SOIL CHARACTERISTICS IN THE RHIZOSPHERE AND ITS RELATIONSHIP WITH THE GROWTH OF THE CAMPHOR TREES IN SIRANDORUNG SUBDISTRICT, TAPANULI TENGAH DISTRICT

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ABSTRACT

The studied to evaluate soil characteristics in the rhizosphere and its relationship with the growth of Camphor Trees (Dryobalanops aromatica) which was carried out from April to June 2018 in Siordang Village, Sirandorung Sub District, Tapanuli Tengah. The research was funded by the Direktorat Riset dan Pengabdian Masyarakat Direktorat Jenderal Penguatan Riset dan Pengembangan Kementerian Riset, Teknologi dan Pendidkan Tinggi, fiscal year 2018. The study used a survey method with the determination and sampling of land carried out intentionally (purposive sampling), namely on the soil in the root area (rhizosphere) of camphor trees that still exist, maintained by residents in the arable land, as many as 30 observation points. The results showed that the mean value of soil pH in rhizosphere of camphor trees was 4.08 classified as very acidic, C-organic content and N-total soil content of 2.20% and 0.31% were classified as moderate, while nutrient content P-total (mean 0.04%) and K-exchange able (mean 0.25 me/100g) are low and levels of Ca, Mg and Na can be classified as very low. Although the value of the CEC was high (mean 27.39 me/100g), but the saturation of the base was very low (mean only 2.95%). The soil texture of mothballs is sandy clay loam and the soil is generally loose with a mean bulk density of 0.89 g/cm3. The Regression test results showed that both simple regression and multiple regression between soil characteristics with diameter of camphor tree did not significant, but on tree height, some parameters showed a significant.

Keywords: camphor tree, soil characteristics, Tapanuli Tengah.

A. PRELIMINARY

Camphor trees (Dryobalanops aromatica or Dryobalanops camphora Colebr.) are one type of plant from the Dipterocarpaceae group which has several advantages because from one tree stem can be produced a variety of high economic value commodities such as camphor, balsam, resin, essential oils, and wood. The presence of camphor trees at this time according to the International Union for the Conservation of Nature and Natural Resources (IUCN) is red list or in conservation status including Critically Endangered (critical). This status is a state of threat with the highest level before the status becomes extinct (Prasetyo, 2013).

The habitats of camphor tree were widely found in mixed Dipterocarpaceae forests that are up to 300 meters above sea level, on hill slopes, and in the sandy soil textured mountains. Distribution of these rare plants starts from the Malay peninsula, Sumatra, to Borneo (Sarawak, Brunei, Sabah and East Kalimantan). Several regions in Indonesia, including limestone trees distribution areas, are in the western part of the Singkil region, the Natal river, between Sibolga and Padang Sidempuan to Aerbangis and in the eastern part starting from the south of the Rokan river to the north of Batanghari. To the east it can be found in the Riau islands including the Bengkalis and Malacca regions, to the west on the island of Morsala, but this tree is not found on the islands of Simalur, Nias and the Batu islands (Heyne, 1988).

Dryobalanops camphora or Dryobalanops aromatica (camphor tree) as a member of the Dipterocarpaceae group, has several morphological features that are easily recognized by ordinary people. Among the main characters of the limestone tree is a large tree with a stem diameter ranging from 70 cm or more and can reach 62 m or more in height. The stems are erect, straight, round, there is a resin, with a brown bark and are increasingly in the reddish brown color. Single leaf, interspersed, glossy strand surface, flat leaf edge, tight pinnate leaf reinforcement, has a 7 mm stipule on the side of the leaf armpit, if the leaves are squeezed it will give off a strong scent. Bisexual flowers, measuring 5 mm, are white, in short panicles. Nut-shaped fruit, yellow-red-purple, with five wings that come from the base of the petals, 50 mm wing length so that it can be carried away by the wind (Prasetyo, 2013).

The camphor tree (Dryobalanops aromatica) in North Sumatra is attached to the name Barus to Barus Camphor Tree because its habitat is widely found in the Barus region known since the 2nd century AD. Barus is a subdistrict area in Central Tapanuli, North Sumatra, which since the 2nd century AD has been known by the Greeks as a Commercial Airport named Baraosai that produces fragrances or kamfer. From the 4th to the 10th centuries AD Barus became the center of the world's competitive commodity trading. Merchants from China to the Mediterranean region

include Indochina, Southeast Asia, India, Persia, the Middle East, and even Africa has come to Barus. Historical records say that camphor has become a very important item that is able to attract the attention of many Europeans and the Middle East to Barus (Prasetyo, 2013).

As a result of the high price and demand of kamfer at that time, and the limited knowledge of the community that not always inside the limestone tree trunks can be found camellia crystals (camphor), triggering the intensity of cutting high camphor trees. In addition, illegal logging and forest fires also contributed to the drastic decline of the camphor tree population. As a result, camphor trees are increasingly scarce in their habitat, moreover based on data from the Central Bureau of Statistics (BPS) (2013), it can be seen that the total round wood production by Forest Concession Companies from 2004-2011 for limestone species is still high at 2,528,548 m3, with the total amount of production value still relatively above kruwing wood type (2,416,511 m3), and the production trend dropped dramatically in 2011, which was only 209,287 m3 (BPS, 2013). This data means that the presence of limestone trees in Indonesia is getting worse day by day.

The relatively slow growth factor of Dipterocarpaceae members and the rare and simultaneous fertilization phase, pushing the Dipterocarpaceae forests (especially camphor trees) that are unique and susceptible to uncontrolled exploitation causes these camphor trees to become increasingly scarce. For this reason, a study is needed to identify and inventory the remaining camphor trees (Dryobalanops aromatica) and improve product quality and marketing prospects. One of the stages of the research is to study soil characteristics in the root zone (rhizosphere) and its relationship to the growth of camphor trees in Sirandorung Subdistrict Tapanuli Tengah District North Sumatra. This research was funded by the Direktorat Riset dan Pengabdian Masyarakat Ditjen Penguatan Riset dan Pengembangan Kementerian Riset, Teknologi, dan Pendidikan Tinggi, fiscal year 2018.

B. MATERIALS AND METHODS

The study began with seeking information from various parties regarding the presence of camphor trees in the Barus region of Central Tapanuli Regency and its surroundings. Based on information from the Office of Forest Management Unit (KPH) Region XI Sibolga, one family in Siordang Village, Sirandorung Sub-district (an expansion district of Barus District) in North Tapanuli District named Jalungun Silaban still maintains camphor trees and other economic value trees such as meranti rengas, jelutung, and others and interspersed with rubber trees in the land they cultivate by letting them grow to resemble a forest system. One observation point is at coordinates N 02º04'21,67 "E 98º21'33,16". Observations carried out on 30 sample trees included measurements of tree height and trunk circumference at chest level, as well as soil morphological observations and soil sampling in the rooting zone (rhizosphere) to obtain data on the characteristics of the soil.

C. RESULTS AND DISCUSSION

The study of soil characteristics in the root zone (rhizosphere) (rhizosphere) and its relationship to the growth of camphor trees in Sirandorung District, Central Tapanuli Regency, obtained field observations in the form of tree height, windings and chest diameter of 30 trees (samples) observed as presented in Table 1.

From Table 1, it can be seen that camphor trees found on the land owned by the Jalungun Silaban family in Siordang Village, Sirandorung Subdistrict, Central Tapanuli Regency are at elevation (altitude) between 34-52 meters above sea level, on land with a slope of 3% (flat) to 20% (rather steep) with an average chest circumference of 149.6 cm or ranging from 115-226 cm and trunk diameter at breast height of 47.64 cm (ranging from 39.49 to 71.97 cm). The height of camphor trees varies between 35-50 meters with an average height of about 41.17 meters.

Table 1. Field observations of 30 samples of camphor trees in Siordang Village, Sirandorung District, Central Tapanuli Regency.

Sample	Coordinate Point	Elevation (mdpl)	Slope (%)	Trunk Circum-ference (cm)*	Stem Diameter (cm) *	Tree Height (m)
1	N 02º04’21,67”; E 98º21’33,16”	36	8	226	71.97	35
2	N 02º04’17,43”; E 98º21’31,57”	34	8	189	60.19	40
3	-	-	8	165	52.55	40
4	N 02º04’19,64”; E 98º21’30,96”	41	10	164	52.23	35
5	-	-	10	124	39.50	35
6	-	-	10	126	40.13	35
7	N 02º04’20,05”; E 98º21’30,32”	43	10	128	40.76	35

8	-	-	10	132	42.04	35
9	-	-	10	122	38.85	35
10	-	-	10	143	45.54	40
11	-	-	10	124	39.49	40
12	-	-	8	142	45.22	40
13	-	-	8	145	46.18	40
14	-	-	8	154	49.04	40
15	-	-	8	164	52.23	40
16	-	-	8	152	48.41	40
17	N 02º04’20,10”; E 98º21’28,76”	39	8	115	36.62	40
18	-	-	3	145	46.18	40
19	-	-	3	146	46.50	40
20	N 02º04’20,06”; E 98º21’28,51”	44	3	145	46.18	40
21	-	-	3	148	47.13	40
22	N 02º04’21,01”; E 98º21’28,28”	45	15	145	46.18	50
23	-	-	15	142	45.22	50
24	-	-	15	152	48.41	50
25	-	-	15	150	47.77	50
26	-	-	15	152	48.41	50
27	N 02º04’21,47”; E 98º21’31,64”	52	17	180	57.32	40
28	-	-	20	161	51.27	40
29	-	-	15	152	48.41	50
30	-	-	20	155	49.36	50
Average				149.60	47.64	41.17

Description: *) stem circumference and diameter at breast height.

The presence of camphor trees in Siordang Village, Sirandorung Subdistrict, Central Tapanuli Regency at an altitude of 34-52 m.dpl is in accordance with Heyne's (1988) report which states that camphor trees grow well at altitudes of up to 300 m.dpl, while the stem diameter range is 39, 49-71.97 cm and the height range of the tree between 35-50 meters is in accordance with the results of Prasetyo's study (2013) which found that the diameter of camphor stem around 70 cm and the height of the tree can reach 62 m. Some soil properties in the root zone (rhizosphere) (rhizosphere) of 30 samples of camphor trees are presented in Table 2 to Table 4.

Table 2. Soil organic characteristics in the root zone (rhizosphere) (rhizosphere) of 30 samples of camphor trees in Siordang Village, Sirandorung Subdistrict Tapanuli Tengah Regency

Sample	Soil Organic Character			
	C-organic (%)	N-Total (%)	C/N Ratio	P-Total (%)
1	2.38	0.25	9.55	0.05
2	2.73	0.31	8.71	0.05
3	2.10	0.32	6.49	0.03
4	1.76	0.29	6.03	0.03
5	2.11	0.30	7.14	0.04
6	2.35	0.38	6.22	0.03
7	2.63	0.36	7.23	0.03
8	1.98	0.31	6.34	0.04
9	1.83	0.33	5.50	0.05
10	1.55	0.33	4.69	0.03
11	2.45	0.28	8.83	0.03
12	1.74	0.23	7.55	0.03
13	2.59	0.32	8.18	0.03
14	2.52	0.32	7.94	0.03

15	1.94	0.36	5.36	0.03
16	2.56	0.22	11.46	0.04
17	2.22	0.29	7.60	0.02
18	2.44	0.30	8.20	0.02
19	1.49	0.34	4.40	0.03
20	1.87	0.38	4.93	0.03
21	1.45	0.41	3.50	0.04
22	2.96	0.36	8.26	0.03
23	2.08	0.29	7.24	0.03
24	1.62	0.38	4.27	0.10
25	2.80	0.29	9.79	0.07
26	2.31	0.25	9.23	0.10
27	2.41	0.34	7.10	0.04
28	2.25	0.28	7.95	0.05
29	2.86	0.30	9.53	0.05
30	2.05	0.28	7.29	0.04
Average	**2.20 (M)**	**0.31 (M)**	**7.23 (L)**	**0.04 (L)**

Description: M = Medium; L = Low.

From Table 2 it can be seen that soil organic characteristics in the root zone (rhizosphere) of camphor trees are classified as good which are characterized by moderate levels of C-organic and N-total soil, although the total P is low. While the low C / N ratio indicates that the soil around the roots of camphor trees has been completely decomposed or there is no excessive accumulation of fresh litter.

Table 3. Chemical characteristics and soil exchange bases in the root zone (rhizosphere) of 30 samples of camphor trees in Siordang Village, Kec. Sirandorung Kabupaten Tapanuli Tengah

Sample	Soil Chemistry and Exchange Bases						
	pH	CEC (me/100g)	Base Saturations (%)	K-exch. (me/100g)	Ca-exch. (me/100g)	Mg-exch. (me/100g)	Na-exch. (me/100g)
1	4.4	22.26	3.19	0.23	0.21	0.21	0.06
2	4.4	17.70	4.39	0.30	0.16	0.26	0.06
3	4.4	29.84	2.55	0.27	0.16	0.28	0.06
4	4.3	13.64	3.77	0.17	0.11	0.16	0.07
5	4.2	20.93	4.22	0.28	0.28	0.27	0.05
6	4.2	20.89	3.21	0.22	0.19	0.20	0.06
7	4.2	17.60	3.45	0.20	0.18	0.18	0.06
8	4.1	17.14	4.09	0.17	0.21	0.25	0.06
9	4.2	33.94	2.09	0.24	0.19	0.21	0.06
10	4.2	33.77	2.41	0.16	0.30	0.31	0.05
11	4.2	32.80	1.95	0.22	0.16	0.19	0.07
12	4.2	33.51	1.67	0.17	0.15	0.18	0.05
13	4.0	19.02	3.34	0.19	0.18	0.20	0.06
14	4.0	21.12	3.31	0.22	0.20	0.20	0.07
15	4.0	22.23	3.62	0.21	0.28	0.26	0.05
16	3.9	16.39	4.85	0.26	0.22	0.25	0.06
17	4.0	23.57	2.40	0.18	0.16	0.17	0.05
18	4.0	28.36	3.38	0.35	0.26	0.27	0.08
19	4.0	25.56	3.43	0.31	0.23	0.27	0.07
20	3.9	42.14	2.11	0.37	0.21	0.26	0.05
21	4.3	42.03	3.87	0.48	0.50	0.59	0.05
22	4.1	41.40	1.95	0.22	0.30	0.24	0.05
23	4.1	35.75	2.73	0.40	0.21	0.32	0.05
24	4.1	37.77	2.18	0.25	0.23	0.29	0.05
25	4.0	20.66	2.89	0.18	0.18	0.18	0.05
26	4.0	27.53	2.50	0.24	0.20	0.21	0.04
27	4.0	32.55	2.00	0.19	0.18	0.25	0.03
28	3.8	21.82	2.84	0.22	0.17	0.19	0.04
29	3.8	32.20	2.25	0.29	0.21	0.19	0.04
30	3.8	37.56	1.74	0.21	0.20	0.21	0.04
Average	**4.08 (VA)**	**27.39 (H)**	**2.95 (VL)**	**0.25 (L)**	**0.22 (VL)**	**0.24 (VL)**	**0.06 (VL)**

Description: VA = Very Acid; H = Height; VL = Very Low; L = Low.

From Table 3, it can be seen that the reaction (pH) of the roots zone of camphor trees is very acidic (pH <4.5) followed by exchange bases which are generally very low (VA), except K-can exchange which is relatively low (L). Generally very low exchange bases cause the base saturation (BS) to be very low, even though the cations exchange capacity (CEC) is high. In this case, it can be said that many cations are absorbed and exchanged in the soil adsorption complex in the root zone (rhizosphere) of camphor dominated by hydrogen cations (H +)

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Table 4. Soil physics characteristics in the root zone (rhizosphere) of 30 samples of camphor trees in Siordang Village, Sirandorung Subdistrict, Central Tapanuli Regency

Sampel	Soil Physics Characteristics			
	Sand (%)	Silt (%)	Clay (%)	Bulk Density (g/cm^3)
1	64.08	17.95	17.97	0.95
2	63.84	21.69	14.47	1.01
3	49.99	25.00	25.01	0.8
4	57.40	21.29	21.30	0.99
5	60.69	17.86	21.45	0.9
6	46.16	17.94	35.90	0.99
7	56.69	21.65	21.66	0.96
8	53.66	21.38	24.96	0.99
9	64.46	21.32	14.22	0.69
10	46.97	24.74	28.29	1.04
11	64.03	14.38	21.59	0.83
12	53.87	17.74	28.39	0.96
13	49.51	28.84	21.64	0.71
14	56.78	21.60	21.61	0.89
15	53.70	21.36	24.94	0.90
16	53.15	21.62	25.23	0.88
17	60.61	14.32	25.07	0.88
18	46.06	25.17	28.77	0.87
19	54.09	24.71	21.19	0.85
20	53.76	24.89	21.35	0.85
21	50.60	21.17	28.23	0.90
22	41.89	25.42	32.69	0.87
23	42.86	35.70	21.43	0.9
24	50.44	21.24	28.33	0.84
25	56.55	21.72	21.73	0.88
26	49.78	21.52	28.70	0.87
27	42.50	28.74	28.76	0.85
28	49.84	28.66	21.50	0.90
29	42.00	28.99	29.01	0.88
30	42.90	35.68	21.42	0.87
Average	**52.63**	**23.14**	**24.23**	**0.89 (L)**
Texture	**Sandy Clay Loam**			

Description: L = Low.

From Table 4 it can be seen that the soil in the root zone (rhizosphere) of camphor trees is dominated by sand fraction reaching 52.63% which causes the soil texture to be rough, namely sandy clay (sandy clay loam). As a result, the bulk density (BD) value becomes low (mean 0.89 g / cm3) which illustrates that the soil in the root zone (rhizosphere) of camphor trees in Siordang Village, Sirandorung Subdistrict, Central Tapanuli Regency is relatively loose. This is in accordance with the opinion of Heyne (1988) which states that the habitat of camphor trees was widely found in mixed Dipterocarpaceae forests that have altitudes up to 300 meters above sea level, on hill slopes, and in the mountains with sandy soil texture.

Furthermore, the relationship between soil characteristics with stem diameter and height of Barus camphor trees is presented in Tables 5 and 6.

Table 5. Relationship between diameter of camphor trees (cm) with all characteristics of soil characteristics in the root zone (rhizosphere).

Parameter	Regression Model	R	Sig.	α : 0.05
pH	Y = 13.77 + 8.28X	0.203	0.281	ns
C-org. (%)	Y = 42.68 + 2.26X	0.135	0.476	ns
N-Total (%)	Y = 56,68 - 28.83X	0.189	0.317	ns
P-Total (%)	Y = 44.38 + 80.27X	0.221	0.241	ns
KTK (me/100g)	Y = 50.28 - 0.096X	0.116	0.542	ns

K-exch. (me/100g)	Y = 46.99 + 2.63X	0.028	0.882	ns
Ca-exch. (me/100g)	Y = 49.02 - 6.44X	0.065	0.735	ns
Mg-exch. (me/100g)	Y = 46.76 + 3.66X	0.041	0.829	ns
Na-exch (me/100g)	Y = 51.49 - 70.34X	0.111	0.559	ns
BS (%)	Y = 43.54 + 143.06X	0.176	0.353	ns
Sand (%)	Y = 46.63 + .019X	0.019	0.920	ns
Silt (%)	Y = 41.88 + 0.249X	0.182	0.335	ns
Clay (%)	Y = 55.32 - 0.317X	0.220	0.243	ns
BD (g/cm^3)	Y = 42.61 + 5.776X	0.124	0.516	ns
C-org; N-Total; P-total	$Y = 47.98 + 1.62X_1 - 22.16X_2 + 74.79\ X_3$	0.293	0.497	ns
pH; CEC; BS	$Y = 16.35 + 7.05X_1 - 0.017X_2 + 100.86X_3$	0.244	0.655	ns
K, Ca, Mg, Na (exch.)	$Y = 52.68 - 2.55X_1 - 41.04X_2 + 36.01X_3 - 79.07X_4$	0.237	0.826	ns

Description: ns = not significant.

From Table 5 it can be seen that the relationship between the diameter of camphor tree trunks in Siordang Village, Sirandorung Subdistrict, Central Tapanuli Regency with soil properties in the root zone (rhizosphere), both in the form of simple regression and multiple regression, all are not significant (ns). However, it can be seen that some soil properties show a relationship that is inversely proportional to the diameter of the stem, namely by N-total, cation exchange capacity (CEC), Ca-dd, Na-dd and clay fractions. While the nature of the soil which is directly proportional to the diameter of camphor tree trunks in this area is with soil pH, organic C, total P, K-dd, Mg-dd, base saturation (KB), sand and dust fraction and soil bulk density (BD).

Against the height of camphor trees in Siordang Village, Sirandorung Subdistrict, North Tapanuli Regency, several soil characteristics parameters have significant relationships including pH, P-total, cation exchange capacity (CEC), Na-exchangeable, base saturation (KB), sand and dust fraction, also multiple regression characteristics of organic materials and exchange bases (Table 6). From Table 6 it can also be seen that the levels of C, N, P, K, Ca, Mg, clay fractions and soil bulk density did not significantly relationship with tree height. Likewise, multiple regression of soil chemical properties (pH, CEC and KB) which does not significantly affect the height of camphor trees.

Table 6. Relationship between camphor tree height (m) with all soil characteristics parameters in the root zone (rhizosphere) (rhizosphere).

Parameter	Regression Model	R	Sig.	α : 0.05
pH	Y = 99.64 – 14.29X	0.458	0.010	*
C-org. (%)	Y = 34.88 + 2.85X	0.223	0.236	ns
N-Total (%)	Y = 44.07 – 9.28X	0.079	0.677	ns
P-Total (%)	Y = 35.79 + 132.26X	0.476	0.008	*
KTK (me/100g)	Y = 32.69 + 0.31X	0.487	0.006	*
K-exch. (me/100g)	Y = 38.58 + 10.49X	0.147	0.438	ns
Ca-exch. (me/100g)	Y = 39.73 + 6.72X	0.088	0.664	ns
Mg-exch. (me/100g)	Y = 40.44 + 3.01X	0.044	0.817	ns
Na-exch (me/100g)	Y = 53.70 - 229.32X	0.473	0.008	*
BS (%)	Y = 48.56 - 257.76X	0.414	0.023	*
Sand (%)	Y = 63.25 - 0.42X	0.546	0.002	*
Silt (%)	Y = 29.18 + 0.52X	0.496	0.005	*
Clay (%)	Y = 34.19 + 0.29X	0.261	0.163	ns
BD (g/cm^3)	Y = 43.54 - 2.72X	0.076	0.690	ns
C-org; N-Total; P-total	$Y = 28.745 + 2.85X_1 + 2.49X_2 + 132.10X_3$	0.523	0.037	*
pH; CEC; BS	$Y = 51.31 + 22.14X_1 - 0.052X_2 + 316.47X_3$	0.243	0.655	ns
K, Ca, Mg, Na (exch.)	$Y = 52.02 + 29.94X_1 + 15.32X_2 - 32.31X_3 - 250.79X_4$	0.550	0.053	*

Description: ns = not significant; * = significant at α: 0.05

Some parameters have an inversely proportional relationship to the height of camphor trees, such as soil pH, soil N-total content, Na-exchangeable, base saturation, sand fraction, and soil bulk density (BD) (Table 6).

D. CONCLUSION DAS SUGGESTIONS

Conclusion

The camphor trees in Siordang Village, Sirandorung Subdistrict, North Tapanuli Regency grow well at altitudes between 34-52 meters above sea level, with a slope of 3-20%, sandy soil texture, very acidic soil pH, P content and exchange bases and very low base saturation and moderate C-organic and N-total content.

Suggestion

The existence of camphor trees in the Barus District of North Tapanuli Regency and its surroundings needs to be maintained and preserved with various efforts including the construction of artificial forests (arboretum) or conservation forests with the main commodities camphor or mixed trees from the Dipterocarpaceae group which

has many advantages, both from forest products not wood (NTFPs) or wood products.

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