Quagga
Jurnal Pendidikan dan Biologi

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 127 - 137
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.128

Analysis of Soil Properties Variations on Various Slope Directions on the National Vegetation Ecosystem of Mount Ciremai, West Java

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APA Citation: Ismail, A. Y., Kusmana, C., Sudiana, E., Aminudin, S., & Nainggolan, M. F. (2024). Analysis of Soil Properties Variations on Various Slope Directions on the National Vegetation Ecosystem of Mount Ciremai, West Java. *Quagga: Journal of Education and Biology*, 16(2), 127-137. DOI: 10.25134/quagga.v16i2.128.

Received: 07-01-2024 Accepted: 12-04-2024 Published: 01-07-2024

Abstract: *Mount Ciremai National Park has an area of ±15,500 ha with soil characteristics at various heights and varied slope directions. This study aims to determine the characteristics of soil properties in Gunung Ciremai National Park based on slope direction and its relationship with vegetation growth. The method used in this study is a systematic sampling method based on height intervals on four slopes with depths of 0-15 cm and 16-30 cm. The results showed 1). Soil pH in all four slopes with different heights in the acid-neutral category, 2). The soil texture is classified as sandy-loam and sandy-clay loam, 3). C-organic content is classified as low-very high, 4). The content of N-Total is classified as low-high. 5). P_2O_5 content is classified as very low-low, 6). K content is classified as low-very high, 7). Ca content is low-very high, and 8). Mg content is classified as low to high. Significant correlation tests of soil physical and chemical properties are found on several parameters such as C/N ratio, K, and Mg.*

Keywords: *Classified; Correlation, Mount Ciremai; Soil; Vegetation*

1. INTRODUCTION

Mount Ciremai National Stop (TNGC) is one of the National Parks in Java Island which was assigned based on the Proclaim of the Serve of Ranger service No 424 / Menhut-II / 2004 on October 19, 2004. TNGC is found within the Kuningan Rule of West Java Territory, with an range of ±15,500 ha and an elevation of 3,087 m over sea level. This range may be a generation woodland and secured timberland region (Ismail *et al*., 2021).

Mount Ciremai National Park based on research by Ismail *et al*. (2019) grouped the area based on four slope directions, namely the west, east, south, and north slopes with dominating tree species dominated by Pinus merkusii species in the east, south and north slopes while on the western slope the dominating trees were Maesopsis eminii species. Previous research highlights the importance of understanding the characteristics of plants and ecosystems in Mount Ciremai National Park. The results of Ismail *et al.* (2019) research provide a deeper understanding of biodiversity and ecological dynamics in the region. Through the analysis of slope direction and dominating tree species, this study provides a comprehensive picture of the uniqueness and natural diversity that exists in Mount Ciremai National Park.

Java Island according to Suyana *et al*. (2022) has a high diversity of vegetation. One of the factors that affect the growth of a vegetation is soil

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(Triadiawarman, 2018). Soil characteristics or properties consisting of soil physical and chemical properties are parameters of soil fertility and vegetation growth (Lasa *et al*., 2018; Mus'af *et al*., 2021). Soil characteristics or properties consisting of soil physical and chemical properties are important parameters in determining soil fertility and optimal vegetation growth (Chen, L et al., 2019). Logical investigation has broadly considered different realities and discoveries with respect to the relationship between soil characteristics, soil richness, and vegetation development (Sharma, 2016; Zhang,2019).

Soil physical properties incorporate soil surface, soil structure, and soil porosity. Soil surface depicts the extent of soil particles such as sand, dust, and clay, which affect the soil's ability to store water and nutrients (Smith, 2022). Soil structure alludes to the course of action of soil particles in totals that shape cavities and aviation routes, influencing water waste and discuss circulation within the soil. Soil porosity decides how much water and discuss can be gotten to by plant roots (Keller, 2018).

Soil chemistry includes soil pH, supplement concentration, and cation trade capacity. Soil pH influences the accessibility of supplements to plants and the action of soil microorganisms. The concentration of supplements such as nitrogen (N), phosphorus (P), and potassium (K) is critical for solid plant development (Chen, 2021). The cation trade capacity shows the capacity of soil to store and discharge cations of supplements such as calcium, magnesium, and potassium (Garcia *et al*., 2019).

This combination of soil physical and chemical characteristics encompasses a critical part in directing the physical, chemical, and organic properties of soil. For illustration, over the topsoil surface of sand may have fast drainage, thus influencing the accessibility of water to plants. In the meantime, soil sharpness that's as well moo (tall pH) can repress the accessibility of certain nutrients (Davis *et al*., 2021). Soil characteristics in different areas and heights are exceptionally different, such as within the inquire about of Tambunan *et al*. (2018) which said that slants in the Poboya watershed of Palu City cause differing soil chemical characteristics. Additionally, the investigate of Lasa *et al*. (2018) said that the physical characteristics of soil are affected by the sort of vegetation. Based on the over conditions, it is fundamental to conduct investigate on the characteristics of soil properties in Mount Ciremai National Stop based on the heading of the slant and its relationship with vegetation development.

2. RESEARCH METHODOLOGY

The study was conducted in Gunung Ciremai National Park based on the slopes, namely west, east, south, and north (figure 1). The materials used in this study are: 1). Soil samples, 2). Plastic bags, 3). Fiber and plastic crates, 4). Labels, and 5). Chemical substances. While the tools used are: 1). Ring sample, 2). Ring collider, 3). Machetes and shovels, 4). GPS, 5). ATK, and 6). Camera.

The method used in this study is the systematic sampling method, which is systematic soil sampling based on height intervals in four slope directions. Soil sampling is carried out from a depth of 0-15 cm and 16-30 cm with soil variables measured including soil physical properties, namely soil texture, soil acidity and soil physical properties, namely microelements, Ca, Mg, pH, and C / N ratio. Then the samples that have been obtained are analyzed at the Biotropic-Bogor Laboratory.

Data on the physical and chemical properties of soil will be analyzed using the *Pearson correlation* method with the Minitab application with the aim of determining the level and type of relationship (positive and negative) from one parameter to another.

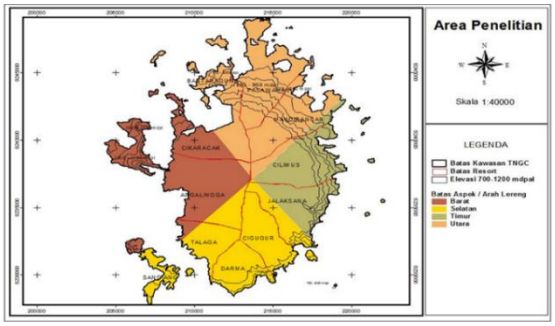

Figure 1. Map of the research location

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3. RESULTS AND DISCUSSION

Soil pH

Soil pH is one of the important parameters whether a plant can grow well or not. This is related to the availability of nutrients in the soil, where soil with an acidic pH causes nutrients, especially phosphorus, cannot be absorbed by plants because they are bound by Al. Acidic soil also indicates the presence of toxic (toxins) that can interfere with plant growth. The pH values in each slope direction at various altitudes can be seen in Table 1.

Table 1. pH value based on slope direction and altitude of place in TNGC

No	Slope direction	Altitude (m asl)	pH		Category
			15 cm	30 cm	
1	West	600	7.09	6.82	Neutral
		700	5.68	5.45	Sour
		800	6.73	6.74	Neutral
		900	5.99	5.94	Slightly Sour
		1000	6.20	6.25	Neutral
	Average		6.34	6.24	Neutral
2	South	500	6.65	6.28	Neutral
		800	6.47	6.75	Neutral
		900	6.47	6.32	Neutral
		1000	4.73	4.28	Sour
		1200	6.34	6.11	Neutral
	Average		6.13	5.95	Neutral
3	East	500	6.06	6.10	Neutral
		600	5.88	5.91	Slightly Sour
		700	5.58	5.59	Slightly Sour
		800	5.87	5.97	Slightly Sour
		900	6.21	6.22	Neutral
		1000	5.45	5.46	Slightly Sour
		1100	5.22	5.23	Slightly Sour
	Average		5.75	5.78	Slightly Sour
4	North	500	6.54	6.61	Neutral
		600	6.82	6.51	Neutral
		700	5.79	6.02	Slightly Sour
		800	6.46	6.46	Neutral
		900	4.18	5.12	Sour
		1000	6.26	6.29	Neutral
	Average		6.01	6.17	Neutral

The results of soil analysis showed that the soil pH at the study site on the four slopes with different heights was included in the acidic to neutral category (5-7). Based on our discoveries, it shows up that the nearness of pH varieties within the soil influences the condition of vegetation in Mount Ciremai National Park. Abundant natural matter within the soil includes a noteworthy affect on the retention of water within the soil. The more water contained within the soil, the more H+ particle discharge responses will be, so the soil tends to ended up acidic. On the other hand, on the off chance that the water within the soil is restricted, at that point the response of discharging H+ particles will diminish, and the soil will tend to ended up more unbiased. The affect of changes in soil pH on vegetation is exceptionally critical. Certain plants are way better suited to impartial pH conditions, whereas others are better suited to more acidic pH conditions. In this manner, varieties in soil pH at the Mount Ciremai National Stop inquire about location can influence the composition and differing qualities of vegetation within the zone.

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Ask approximately (Johnson, R. *et al*., 2017) states that a more acidic soil pH tends to reinforce the advancement of acid-tolerant plants such as rhododendrons and blueberries, whereas a more unbiased soil pH is more reasonable for plants such as oak and maple. Varieties in soil pH can too influence the accessibility of plant supplements and the action of microorganisms that play an imperative part in supplement cycling and decay of natural matter. The changing pH esteem contains a relationship with C-organic cosnetration gathered on the soil surface (Tambunan *et al*., 2018). Usually in line with Prabowo *et al*. (2018) that inexhaustible natural matter will influence the assimilation of water within the soil so that with more water within the soil the discharge of H + particles will be more copious so that the soil will get to be acidic and bad habit versa.

Soil Texture

The physical properties of the soil are important factors for the transportation of air, heat, water and dissolved materials in the soil and factors that affect the physical properties of the soil, namely soil temperature, permeability, surface flow sensitivity, erosion, and the ability to bind water supplied to plants (Suprihatin *et al*., 2018). Soil texture which is one of the physical properties of the soil in this study based on the direction of the slope and height of the place from the analysis results shows a texture that tends to vary (Table 2). The soil texture in the direction of the western and northern slopes is classified as sandy loam to loam, while in the direction of the southern and eastern slopes it is classified as a class of sandy to clayey clay texture. Sandy clay soil according to Mulyono *et al*. (2019) has inherent characteristics, rather rough, forms a rather hard ball but is easily destroyed. While clay soil is a type of soil that easily absorbs water in dry conditions with soil characterization of more clay and less sand (Arsyad et al, 2018) and clay is a type of soil that has a very small and fine particle size (Fariedah *et al*., 2018).

Soil textures that contain more sand have large pores that facilitate the process of water entering the soil (Ayuningtyas *et al*., 2018). Muasdalipa et al (2018) said that the faster the process of water entry into the soil in line with the heavier vegetation roots to minimize the occurrence of landslides (Kalembiro *et al*., 2018; Mutmainnah et al, 2021). In addition, according to Prehaten *et al*. (2018) that plant growth is influenced by soil texture, further soil texture with sand and dust content that is much compared to others makes plants grow well. The abundant content of sand and dust also has a positive effect on the availability of nutrients for plants. Sand and dust particles have the ability to store essential nutrients such as nitrogen, phosphorus, and potassium. This allows plants to access these nutrients more efficiently, thus improving plant growth and health in Mount Ciremai National Park.

Overall, this study shows that soil texture in Mount Ciremai National Park with more sand and dust content compared to other areas has a significant impact on plant growth. The presence of this sand and dust helps in good drainage, optimal air circulation, and the availability of adequate nutrients for plants. Thus, understanding the relationship between soil texture and plant growth in Mount Ciremai National Park is important to maintain the sustainability of the ecosystem in it.

Chemical properties of soil

Soil chemistry on all four slopes at various altitudes contains diverse nutrients (Table 4). The results of soil analysis show that the C-organic content of soil in each slope direction is very diverse, namely classified as medium-very high in the direction of the west and east slopes, low-high in the direction of the south slope, and low-very high in the direction of the north slope. According to Prabowo *et al*. (2018) and Mulyono *et al*. (2019) the high and low content of C-organic is influenced by vegetation, when vegetation is high, the C-organic content is high while when vegetation is low, C-organic is low. This result is in line with the research of Ismail *et al*. (2021) the number of species in forest vegetation in Mount Ciremai National Park based on the results of vegetation analysis varies greatly in various growth rates, namely at the seedling level of 1.060, the sapling rate of 1.422, the pole level of 1.298, and the tree level of 3.672 individuals/ha.

Nitrogen is an essential nutrient, which means it is needed by plants with large quantities (Sari *et al*., 2019). The N-Total soil content in the

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four slope directions shows differences ranging from the direction of the south and east slopes which are classified as low-medium, the direction of the western slope is classified as medium, and in the direction of the north slope is classified as low to high. Low N-total content is caused by the lack of organic matter contained in the soil (Tambunan *et al*., 2018). Based on the results of the Coleration Test analysis, the N-total content has a positive correlation with the C-organic content, meaning that the N-total content will be directly proportional to the C-organic content in the soil (Suyana *et al*., 2022). This positive correlation states that an increase or decrease in total N-content will be in line with an increase or decrease in C-organic content in the soil (Devi *et al*., 2019).

The P_2O_5 content on the west, east and north slopes is very low, while on the southern slopes it is very low. This shows that in general the P_20_5 content in the soil at various soil depths at the study location tends to be very low, this is suspected because the P2O5 content is transported by plants (Sari *et al*., 2019). The growth of riap and the diameter and height of this plant are influenced by the element P_2O_5 (Erizilina *et al*., 2018). This low P_2O_5content affects the ability of the soil to maintain fertility due to lack of root growth stimulation so that growth will be disrupted (Mustafa *et al*., 2022). Expanding the substance of P_2O_5can be done by planting plant sorts that develop quick and have numerous takes off (Hamid *et al*., 2017).

The K substance within the course of the slant changes from the course of the western incline classified as low-very tall, the course of the southern incline is exceptionally low-very tall, the course of the eastern slant is high-very tall, and the course of the north slant is medium-very tall. The changing K substance is thought to be due to differences in C-organic substance within the soil (Istiawan *et al*., 2019) and filtering due to sandy soil surface that has huge pores (Punuindoong *et al*., 2021). For plants, potassium could be a exceptionally vital component within the soil since it is required for physiological forms and plant root advancement (Barus et al., 2020; Syofiani *et al*, 2020).

Ca content on the western and southern slopes is low to very high, while on the eastern and northern slopes it is low-high. This is thought to be because the source of Ca in Mount Ciremai National Park does not only come from the parent rock but is carried by water that carries organic matter on the ground surface. Ca element has many uses including as one of the parameters of soil chemical fertility (Triadiawarman, 2018). Then Ca elements have a positive correlation with growth characteristics such as plant height, root diameter, leaf biomass, stems and roots, and so on (Prehaten *et al*., 2018). Ca deficiency in soil can cause inhibited cell division, namely the growth of old plants (Hardjowigeno, 2010).

The Mg content on the west, south, north slopes is low to high, while on the east slope is classified as medium to high. Arifin *et al*. (2020) said that the Mg element comes from ferro-magnesium minerals, the Mg content has a relationship with the level of soil development, namely when the leaching process gets stronger, the Mg content will be smaller. The results of chemical properties analysis show that nutrients in the soil tend to decrease along with increasing soil depth. This is in line with research (Sipahutar *et al*, 2014; Wibisono et al, 2016; and Riswanto *et al*., 2020) that nutrient content in the soil will decrease as the depth of the soil increases.

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DOI: 10.25134/quagga.v16i2.128

Table 2. Analysis of Soil Texture Properties based on slope direction and altitude in TNGC

Slope direction	Altitude (m asl)	Soil depth							
		0-15 cm				15-30 cm			
		Sand (%)	Dust (%)	Clay (%)	Texture	Sand (%)	Dust (%)	Clay (%)	Texture
West	600	63.39	26.32	10.29	Sandy loam	57.03	33.05	9.92	Sandy loam
	700	33.73	37.00	29.27	Clay clay	25.24	35.63	39.13	Clay clay
	800	50.35	31.70	17.95	Clay	47.05	33.19	19.76	Clay
	900	68.82	22.41	8.71	Sandy loam	63.12	28.36	8.52	Sandy loam
	1000	54.01	26.71	19.28	Sandy loam	47.58	26.12	26.03	Clay
South	500	20.17	18.63	61.20	Clay	26.67	32.10	41.23	Clay clay
	800	43.76	27.07	29.18	Clay clay	50.00	26.30	23.70	Sandy clay
	900	54.41	33.52	12.07	Sandy loam	57.66	32.92	9.42	Sandy loam
	1000	56.80	18.21	24.99	Sandy clay	58.86	11.78	29.36	Sandy clay
	1200	67.26	14.06	18.68	Sandy loam	66.33	16.93	16.74	Sandy loam
East	500	63.38	18.42	18.20	Sandy loam	63.13	18.54	18.33	Sandy loam
	600	1.94	42.44	55.62	Clay	4.01	31.96	64.04	clay
	700	55.19	27.60	17.21	Sandy loam	63.61	19.54	16.85	Sandy loam
	800	33.13	33.99	32.88	Clay clay	27.92	28.65	43.43	Clay clay
	900	59.81	32.63	7.56	Sandy loam	60.93	31.72	7.35	Sandy loam
	1000	52.50	35.17	12.33	Clay	52.91	29.98	17.11	Clay
	1100	47.01	35.89	17.10	Clay	56.96	28.99	14.05	Sandy loam
North	500	64.70	18.11	17.19	Sandy loam	59.44	23.29	17.27	Sandy loam
	600	53.12	29.72	17.16	Clay	45.75	42.11	12.14	Clay
	700	38.88	47.52	19.25	Clay	38.97	44.76	20.02	Clay
	800	46.08	41.85	12.07	Clay	60.45	22.41	17.14	Sandy loam
	900	58.11	25.12	16.77	Sandy loam	51.40	32.07	17.30	Clay
	1000	68.43	15.88	15.69	Sandy loam	67.99	16.10	15.91	Sandy loam

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Table 3. Analysis of Soil Physical Properties based on slope direction and altitude in TNGC

Slove direction	Altitude (m asl)	C-organik (%)*		N Total (%)*		P_2O_5 (ppm)*		K (cmol(+)/kg)*		C/N ratio*		Ca (cmol(+)/kg)*		Mg (cmol(+)/kg)*	
		15	30	15	30	15	30	15	30	15	30	15	30	15	30
West	600	2.55	2.53	0.26	0.24	3.2	2.24	0.85	0.91	10.83	10.5	20.24	22.06	6.76	6.81
	700	2.45	2.5	0.25	0.25	2.5	2.39	1.13	1.08	9.86	10.29	3.89	4.26	1.74	1.64
	800	3.5	2.38	0.41	0.35	2.1	1.51	1.54	0.61	8.68	6.15	15.05	13.14	3.1	2.88
	900	2.54	2.19	0.26	0.28	1.9	2.2	0.98	0.86	9.88	8.15	5.38	4.31	1.79	1.39
	1000	6.2	6.25	0.48	0.4	1.2	0.81	0.19	0.12	11.29	11.51	4.06	2.49	1.04	0.43
South	500	4.22	2.79	0.38	0.26	0.7	0.62	0.17	0.16	11.09	19.94	4.46	5.43	2.04	1.79
	800	3.45	2.05	0.32	0.23	4.5	3.23	2.63	1.81	11.04	8.6	12.82	6.57	4.38	3.51
	900	2.26	1.88	0.22	0.22	1.6	2.07	0.95	0.54	8.69	10.81	10.53	8.99	2.39	2.41
	1000	2.66	1.66	0.28	0.23	1.4	0.5	0.5	0.47	11.22	7.42	8.45	5.45	0.66	2.14
	1200	1.62	2.5	0.18	0.27	0.2	1.71	0.2	0.09	9.35	9.71	3.82	2.32	1.81	1.16
East	500	2.98	3	0.3	0.3	3.1	3.1	1.93	2.03	10.08	10	13.58	6.11	2	2.14
	600	2.78	2.93	0.28	0.3	2.8	3	1.65	1.84	9.91	9.93	5.68	5.71	2.18	2.22
	700	2.71	2.81	0.26	0.28	3.6	3.8	1.25	1.38	10.36	10.16	5.16	5.17	2.07	2.03
	800	2.86	2.23	0.27	0.21	1.6	1.45	1.57	1.24	10.55	10.96	7.54	5.33	2.49	1.97
	900	4.59	3.51	0.49	0.38	1.8	1.09	1.14	0.79	9.42	9.3	10.48	8.34	2.98	2.4
	1000	2.5	2.51	0.25	0.26	2.7	2.8	1.24	1.23	10.07	9.76	5.17	5.2	2.18	2.16
	1100	2.2	2.21	0.21	0.21	2.2	2.2	1.43	1.51	10.48	10.78	5.23	5.3	2.18	2.17
North	500	1.84	2.15	0.2	0.2	2.2	2.32	2.05	1.37	9.7	11.06	9.7	8.88	2.98	3.06
	600	5.59	4.24	0.53	0.4	3	3.02	1.57	1.04	10.46	10.84	14.44	9	4	2.36
	700	2.29	2.34	0.23	0.25	2.4	2.36	2.25	2.36	10.04	10.24	10.49	10.4	3.37	3.09

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800	2.04	2.2	0.19	0.2	2.6	4.2	0.95	0.8	10.62	11.16	9.34	9.67	2.27	2.31
900	2.18	2.18	0.2	0.21	2.8	2.84	1.37	1.35	6.44	10.35	5.45	5.19	1.69	1.74
1000	2.2	5.71	0.63	0.57	1.7	1.87	0.55	0.51	5.98	6.15	6.93	5.49	1.26	1.27

Notes : C-Organic = (Very Low <1.00%), (Low 1.00-2.00%), (Medium 2.01-3.00%), (High 3.01-5.00%), (Very High >5.00%); N Total = (Very Low <0.10), (Low 0.10-0.20%), (Medium 0.21-0.50%), (High 0.51-0.75%), (Very High >0.75%); P_2O_5 ppm = (Very Low <10%), (Low 10-15%), (Medium 16-25%), (High 26-35%), (Very High >35%); K= (Very Low <0.1%), (Low 0.1-0.2%), (Medium 0.3-0.5%), (High 0.6-1.0%), (Very High >1.0%); C/N ratio = (Very Low <5%), (Low 5-10%), (Medium 11-15%), (High 16-25%), (Very High >25%); Ca = (Very Low <2%), (Low 2-5%), (Medium 6-10%), (High 11-20%), (Very High >20%); Mg = (Very Low <0.4%), (Low 0.4-1.0%), (Medium 1.1-2.0%), (High 2.1-8.0%), (Very High >8.0%) .

Table 4. Correlation Analysis of Physical and Chemical Properties of Soil

Parameter	Soil pH	C-organic	N Total	P2O5	K	C/N Ratio	Ca
C-organic	0.560						
N Total	0.514	0.869					
P2O5-P2O1	-0.394	0.275	0.561				
K	-0.654	0.024	0.286	**0.952***			
C/N Ratio	-0.354	-0.753	**-0.974***	-0.717	-0.470		
Ca	0.858	0.832	0.882	0.118	-0.190	-0.777	
Mg	0.858	0.906	0.801	-0.031	-0.320	-0.647	**0.953***

Note : *Significant (p<0.05)

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Jurnal Pendidikan dan Biologi

p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 127 - 137
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.128

The condition of the physical and chemical properties of the soil in Mount Ciremai of National Park varies from 4 slopes, namely west. South. east. and north. Physical properties of the soil include soil pH which shows slightly acidic to neutral conditions. Then the soil texture is classified as clay. sandy clay. and sandy loam. Then the chemical properties of the soil consisting of soil micronutrients with varying levels. C-organic content is classified as medium to high. Total N is classified as medium. P_2O_5 is very low. K is classified as high to very high. C/N is low to medium. Ca is classified as medium. and Mg which is classified as high. Analysis of the correlation test of physical and chemical properties of soil shows that several parameters have a significant correlation relationship (Table 4).

The C/N ratio and Total N parameters show a negative correlation of -0.947. Conditions in the field show that the C/N ratio value is low and the total N is moderate. This indicates that the high content of total N unusr will be followed by the low content of C/N. This low C/N ratio indicates that the abundance of vegetation growing in Mount Ciremai of National Park will increase microbial activity to decompose organic matter. Vegetation conditions are dominated by tree level with a total of 3,672 individuals. It was followed by a pole of 1,298 individuals. saplings 1,422 individuals and seedlings 1,060 individuals (Ismail *et al*., 2021).

Furthermore, parameters K and P_2O_5 show a positive correlation with a value of 0.952. The K content analyzed is very high, while the P_2O_5 content is very low. Applying fertilizer will increase these two elements. Research by pasang *et al* (2019) shows low P and K elements in the soil When applied fertilizer will increase the content of these elements. The next parameter is that the Ca element correlates positively with the Mg element with a value of 0.953. The abundance of usnur Ca and Mg in Mount Ciremai of National Park is classified as medium and high. When the high content of Ca will be followed by a high content of Mg (Castan *et al*, 2016).

4. CONCLUSION

The characeristic of soil physical properties in Mount of Ciremai Naional Park are soil pH in various slope directions with different heigh in the acid-neutral category and soil texture clasified as sandy-loam and sandy-clay loam.

The chemical properties of the soil are categorized as follows: low-very high for the C-organic content; low-high for the N-total content; very low-low for the P2O5-P2O1 content; low-very high for the K content; low-very high for the Ca content; and low-high for the Mg content.

5. ACKNOWLEDGEMEN

Auhor wihing o acknowledge uppor and encouragemen from the Kuningan Univeriy. for all he uppor and ponored he udy.

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p-ISSN 1907-3089, e-ISSN 2615-5869
Vol 16, No. 2, 2024, pp 127 - 137
Available online https://journal.fkip.uniku.ac.id/quagga/index
DOI: 10.25134/quagga.v16i2.128

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