SOIL PHYSICOCHEMICAL PROPERTIES AND BIO-AVAILABLE NUTRIENTS UNDER MANGLIETIA CONIFERA PLANTATION AT XUAN SON NATIONAL PARK, TAN SON, PHU THO

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SUMMARY

Soil physicochemical properties and soil nutrient dynamics have reciprocal relationship with soil forming factors such as parent material, climate, topography and vegetation types. This study was conducted in three terrain positions under 20-year-old *Manglietia conifera* plantations including toe-slope and back slope and summit in Xuan Son National Park, Phu Tho province. Soil samples in each position were collected in three layers, including topsoil layer (0 - 10 cm), 10 - 20 cm layer and 20 - 50 cm layer. Research results showed soil proportion was 1.07 - 1.28g/cm^3, soil density was 2.42 - 2.65g/cm^3, soil porosity reached 49.34 - 59.88% and soil texture were sandy silt loam. Except for soil proportion and soil texture, soil density and porosity were different between terrain positions and soil depths. pH_{H_2O} value was 4.97 - 6.23 and different between studied positions. Soil organic carbon (SOC) reached 1.92% - 3.56% classified from poor to medium of SOC and there was a great difference between the toe-slope and the summit. Bio-available nitrogen content was 1.02 - 2.59mg/100g, bio-available phosphorus content reached 0.1 to 0.26mg/100g and bio-available potassium content gained 2.56 - 6.17mg/100g. Except for bio-available phosphorus content, bio-available nitrogen and potassium contents were different between toe-slope and back slope. The bio-available content of N, P, K nutrients was proportional to soil organic matter, porosity, clay particle composition and pH. Meanwhile, soil density, sand and limon particles had an inverse relationship with bio-available N, P, K content.

Keywords: Bio-available nutrients, *Manglietia conifera*, soil depth, soil physicochemical properties, Xuan Son National Park.

1. INTRODUCTION

The physical properties of forest soils are involved in important processes in soil such as: (1) root growth promotion; (2) water holding and supply; (3) mineral nutrients cycles; (4) optimal gas exchange promotion; (5) creating favorable conditions for biological activity; and (6) adopting, holding, and releasing carbon (Burger and Kelting, 1999). Physical properties include porosity and soil texture, which can vary at different times (Schoenholtza et al., 2000) and depend on precipitation, light, temperature and organic matter cover.

The mineralization and humus process are influenced by various factors such as temperature, humidity, light and soil microorganisms. These processes help soil physics (porosity, soil texture) as well as chemical properties (pH, organic carbon, and soil nutrients) has also been markedly improved (Ha Quang Khai et al., 2000).

The distribution of nutrients in soil layers is influenced mainly by four processes including weathering, atmospheric deposition, leaching, and biological cycling (Trudgill 1988). Particularly, plants play a significant role in soil nutrient formation through their properties such as tissue stoichiometry, biomass cycling rates, above- and belowground allocation, root distributions, and maximum rooting depth (Schoenholtza et al., 2000). Additionally, plants contribute a large part in the absorption and transport of nutrients to the soil layers by returning of organic matter and roots to soils (Trudgill 1988; Stark 1994).

Study of soil physicochemical properties and nutrient dynamics in soil layers reflects the effects of soil forming factors such as climate, topography, and vegetation types on soils (Jenny 1941; Marion et al.1985; Honeycutt et al. 1990). Therefore, nutrient inputs, outputs, and cycling processes are demonstrated by studying the vertical distribution of soil nutrients (Smeck 1973; Kirby 1985).

Xuan Son National Park is located at the end of Hoang Lien Son mountain range. There are strictly protected area with 9,099 ha and ecological restoration area with 5,737 ha to conserve biodiversity in Xuan Son. These areas were used to conserve and promote special nature values, standard ecosystem samples, and biological genetic resources (Xuan Son National Park). According to a survey by the Institute of Ecology and Biological Resources in 2008, Xuan Son National Park has a highly diverse flora with nine types of ecosystems and vegetation (four primary forest types, five secondary forest types). In which, forest ecosystem is very diverse with dominant flora families such as *Lauraceae, Magnoliaceae, Fagaceae, Sapotaceae, Manglietia conifera*... and some endemic plant species including *Vatica diospyroides, Parashorea chinensis, Pometia pinnata* (Hung Tran Quang, 2008).

Particularly, *Manglietia conifera* species has simple planting techniques, favorable growth and development (Hung Tran Quang, 2008). Therefore, this species is used to restore poor secondary forest area and improve soil properties in the national park. However, there is no research on soil properties under *Manglietia conifera* plantations in the national park. Therefore, this study is very practical in order to provide a scientific basis for the influence of *Manglietia conifera* plantations on soil properties in Xuan Son National Park.

Based on data collection and soil analysis in different terrains and soil depths under 20-year-old *Manglietia conifera* forest canopy, this paper has revealed results on: (i) Various soil physical properties; (ii) pH and soil organic carbon; (iii) Bio-available nitrogen, phosphorus and potassium; (iv) Relationship between physicochemical properties and bio-available nutrients.

2. RESEARCH METHODOLOGY

2.1. Data collection in the field

2.1.1. Establishing standard plots and setting up the soil profile system

Three standard plots with an area of 1000m^2 (40 m x 25 m) was established in 3 positions: toe-slope, back slope, summit. Tree growth indicators were collected according to the techniques instructed in the Forest Inventory textbook (Vu Tien Hinh, 1997).

In each plot, three locations were selected for excavating soil profiles. These locations have represented conditions in the plantation state, the uniformity and accuracy of the research results. Some features of the soil profile system are summarized below:

Table 1. Some characteristics of the soil profile system at the study sites

Location	Topographic	$\overline{D}_{1.3}$ (cm)	$\overline{H}_{vn}$ (m)	Canopy cover rate	Forest cover (%)	Shrubs
Toe-slope	- Slope degrees: 17º - Slope direction: South East, - Absolute altitude: 135m, - Relative altitude: 112m.	20	18.47	0.7	75	*Rauwolfia Vertilillata, Melastoma candidum, Nephrolepis cordifolia, Imperata cylindrica*, … Average height: 0.8m
Back slope	- Slope degrees: 21º - Slope direction: South East, - Absolute altitude: 137m, - Relative altitude: 113m.	16.69	17.39	0.6	60	*Rauwolfia Vertilillata, Clerodendrum cyrtophyllum, Melastoma candidum, Imperata cylindrica, Imperata cylindrica, Nephrolepis cordifolia...* Average height: 0.6m
Summit	- Slope degrees: 11º - Slope direction: South East, - Absolute altitude: 165m, - Relative altitude: 140m.	18.5	16.18	0.55	65	*Imperata cylindrica, Nephrolepis cordifolia, Rauwolfia Vertilillata …* Average height: 0.7m

2.1.2. Soil sample investigation and collection methods

In each plot, 3 soil profiles were dug in representative positions. In each profile, took soil samples at 3 levels of depth: 0 - 10 cm, 10 - 20 cm and from 20 - 50 cm. At each depth, 500 g of soil was collected at random locations. Soil samples in 3 profiles of each depth were mixed to form synthetic samples for chemical and physical analysis. These synthetic samples were put into separate plastic bags, marked with distinctive labels. Soil samples used for soil density analysis were taken separately (MARD, 2008).

2.2. Methods of soil analysis in the laboratory

2.2.1. Soil sample treatment

The soil sample was dried under the shade, removed roots, leaves, plant residue, agglomeration, gravels... crushed with a small copper mortar or a small rubber-tip pestle, sifted through a sieve with a diameter of 1mm.

2.2.2. Soil sample analysis

The soil samples after being processed according to the guidelines (MARD, 2008) were analyzed at the Soil Analysis Division, Center for Forestry and Climate Change, Vietnam National University of Forestry. All indicators were analyzed and repeated 3 times. The soil analysis methods used include:

* The density was determined by the metal cylinder method (D = P / V, where P is the mass of natural soil in the closed cylinder after being completely dried, V is the volume of the cylinder - cm^3);

* Soil density was determined by the Pycnometer method (MARD, 2008).

* Soil porosity was determined by density and proportion by calculation formula (MARD, 2008).

* Soil texture was determined by Robinson straws method.

* pH_{H2O} was calculated by pH metter.

* Soil humus content in soil was determined by Tiurin method.

* Bio-available nitrogen was determined by a colorimetric method.

* Bio-available phosphorus determined by a colorimetric method.

* Bio-available potassium was determined by the flame photometer method (TCVN 8662:2011)

2.3. Data analysis methods

Collected data were analyzed using SPSS ver. 20, including: Testing differences in soil chemical and physical properties, and nutrients contents in the soil between locations (toe-slope, back slope, summit) and between depths (0-10cm, 10-20cm, 20-50cm) by mixed linear models.

Following commands were used for testing different positions:

```
MIXED OM BY Position
 /CRITERIA=CIN(95) MXITER(100) MXSTEP(10)
SCORING(1) SINGULAR(0.000000000001)
HCONVERGE(0, ABSOLUTE) LCONVERGE(0,
ABSOLUTE) PCONVERGE(0.000001, ABSOLUTE)
 /FIXED=Position | SSTYPE(3)
 /METHOD=REML
 /PRINT=SOLUTION.
```

Following commands were used for testing different depths:

```
MIXED OM BY Depth
 /CRITERIA=CIN(95) MXITER(100) MXSTEP(10)
SCORING(1) SINGULAR(0.000000000001)
HCONVERGE(0, ABSOLUTE) LCONVERGE(0,
ABSOLUTE) PCONVERGE(0.000001, ABSOLUTE)
 /FIXED=Depth | SSTYPE(3)
 /METHOD=REML
 /PRINT=SOLUTION.
```

Testing the correlation between physical and chemical properties and the content of digestible nutrients by principal component analysis.

```
FACTOR
 /VARIABLES OM pH Nitrogen Phosphorus Potassium
Density Proportion Porosity Sand Limon Clay
 /MISSING LISTWISE
 /ANALYSIS OM pH Nitrogen Phosphorus Potassium
Density Proportion Porosity Sand Limon Clay
 /PRINT INITIAL EXTRACTION
 /PLOT ROTATION
 /CRITERIA MINEIGEN(1) ITERATE(25)
 /EXTRACTION PC
 /ROTATION NOROTATE
 /METHOD=CORRELATION.
```

Graphs were used to display the differences of variables between different positions and soil depths.

3. RESULTS AND DISCUSSIONS

3.1. Soil physical properties in research locations

Soil physical properties differed depending on the soil type, soil formation and use conditions. Analysis results of the physical properties at different positions and depths were presented in Table 2.

Table 2. Some basic physical properties at research locations

Position	Depth (cm)	Density (g/cm^3)	Proportion (g/cm^3)	Porosity (%)
Toe-slope	0-10	1.07±0.03	2.55±0.11	58.19±1.46
	10-20	1.17±0.03	2.57±0.00	54.61±1.23
	20-50	1.20±0.02	2.56±0.04	52.98±0.65
Back slope	0-10	1.25±0.02	2.58±0.05	51.34±0.58
	10-20	1.28±0.01	2.59±0.01	50.40±0.57
	20-50	1.27±0.03	2.56±0.01	50.39±0.98
Summit	0-10	1.14±0.01	2.47±0.04	53.98±0.78
	10-20	1.22±0.04	2.59±0.05	52.94±0.84
	20-50	1.26±0.01	2.55±0.04	50.80±1.27

3.1.1. Soil density (D, g/cm³)

Soil density in the study locations ranged from 1.07–1.28 g/cm^3, so it is slightly compacted soil (MRAD, 2008). In which, the soil density between toe-slope and back slope; between back slope and summit were significantly different, because Sig. values were 0.028 and 0.017 respectively.

In addition, at different depths in each research location there was also a clear difference in the density values. At the toe-slope position, the density value in the topsoil layer was distinctly different from the 11 - 20 cm layer with the Sig value 0.01. Meanwhile, this value was not significantly different between 11 - 20 cm layer and 20 - 50 cm layer, because Sig. value was 0.127. However, in the back slope position, the density value in the surface layer was not different from the other two layers of soil because Sig. values were 0.272 and 0.451, respectively. Finally, in the summit position, the soil density difference between the three floors was similar to that of the toe-slope position. Meaning, the soil density was significantly different between the topsoil layer and the 11 - 20 cm and 21 - 50 cm layers, because Sig values were 0.01 and 0.097, respectively.

The toe-slope position had the smallest value (1.15g/cm³) because in this position there is a large canopy, thicker cover of fresh vegetation, and the amount of organic matter is washed away from above to accretion. Therefore, soil in this location had a high humus content (MRAD, 2008), thus affecting the density value. The average peak density was 1.20 g/cm³, at the top of the hill, the fresh vegetation layer is thinner and the amount of organic matter has been partly washed away by the water, so the density here is larger than the toe-slope location. At the hillside position due to the greatest slope (21°), the coverage of the green vegetation is smallest, so influence of erosion here is the greatest, that is why the soil has the largest density (1.27 g/cm^3). This it can be seen that tree layers and the shrub and vegetation layers have a beneficial effects on the reduction of soil density, making the soil more porous.

3.1.2. Soil proportion (d, g/cm³)

The soil proportion in locations under the plantations ranged from 2.42 to 2.65 g/cm^3, which is typical value of sub-forest soil (MRAD, 2008). The proportion values were significantly different between toe-slope, back slope and summit positions, because Sig. values were 0.315 and 0.171, respectively.

At different depths of the toe-slope position, the proportion was no clear difference between 3 soil layers. This was proved by Sig. values: 0.818 and 0.613, respectively. Similarly, there was no significant differences of proportion values between soil horizons. In the back slope position, Sig values were 0.494 and 0.317 respectively. And in the summit position the Sig. values were 0.055 and 0.353 respectively. The reason is that soil under the plantation has a relatively similar texture among the study sites (see section 3.3.4). That is the main reason leading to the above results because the proportion depends greatly on the soil texture (Ha Quang Khai et al., 2000). In addition, the proportion of soil increases with depth, this is completely appropriate because the top layer concentrates more humus and organic matter than the deeper layers, making the proportion smaller than the deeper layers.

3.1.3. Soil porosity (P, %)

Soil porosity in the study locations ranged from 49.34% to 59.88%, so the soil is a porous type (MARD, 2008). In which, the porosity between three slope positions had a significant difference because the Sig. values were 0.004 and 0.037 respectively. The soil porosity was highest (55.26%) in toe-slope, followed by the back slope position (52.57%) and the summit position (50.71%).

The soil porosity of the topsoil layer (depth 0 - 10 cm) was significant different from the deeper soil layers (11 - 20 cm and 21 - 50 cm). At the toe-slope position, the porosity value in the topsoil layer was markedly different from the 11 - 20 cm layer (Sig. = 0.02). Meanwhile, the porosity was not significantly different between 11 - 20 cm and 20 - 50 cm layers (Sig. = 0.140). In the back slope position, the porosity value in the surface layer was not different from the other two soil layers (Sig. values were 0.162 and 0.592, respectively). Finally, in the summit position, the difference in porosity between the horizons was very clear because Sig. values were 0.08 and 0.038, respectively.

This is explained by: the profile depth increases, the proportion of limon particles and clay increases as well as the ratio of humus decreases which leads to a tighter bonding of soil particles and a decrease in soil porosity.

3.1.4. Soil texture (%)

The difference in soil texture depends on many different factors such as the parent rock forming soil, the decomposition and accumulation of organic matter and humus in the soil, plant species composition in the canopy (Blume et al., 2016).

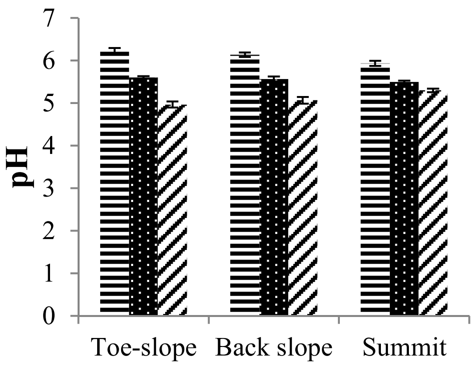
Table 3. Soil texture in the study locations

Position	Depth (cm)	Texture (%)		
		Sand (<0.002mm)	Limon (0.02-0.002mm)	Clay (2-0.02mm)
Toe-slope	0-10	22.67±2.55	39.98±1.04	37.35±1.95
	10-20	26.34±2.84	42.11±0.42	31.55±3.24
	20-50	28.21±2.02	44.13±0.24	27.66±2.13
Back slope	0-10	32.80±2.51	44.09±0.63	23.12±3.04
	10-20	30.14±2.35	44.33±2.27	25.53±4.62
	20-50	25.92±0.63	47.48±3.15	26.60±3.30
Summit	0-10	25.58±1.94	48.06±0.63	26.36±1.44
	10-20	30.20±0.48	44.47±0.73	25.33±1.04
	20-50	27.28±0.48	49.57±2.29	23.16±2.60

The soil in three locations has a medium clay (MARD, 2008). The composition of sand, limon and clay grain levels between the three locations of the plantation did not differ significantly (Sig. > 0.05). Soil in a pure plantation usually does not differ significantly in terms of texture because they are composed of same parent rock type and the same vegetation type and weather conditions (Burger et al., 1999). From there, the difference in organic material accumulation changes a series of soil chemical properties such as acidity, nitrogen, and phosphorus content (Ha Quang Khai et al., 2000).

3.2. Soil reaction and organic matter content in the soil under the plantations

Different plant species composition through the amount of falling objects, decomposition, organic matter synthesis and humus will directly affect soil pH, soil organic content and macronutrients content: NH_4^+, P_2O_5, K_2O (Blume et al., 2016).



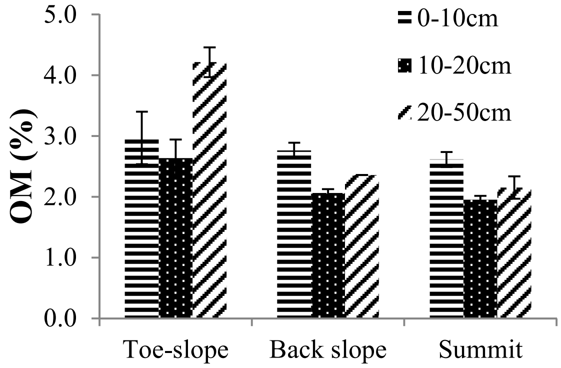


Figure 1. pH value and organic matter content (OM) at different soil depths and positions

3.2.1. Soil reaction

The reaction of the soil in the study locations ranged from 4.97 to 6.23, so the soil is slight acidic (MARD, 2008). The acidity value had a clear difference between the three positions (Sig. = 0.000); between the middle and top ridge position with the value Sig. is 0.000.

At the hillside position, there was a big difference in pH between all soil layers. Meanwhile, at the back slope position, there was only a difference in pH value between the topsoil layer and the 11 - 20 cm layer (Sig. = 0.010). There was no difference between the 11 - 20 cm layer and the 21 - 50 cm layer (Sig. = 0.050). Finally, at the summit position, there was a very clear difference between the topsoil layer and the other two studied layers (Sig. values were 0.000 and 0.001, respectively). This difference is mainly due to the difference in organic matter content in the soil. The topsoil often has high organic matter accumulation. It is where organic matter decomposition and humus synthesis occur. The humus acids might be the main factor causing that difference.

3.2.2. Soil organic carbon content (SOC%)

The organic carbon content accumulated in the soil in the study sites ranged from 1.92% to 3.56%, so the soil is poor to medium humus content (MARD, 2008).

There was a significant difference in humus content between the positions (Sig. values were 0.002 and 0.019, respectively). Slope affects the movement of organic matter and humus (Burger et al., 1999). Therefore, the SOC content of the back slope position is the smallest, followed by the summit and toe-slope positions.

The decomposition of organic matter occurs strongly in the topsoil because organic matter is accumulated and aerobic microorganism is active. Therefore, in all research locations, there is a significant difference in the accumulation of humus content between the topsoil layer and the remaining layers (All Sig. values were less than 0.05).

3.3. Content of nutrients in soil under the plantations

N, P, K are important macronutrients in the soil, playing a decisive role in crop yield (Blume et al., 2016). They play a major role throughout the life of plants, and have a strong impact on flowering and fruiting, but these elements are always rapidly changing in the soil. This transformation process depends on the process of weathering, mineralization and the process of accumulation, activity of microorganisms and vegetation layers, weather and human impacts (Schoenholtza et al., 2000).

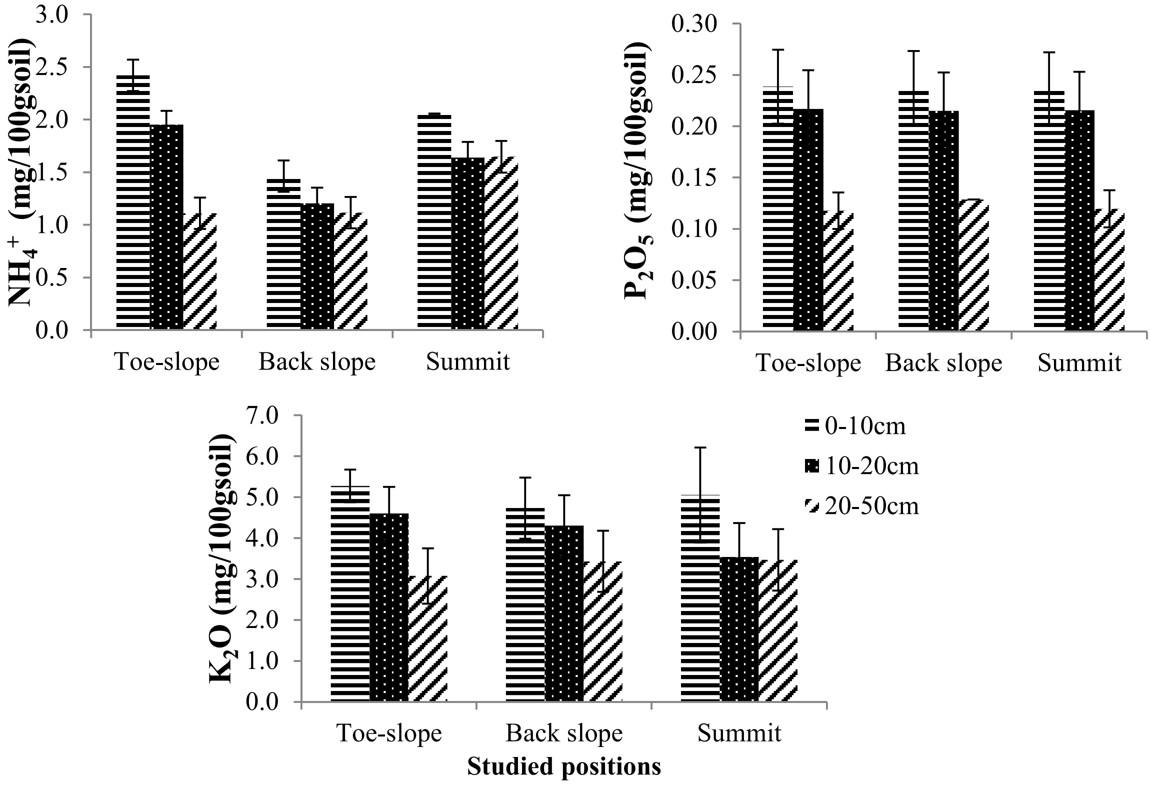


Figure 2. Bio-available nitrogen (NH_4^+), phosphorus (P_2O_5) and potassium (K_2O) at different soil depths and positions

3.3.1. Bio-available nitrogen - NH_4^+ (mg/100gđ)

The content of bio-available nitrogen in the soil under the plantation ranged from 1.02 to 2.59 mg/100g, belonging to poor nitrogen soil type (MARD, 2008). The content of nitrogen in the toe-slope position was significantly different from the hill top position (Sig.=0.002). Meanwhile, the difference was not obvious between the back slope and summit positions (Sig. = 0.190). The toe-slope position had the greatest accumulation of organic matter (see 3.2), in addition, the vegetation had a relatively high coverage (see Table 1). Therefore, the nitrogen content in the toe-slope position was much higher than other positions.

Nitrogen content in the study areas tended to decrease with the profile depth at all study sites (see figure 2). In the toe-slope position, the content of nitrogen was markedly different from other layers (Sig. = 0.000). In the back slope position, the difference occurred only between the topsoil layer and the 11 - 20 cm layer (Sig. = 0.030). In contrast, there was no difference between 11 - 20 cm and 21 - 50 cm horizons (Sig. = 0.506). This trend was similar to the summit position.

3.3.2. Bio-available phosphorus - P_2O_5 (mg/100g)

Although phosphorus in the soil is not as much as potassium, but due to much absorption by plants, phosphorus is mainly concentrated in the topsoil through the mineralization process of falling objects, the effectiveness of phosphorus is best for plants was soil with pH from 5.5-6.5 (MARD, 2008).

The content of phosphorus in the soil in the study locations ranged from 0.1 to 0.26 mg/100g, belonging to poor phosphorus soil type (MARD, 2008). The phosphorus content the toe-slope position was not significantly different from other positions (Sig. values were 0.938 and 0.907, respectively).

However, the content of available phosphorus differed significantly between soil depths. At all study positions, there was a clear difference in phosphorus content between topsoil horizon and 11 - 20 cm – 21 - 50 cm horizons. All Sig value were less than 0.01.

Thus, research results showed that phosphorus content in soil decreased by profile depth and there was a significant difference between soil layers. This is explained by the fact that soil in the surface layer has a high proportion of roots, active microorganisms. Mineralization in this layer occurred faster so that the amount of acid secreted by plants is increased. Therefore, they dissolve more phosphorus. On the other hand, the deeper horizons, P_2O_5 is fixed more to form iron phosphorus and aluminum phosphorus compounds, reducing the content of available phosphorus in the soil (Blume et al., 2016).

3.3.3. Bio-available potassium - K_2O (mg/100g)

Potassium content in the soil depends on the parent rock type, weathering and the leaching process. The total amount of potassium in soils with heavy clay soil accounts for up to 2%, in slit clay soils is often less potassium (Stark, 1994).

Available potassium content in the study area ranged from 2.56 - 6.17 mg/100g, so the soil is poor potassium soil type (MARD, 2008). Content of potassium in the toe-slope position did not differ significantly with two other positions (Sig. values were 0.549 and 0.785 respectively).

However, at the toe-slope position, there was a clear difference in the potassium content between the topsoil layer and 11 - 20 cm – 21 - 50 cm layers (Sig value were 0.004 and 0.019, respectively). However, in the back slope and summit positions, there was no significant difference between the depth horizons, because of all the Sig values were greater than 0.08. Thus, the research results showed that there was almost no difference in potassium content between the research sites and the soil depths. The difference only occurs between the topsoil layer and the other two layers. That is explained by the source of potassium mainly from the parent rock (Blume et al., 2016) because the synthesis of potassium from plants and vegetation floor occurs very slowly.

3.4. Relationships between some soil chemical, physical properties and the content of nutrients in the soil

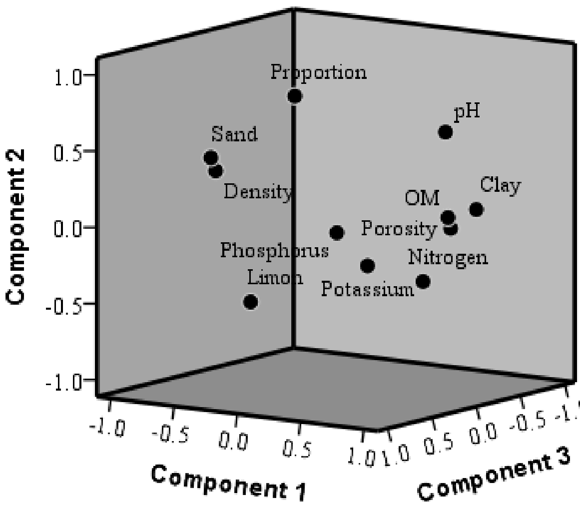


Figure 3: Analysis of principal components affecting soil nutrient content

The figure 3 showed that the content of nitrogen, phosphorus and potassium was proportional to the humus content in the soil. The humus content in the soil is the main material resources to help microorganisms decompose and synthesize nutrients for plants (Blume et al., 2016). Besides, the clay texture also had a close relationship with the content of nutrients in the soil because clay particles are the main adsorption and metabolic of soil cations with plants (Burger et al., 1999). Clay particles contain inorganic nutrients derived from parent rock, especially the source of potassium in the soil.

The porosity was also positively related to the humus content in the soil and the amount of nutrients. Higher porosity means greater soil ventilation, which is a favorable environment for aerobic microorganisms to decompose and synthesize nutrients for the soil. Soil reaction is an important environment for the synthesis of nutrients. The soil from slight to medium acidic is an excellent environment to the synthesis of nutrients by microorganisms (Blume et al., 2016).

Meanwhile, the density, composition of sand particles and limon had an negative relationship with the content of nutrients in the soil. That is consistent with the fact that the higher the density value of the soil, the lower the humus content and it is the source of nutrients generated in the soil.

4. CONCLUSIONS

The soil density in the study area ranged 1.07–1.28 g/cm^3. The soil proportion under the plantation ranged from 2.42 to 2.65g/cm^3. Soil porosity in the study sites ranged from 49.34% to 59.88% and there was a significant difference between the study locations. Soil in the three sites was medium clay soil type and did not differ in the texture in three locations.

The reaction of the soil in the study locations ranged from 4.97 to 6.23. The soil is slight acid soil. The organic carbon content accumulated in the soil ranged from 1.92% to 3.56%, belonging to poor to medium level.

The bio-available content of nitrogen in the soil under the plantation ranged from 1.02 to 2.59 mg/100g dried soil. The content of available phosphorus in the soil ran between 0.1 and 0.26 mg/100g dried soil, while the potassium content ranged from 2.56 - 6.17 mg/100g dried soil. Therefore, the soil is poor potassium type.

The bio-available content of nitrogen, phosphorus and potassium was proportional to the humus content in the soil, porosity, clay particle composition and pH. Meanwhile, the density, composition of sand grains and limon particles had a negative relationship with the concentration of nutrients in the soil.

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TÍNH CHẤT LÝ HÓA HỌC ĐẤT VÀ HÀM LƯỢNG CÁC CHẤT DINH DƯỠNG DỄ TIÊU TRONG ĐẤT RỪNG TRỒNG MỠ (*Manglietia conifera*) TẠI VƯỜN QUỐC GIA XUÂN SƠN, TÂN SƠN, PHÚ THỌ

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TÓM TẮT

Tính chất lý hóa học đất và sự biến động chất dinh dưỡng trong đất có mối quan hệ qua lại với các nhân tố hình thành đất như khí hậu, địa hình và loại hình thực vật. Nghiên cứu được tiến hành ở ba vị trí sườn chân, sườn giữa và sườn đỉnh dưới rừng trồng Mỡ 20 tuổi thuần loài tại vườn quốc gia Xuân Sơn, tỉnh Phú Thọ. Các mẫu đất ở mỗi vị trí được thu thập ở ba tầng đất gồm tầng đất mặt từ 0 - 10 cm, 10 - 20 cm và 20 - 50 cm. Kết quả nghiên cứu cho thấy đất có giá trị dung trọng từ 1,07 - 1,28 g/cm^3, tỷ trọng từ 2,42 - 2,65g/cm^3, độ xốp đạt 49,34% - 59,88% và thành phần cơ giới thuộc loại đất thịt nhẹ. Trừ tỷ trọng và thành phần cơ giới, dung trọng và độ xốp đều có sự khác biệt giữa các vị trí và các tầng độ sâu tầng đất. Giá trị pH_{H_2O} từ 4,97 - 6,23 và giữa các vị trí có sự khác biệt. Hàm lượng mùn trong đất đạt 1,92% - 3,56%, có sự khác biệt rõ rệt giữa sườn chân và sườn đỉnh. Hàm lượng đạm dễ tiêu là 1,02 - 2,59 mg/100gđ, hàm lượng lân dễ tiêu từ 0,1- 0,26 mg/100gđ và hàm lượng kali dễ tiêu từ 2,56 - 6,17 mg/100gđ. Trừ hàm lượng lân dễ tiêu, hàm lượng các đạm và kali dễ tiêu trong đất thể hiện sự khác biệt giữa vị trí sườn chân và sườn giữa. Hàm lượng các chất dinh dưỡng dễ tiêu tỷ lệ thuận với hàm lượng mùn trong đất, độ xốp, thành phần hạt sét và pH. Trong khi đó, dung trọng, thành phần hạt cát và hạt limon có mối quan hệ nghịch với hàm lượng các chất dinh dưỡng N, P, K dễ tiêu.

Từ khóa: cây Mỡ, chất dinh dưỡng dễ tiêu, độ sâu tầng đất, tính chất lý hóa học đất, Vườn quốc gia Xuân Sơn.

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