was displayed by a photometer as mg/l K.

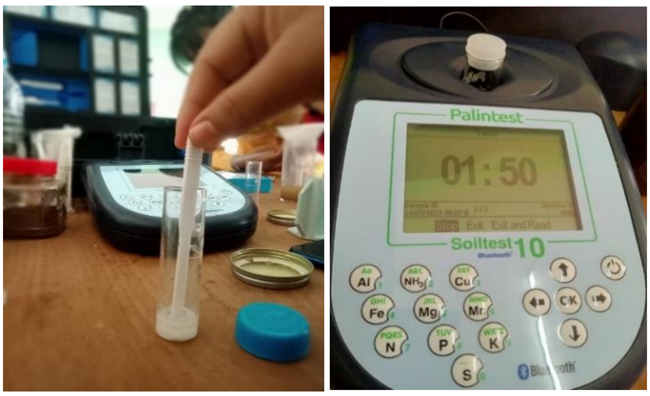

Figure 12 Procedure of K (Potassium Test)

X-Ray Fluorescence Spectrometry

X-ray fluorescence spectrometry (XRF) is a non-destructive analytical method, it is fast and can simultaneously measure many elements, both solid and liquid samples. XRF is used in controlling the quality of many products, such as Fe determination in milk powder or determination of vitamins and essential minerals, as new examples of XRF applications in human health.

Figure 13 Measurement condition of Energy Dispersive X-Ray Fluorescence (EDXRF) Spectrometer (EDX 7000 Shimadzu)

Results and Discussion

Potential Hydrogen (pH) Analysis

The pH of six soil samples was measured three times at room temperature, one week apart. Therefore, the result data of pH values of all soil samples were different. So, the pH (potential hydrogen) values depend on the moisture of soils. Generally, 6.6 or lower indicates acidic soil, 6.7 to 7.3 means neutral soil, and soils are generally alkaline from high pH 8.0 to 8.5.

Table 1 Result data of pH (potential hydrogen) measurements of samples

No	Sample Name	Measurements of potential hydrogen(pH) soil level			Average values of pH
		1st Week	2nd Week	3rd Week	
1	Sample 1	6.7	6.7	6.7	6.7
2	Sample 2	6.7	6.7	6.4	6.6
3	Sample 3	6.6	6.7	6.5	6.6
4	Sample 4	6.3	6.4	6.2	6.3
5	Sample 5	6	6.2	6	6.1
6	Sample 6(mixed)	6.6	6.5	6.5	6.5

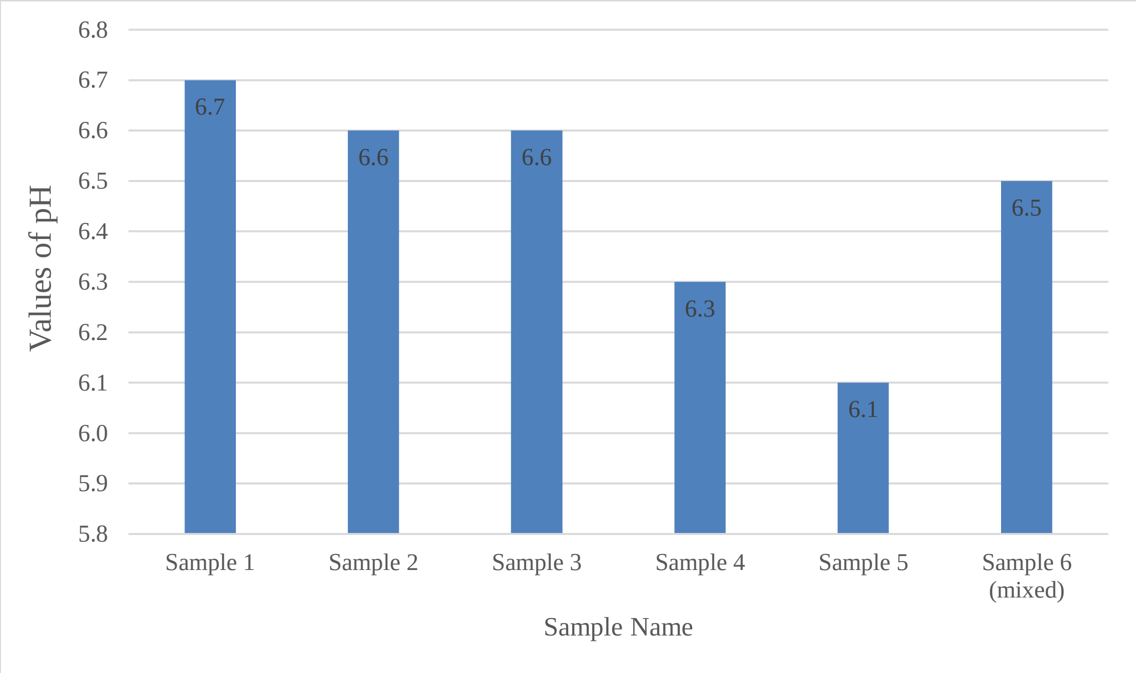

Figure 14 The comparison of average values of pH in six samples

At 1st week, the samples 1 and 2 were neutral soils and samples 3, 4, 5 and 6 were acidic soils. After one week apart, 2nd week, the values of pH of samples were changed due to moisture of soils at room temperature. The result data of samples 1, 2 and 3 were neutral soil and samples 4, 5 and 6 were acidic soils. Next, 3rd week, the sample 1 was neutral soil and samples 2, 3, 4, 5 and 6 were acidic soils.

Electrical Conductivity Analysis

Table 2 Test results of electrical conductivity of six samples

No	**Sample Name**	**Room temperature**	***Measurements of Electrical Conductivity(mS/cm)***
1	Sample 1	25˚C	25.4 *mS/cm*
2	Sample 2	25˚C	23.3 *mS/cm*
3	Sample 3	25˚C	24.5 *mS/cm*
4	Sample 4	25˚C	26.1 *mS/cm*
5	Sample 5	25˚C	24.1 *mS/cm*
6	Sample 6(mixed)	25˚C	23.8 *mS/cm*

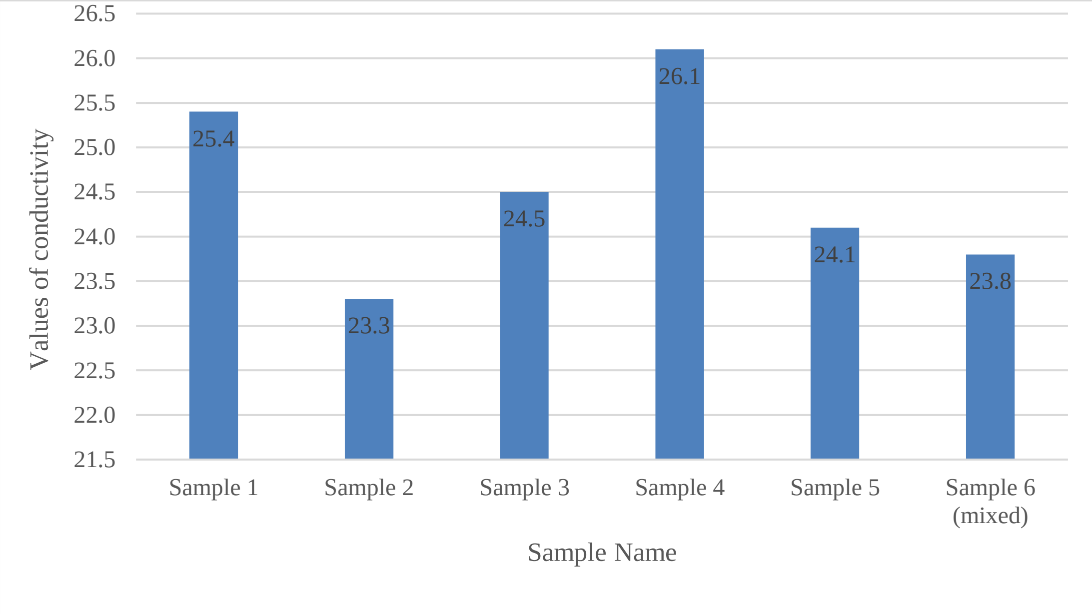

Figure 15 The comparison of values of electrical conductivity in six samples

The Multi-Range of HI 8633 Conductivity Meter is from 0.0 µS/cm to 199.9 mS/cm. Sands have a low conductivity, silts have a medium conductivity, and clays have a high conductivity. Thus, all the soil samples collected from Kalay University campus were sandy soils, the amounts of salts in soil samples were low and enough nutrients were not given due to low conductivities.

NPK (Nitrogen, Phosphorus and Potassium) Analysis

Nitrogen is responsible for leaf and stem growth and applying it will give big green leaves. Phosphorus is responsible for energy transfer and utilization in plants. Applying it will help plant grow and mature, and help its root systems develop better. Soil potassium is responsible for sugars and water movement around plant cells and applying it will help fruit and flower quality. Healthy levels of nitrogen in soil range 40 ppm or 0 to 25 mg/l N. Healthy levels of phosphorus in soil range from 25 to 50 ppm (or) 0 to 150 mg/l P. Healthy levels of potassium in soil range from 40 to 80 ppm (or) 0 to 450 mg/l K.

Table 4 Test result of soil NPK

No	Sample name	Measurements of soil NPK result (mg/l)					
		Soil Nitrogen		Soil Potassium		Soil Phosphorus	
		1st	2nd	1st	2nd	1st	2nd
1	Sample 6 (mixed)	$3.0_{N}^{mg/l}$	$0.0_{N}^{mg/l}$	$85_{K}^{mg/l}$	$50_{K}^{mg/l}$	$\ll_{P}^{mg/l}$	$\ll_{P}^{mg/l}$

Source: Laboratory Test result from Department of Geography

The result data of soil sample were found that not only nitrogen but also potassium was present but phosphorus was absent in soil. Due to presence of nitrogen and potassium, the samples were suitable for planting fruits and flowers and then leaf and stem growth but root system need to be taken care of due to phosphorus deficiency.

Energy Dispersive of X-Ray Fluorescence Analysis

Table 5 The quantitative result of EDXRF of sample 6

Analyte	Result (%)	Standard Deviation	Calculated Procedure	Line	Intensity
Si	57.053	[1.256]	Quan-FP	SiKα	7.6966
Al	19.727	[5.464]	Quan-FP	AlKα	0.5019
Fe	12.745	[0.033]	Quan-FP	FeKα	619.8347
K	7.237	[0.091]	Quan-FP	K Kα	25.5751
Ti	1.616	[0.021]	Quan-FP	TiKα	23.3316
Ca	0.882	[0.018]	Quan-FP	CaKα	5.2584
Mn	0.344	[0.005]	Quan-FP	MnKα	12.5076
Zr	0.134	[0.003]	Quan-FP	ZrKα	26.4726
V	0.051	[0.011]	Quan-FP	VKα	1.0686
Zn	0.049	[0.004]	Quan-FP	ZnKα	3.7620
Sr	0.045	[0.003]	Quan-FP	SrKα	8.2695
Cu	0.043	[0.005]	Quan-FP	CuKα	2.8035
Cr	0.026	[0.007]	Quan-FP	CrKα	0.7733
Y	0.020	[0.003]	Quan-FP	Y Kα	3.7107
Rb	0.016	[0.003]	Quan-FP	RbKα	2.7514
Ni	0.013	[0.005]	Quan-FP	NiKα	0.6795

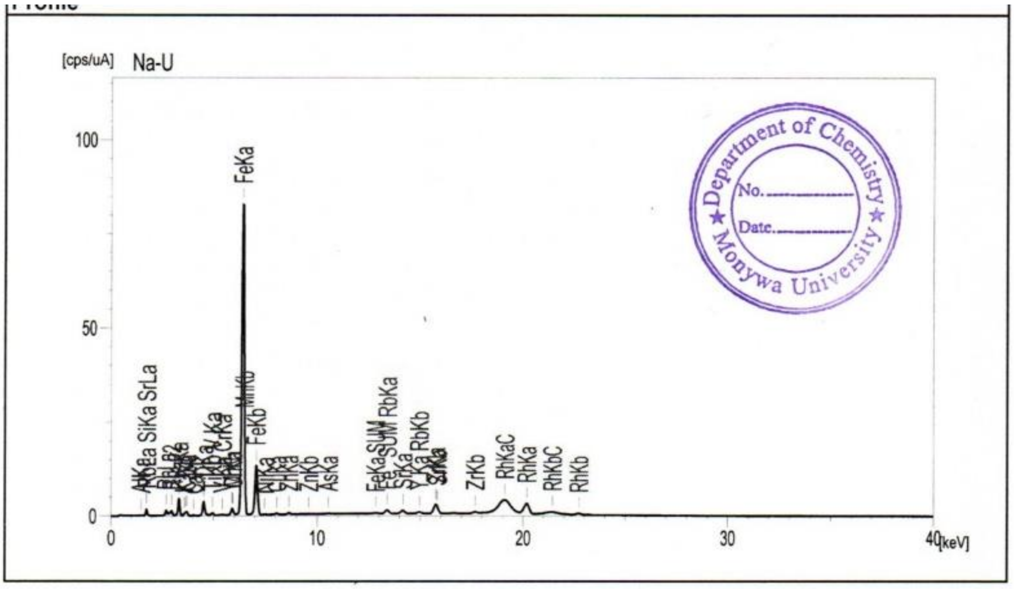

Figure 16 The comparison of intensity of metals in soil

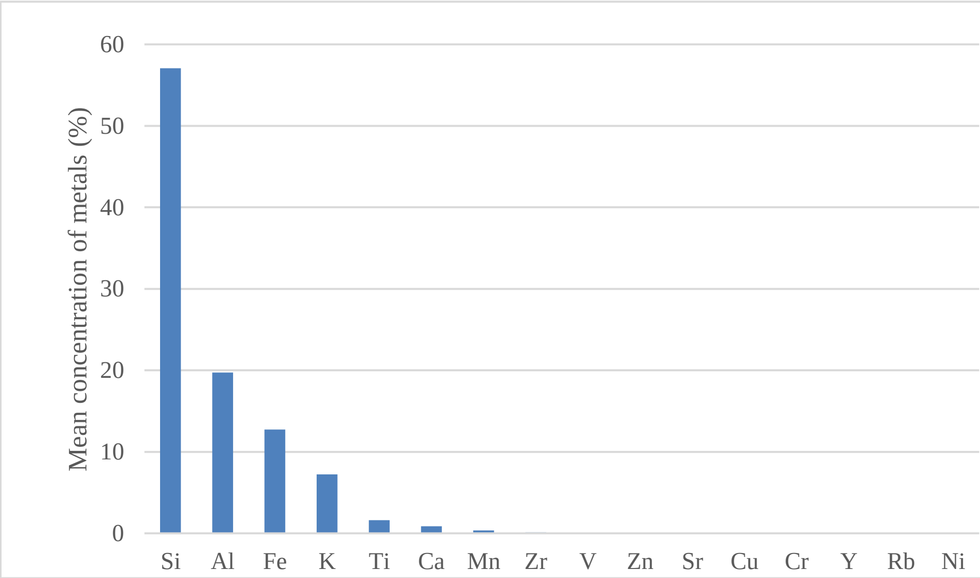

Figure 17 The comparison of mean concentration of metals in soil

It was found that the decreasing order of heavy metal concentration was Si >Al > Fe > K > Ti > Ca > Mn > Zr > V > Zn > Sr > Cu >Cr > Y >Rb >Ni. The mean value of concentration of Silicon (Si) was the highest and that of Nickel (Ni) was the lowest value. Elements like Silicon, Aluminum, Iron, Potassium and Titanium can be clearly identified; traces of Calcium, Manganese, Zirconium, Vanadium, Zinc, Strontium, Copper, Chromium, Yttrium, Rubidium and Nickel in lower concentration can be also observed. The peak FeKα was highest and then peak AlKα was lowest.

Conclusion

As the values of pH (pH<7) in all soil samples were low, it was found that Kalay University's soil samples were acidic soils. It was suitable for growing only acid-loving plants.

All of six soil samples were sandy soils, amount of salts in soil samples were low and enough nutrients due to low conductivities.

Then, the content of nitrogen and potassium of the sample 6 was suitable for planting fruits and flowers and then leaf and stem growth but root system need to be taken care of due to phosphorus deficiency.

The sixteen metals were found in soil samples 6. The mean concentration of Silicon (Si) was extremely higher than the other metals. The concentrations of micronutrients of Copper, Zinc, Iron, Manganese, Zirconium, Strontium, Chromium, Rubidium, Vanadium, Nickel and Yttrium become toxic only when a concentration limit is exceeded.

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