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# Assessment of physical properties of soil collected from various blocks of district Ri-Bhoi, Meghalaya, India

**Antara Laha, Dr. Amreen Hasan, Dr. Tarence Thomas and Dr. Arun Alfred David**

**Abstract**
The present study was conducted to assess the various physical properties of soil that was collected from different locations of district Ri-Bhoi, Meghalaya, India. For the purpose of analysing the physical properties of soil, a total of 27 soil samples from three different villages were collected from three profile depths (0-15 cm, 15-30 cm, and 30-45 cm). For analysis, nine sampling points were chosen. The findings showed that in dry condition, the colour of the soil ranged from yellowish brown to brown, whereas in the wet condition, dark reddish brown to reddish brown predominated. The soil's predominant soil types were clay loam, sandy clay loam, and loam. The bulk of these soils are suitable for paddy production due to their high clay concentration. The pore space percentage of the soil ranged from 47.70 to 52.96% and the water holding capacity ranged from 43.70 to 48.96%. The value of bulk density ranged from 1.11 to 1.37 Mg $m^{-3}$, for particle density, the value ranged from 2.36 to 2.65 Mg $m^{-3}$ and for specific gravity, it ranged from 1.18 to 2.65 Mg $m^{-3}$.

**Keywords:** Physical properties, bulk density, particle density, pore space percentage, water holding capacity and specific gravity, district Ri-Bhoi, Meghalaya

## Introduction
Under ideal circumstances, soil serves as a natural medium for plant growth. To comprehend how soil behaves toward vegetation, a thorough understanding of soil is required. The kind of natural vegetation that grows there is a reflection of the current soil conditions. The types of vegetation are affected by changes in soil quality. The blend of organic material, minerals, living things, gases, and liquids that makes up soil is what keeps it alive. It typically (or typically) contains 25% of air, 25% of water, 45% of minerals, and 5% of organic materials (humus, tiny living organisms and sometimes plant residue). In a natural setting, it is the medium that supports rooted plants (Chaurasia *et al*., 2013) [10].

Under ideal circumstances, soil serves as a natural growing substrate for plants. Understanding how soil behaves towards vegetation requires a thorough knowledge of the substance. The predominant soil conditions can be seen in the sort of natural plant that exists. The type of vegetation changes in response to changes in the soil environment. The life of soil is supported by a complex mixture of organic material, minerals, living things, gases, and liquids. It typically (or typically) contains 25% air, 25% water, 45% mineral matter and 5% organic matter (humus, tiny living organisms and sometimes plant residue). In a natural setting, rooted plants are supported by it (Chaurasia *et al*., 2013) [10].

For agricultural productivity and the sustainable use of soil, the physical properties of the soil are crucial. The various physical properties of soil include bulk density, particle density, pore space percentage, water holding capacity, and specific gravity. (Adiku *et al.*, 2015) [1].

A state in northeastern India, Meghalaya is known as the "abode of clouds". On January 21, 1972, Meghalaya was created by dividing the state of Assam into two districts: United Khasi Hills, Jaintia Hills, and Garo Hills. Shillong is the capital of Meghalaya. The economy of Meghalaya is mostly agrarian, with a sizable commercial forestry sector. Rice, millet, corn (maize), potatoes, pepper, chillies, cotton, ginger, jute, betel nuts, fruits (such as oranges and mangoes) and vegetables are the principal crops farmed in Meghalaya. In order to decrease soil erosion and enhance productivity, the farmers have employed their expertise together with centuries-old farming techniques. Here, there are two different sorts of agricultural operations used: settled and shifting. The majority of the forest regions, with the exception of protected forests, sacred groves, limited forests, and private woods, are available for jhum, or shifting agriculture.

Shift cultivation is done using a form of cut-and-burn or burn-and-plant technique (Jeeva *et al.*, 2006) [14].

Ri-Bhoi's highest recorded temperature on record is 33.0 °C (91.4°F), with July 6th typically ranking as the hottest day of the year. The district's lowest recorded temperature in a year is 9.8 °C (49.6°F), with January 10th often being the coldest day. The state's climate varies according to height. Khasi and Jaintia Hills have a particularly pleasant and brisk climate. The climate across the plains of the Garo Hills is mild and humid, with the exception of winter and it is neither excessively hot in the summer nor too cold in the winter. About 1,150 cm of rain falls on average each year.

## Materials and Methods

Soil samples were collected from three different blocks viz., Umsning, Bhoirymbong and Umling block of district Ri-Bhoi, Meghalaya, India. From each block, soil samples were taken from three different villages and from three different depths. Paddy-producing soil samples were taken from the middle of the hill. The collections of soil samples were done from three different depths of soil, namely 0-15 cm, 15-30 cm and 30-45 cm. Altogether, twenty-seven soil samples were taken from nine different villages. Each time, a soil sample weighing about 1.5 kg was taken. This depth is typically the only one where most fertilizer applications and root activity occur.

The sampling location's surface area was first cleaned up. Stones, leaves, and weeds were taken out. Garden hoe/spade was used to dig a "V"-shaped trench that was 15 cm deep. The depth of the pit was measured using a metre scale, and 1 to 2 cm slices of dirt were collected. The soil was uniformly spread out and placed in a piece of clean, white paper. Roots, stones, pebbles and other foreign objects were taken out. If the soil was wet, it was allowed to air dry on the job site, out of the way of wind-and sun-borne contaminants. The soils were then carefully combined and divided into four equal portions. The remaining two soil quarters were combined after discarding the two opposite ones. A tidy piece of cloth or polythene bag was used to gather the soil sample. The bag was tagged with the necessary information, including the date, soil sampling number, sample depth, GPS coordinates of the sampling site, farmer's name, field name, and crop history. In this manner, the second soil sample was also taken from the same sampling site at depths of 0-15 cm, 15-30 cm and 30-45 cm. Each soil sample was spread out on a fresh sheet of white paper and was allowed to air dry at room temperature. Using a wooden mallet, the huge lumps and clods were broken up into their smallest possible soil particles. A 2 mm sieve was used to filter the ground-up soil. The soil sample was collected and appropriately labelled for laboratory analysis in a clean cloth or polythene bag. Standard techniques were used to examine the soil: the Bouyoucos Hydrometer method for determining soil texture (Bouyoucos, 1927) [8]. Soil colour according to the Munsell soil colour chart (Munsell, 1954) [18]. Specific gravity using a Pycnometer or relative density bottle (Black, 1965) [6]. Graduated 100 ml measuring cylinder method for bulk density, particle density, water holding capacity and pore space percentage (Muthuaval *et al.*, 1992) [19]. In dry condition, the colour of soil ranged from yellowish brown to brown, and when it was wet, it ranged from dark reddish brown and dark yellowish brown to reddish brown. The predominant types of soil texture identified were clay loam, sandy clay loam and loam. The bulk of these soils are suitable for paddy production due to their high clay concentration. These results concurred with those of Adiku *et al.* (2015) [1]. The bulk density of the area under study was between 1.11 and 1.37 Mg $m^{-3}$, and the particle density ranged from 2.36 to 2.65 Mg $m^{-3}$. It was observed that bulk density and particle density increased with increasing depth. This is due to the presence of organic matter and the presence of clay in surface soils. Less cultivation may be the cause of the higher compaction in the subsurface soils. (Dutta *et al.*, 2015 and Lamare and Singh, 2017) [13, 15]. The fraction of pore space varied from 47.70% to 52.96%. The range of measured pore space values indicates clayey soils. With increasing depth, it was discovered that there was less pore space, which was related to increased subsurface compaction. These results were consistent with those from Pandey *et al.*, 2018 [21]. The value of water holding capacity ranged from 43.70 to 48.96%, showing significant clay content and the ability of the clay to keep considerable amounts of water for an extended length of time in the micro pores. The variations in water holding capacity are caused by changes in the concentration of sand, silt, clay and organic carbon. Similar findings were also reported by Bordoloi *et al.* in 2018 [7]. The value of specific gravity ranged from 1.18 Mg $m^{-3}$ to 2.65 Mg $m^{-3}$, indicating porous particles and a significant amount of organic components in the various communities. (Sujatha *et al.*, 2016) [22].

## Geographical map of the study area


**Fig 1:** Meghalaya


**Fig 2:** Umling and Umsning block


**Fig 3:** Bhoirymbong block

## Results and Discussion

### Physical Properties

According to tables 1, 2 and 3, the soil's colour ranged from yellowish brown to brown when it was dry and from dark reddish brown to reddish brown and dark yellowish brown to reddish brown when it was wet. When the soil's texture was examined, it was discovered that sandy loam, sandy clay loam and clay loam predominated. The bulk of these soils are suitable for paddy production due to their high clay concentration. (Adiku *et al*., 2015) [1]. The bulk density of the examined area ranged between 1.11 and 1.37 Mg $m^{-3}$, indicating a significant amount of organic materials. Due to increased subsurface compaction, it was discovered that the bulk density increased with increase in depth. (Chaudhari *et al*., 2013) [9]. The particle density ranged from 2.36-2.65 Mg $m^{-3}$. With increasing depth, the value of particle density also increased, which is an indication of the presence of higher amounts of organic matter. (Barthwal *et al*., 2019) [5]. The highest range of pore space recorded was 52.96% and the lowest range obtained was 47.70%. The range of pore space values found is an indication of clayey soils. Increased compaction in the subsurface was found to be the cause of the observed decrease in pore space with depth. (Pandey *et al*., 2018) [21]. The water holding capacity of soil in different villages ranged from 43.70 to 48.96 percent, showing a high clay content that may absorb a considerable amount of water for a long period of time in the micro pores. The cariations in the water holding capacity result from variations in the amounts of sand, silt, clay and organic carbon. (Bordoloi *et al*., 2018) [7]. Specific gravities ranged from 1.18 to 2.65 Mg $m^{-3}$, which is an indication of porous particles and a high level of organic matter. These results were consistent with Sujatha *et al*., 2016 [22].

**Table 1:** Soil texture and soil colour of district Ri-Bhoi, Meghalaya, India

| Name of the blocks | Name of the village | Soil texture | Soil colour | |
|---|---|---|---|---|
| | | | Range (Dry condition) | Range (Wet condition) |
| Umsning | Mawkhan (A1) | Sandy clay loam | Yellowish brown-Brownish yellow | Dark yellowish brown |
| | Lumnynri (A2) | Sandy clay loam | Yellowish brown | Dark brown-brown |
| | Umshorshor (A3) | Sandy clay loam | Brown-Yellowish Brown-Brownish yellow | Yellowish brown-brown |
| Bhoirymbong | Nonglakhiat (B1) | Sandy clay loam | Reddish brown-Yellowish red | Dark reddish brown |
| | Mawbri (B2) | Sandy clay loam | Reddish brown-Dark reddish brown-Reddish brown | Dark reddish brown |
| | Umktieh Mawkhim (B3) | Sandy clay loam | Yellowish red | Reddish brown-Yellowish red |
| Umling | Borkhatsari (C1) | Loamy | Brown-Strong brown | Reddish brown-Brown |
| | Nalapara (C2) | Clay loam | Brown | Reddish brown |
| | Mawphrew (C3) | Clay loam | Brown | Reddish brown |

**Table 2:** Evaluation of bulk density, particle density and water holding capacity of soil district Ri-Bhoi, Meghalaya

| Name of the blocks | Name of the villages | Bulk Density (Mg m-3) | | | Particle Density (Mg m-3) | | | Water Holding Capacity (%) | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | 0-15 cm | 15-30 cm | 30-45 cm | 0-15 cm | 15-30 cm | 30-45 cm | 0-15 cm | 15-30 cm | 30-45 cm |
| Umsning | Mawkhan (A1) | 1.11 | 1.13 | 1.16 | 2.36 | 2.40 | 2.45 | 48.96 | 48.91 | 48.65 |
| | Lumnynri (A2) | 1.15 | 1.17 | 1.19 | 2.39 | 2.43 | 2.47 | 47.88 | 47.85 | 47.61 |
| | Umshorshor (A3) | 1.12 | 1.15 | 1.18 | 2.32 | 2.36 | 2.41 | 47.72 | 47.27 | 47.03 |
| Bhoirymbong | Nonglakhiat (B1) | 1.25 | 1.27 | 1.29 | 2.48 | 2.51 | 2.54 | 46.59 | 46.40 | 46.21 |
| | Mawbri (B2) | 1.21 | 1.25 | 1.27 | 2.50 | 2.55 | 2.59 | 48.60 | 47.98 | 47.96 |
| | Umktieh Mawkhim (B3) | 1.23 | 1.26 | 1.29 | 2.52 | 2.57 | 2.60 | 48.39 | 48.26 | 48.17 |
| Umling | Borkhatsari (C1) | 1.31 | 1.34 | 1.36 | 2.58 | 2.62 | 2.65 | 45.22 | 44.85 | 44.67 |
| | Nalapara (C2) | 1.33 | 1.35 | 1.37 | 2.56 | 2.59 | 2.62 | 44.04 | 43.87 | 43.70 |
| | Mawphrew (C3) | 1.30 | 1.32 | 1.35 | 2.53 | 2.56 | 2.60 | 45.61 | 45.43 | 45.07 |
| | | F-test | SEm (±) | CD at 5% | F-test | SEm (±) | CD at 5% | F-test | SEm (±) | CD at 5% |
| Due to depth | | S | 0.025002 | 3.23E-19 | S | 0.038335 | 8.31E-18 | S | 0.219343 | 7.7E-19 |
| Due to site | | S | 0.08172 | 2.55E-12 | S | 0.089512 | 3.28E-13 | S | 1.725977 | 1.88E-06 |

**Table 3:** Estimation of pore space (%) and specific gravity

| Name of the blocks | Name of the villages | Pore Space Percentage (%) | | | Specific Gravity | | |
|---|---|---|---|---|---|---|---|
| | | 0-15 cm | 15-30 cm | 30-45 cm | 0-15 cm | 15-30 cm | 30-45 cm |
| Umsning | Mawkhan (A1) | 52.96 | 52.91 | 52.65 | 2.65 | 2.44 | 1.24 |
| | Lumnynri (A2) | 51.88 | 51.85 | 51.61 | 2.48 | 2.46 | 1.26 |
| | Umshorshor (A3) | 51.72 | 51.27 | 51.03 | 2.55 | 2.53 | 1.46 |
| Bhoirymbong | Nonglakhiat (B1) | 49.59 | 49.40 | 49.21 | 2.49 | 2.48 | 1.38 |
| | Mawbri (B2) | 51.60 | 50.98 | 50.96 | 2.24 | 2.20 | 1.18 |
| | Umktieh Mawkhim (B3) | 51.19 | 50.97 | 50.38 | 2.44 | 2.40 | 1.32 |
| Umling | Borkhatsari (C1) | 49.22 | 48.85 | 48.67 | 2.59 | 2.41 | 1.38 |
| | Nalapara (C2) | 48.04 | 47.87 | 47.70 | 2.45 | 2.42 | 1.37 |
| | Mawphrew (C3) | 48.61 | 48.43 | 48.07 | 2.48 | 2.46 | 1.35 |
| | | F-test | SEm (±) | CD at 5% | F-test | SEm (±) | CD at 5% |
| Due to depth | | S | 0.251669 | 5.86E-18 | S | 0.653494 | 0.000593 |
| Due to site | | S | 1.701347 | 1.37E-06 | S | 0.08624 | 4.43E-18 |

## Conclusion

It can be concluded from the above study that the soil in the Ri-Bhoi district is in good physical condition. When the soil was dry, it ranged from yellowish brown to brown, and when it was wet, it ranged from dark reddish brown to reddish brown and from dark yellowish brown to reddish brown. Sandy loam, sandy clay loam, and clay loam were identified to be the predominant soil textures of the studied area. Most of these soils are suitable for paddy cultivation because they contain a high percentage of clay. With increasing depth, an increase in the value of bulk density and particle density was observed, which is an indication of the presence of organic matter.

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