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The Condition of *Uncaria gambir* Roxb. as One of Important Medicinal Plants in North Sumatra Indonesia

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Abstract

Uncaria gambir Roxb. (Gambier), a well known Southeast Asian plant, is one of the important plants in North Sumatera. The aim of this study was to evaluate a production of Gambier plant cultivated in critical land in Pakpak Bharat Regency, North Sumatra Province, since January to October 2013. Descriptive analysis was used to evaluate the progress of Gambier plant growth in relation with the status of soil and chemical substances in land. The study took 12 points of sampling to composite four replicates with the depth of (0 to 20) cm and (40 to 60) cm. Providing of dolomite to raise the pH of the soil has not been done because the pH of the soil is still suitable for the growth and production of Gambier. The interchangeable of K content which belongs from the moderate to high on the top layer and low in the bottom layer. Providing phosphate, Ca, and Mg fertiliziersis absolutely necessary because the P-levels are available, although P-total as well as the levels of Ca and Mg can be exchanged into very low.

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Keywords: Critical land; cultivation; medicinal plants; rehabilitation; *Uncaria gambir* Roxb.

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Nomenclature			
a.s.l.	above sea level	**m**	meter
SOP	Standard Operational Procedure	**cm**	centimeter
		mm	millimeter
		km	kilometer
		g	gram
		kg	kilogram
		mo	month
		wk	week
		yr	year
		ha	hectare

1. Introduction

Uncaria gambir Roxb. (Gambier) is a member of the *Rubiaceae* family and contains an officially recognized pharmacological compound[1]. *Uncaria gambir* Roxb. is one of the commodities of industrial plants which has high economic value as well as a good prospect for farmers and suppliers of foreign countries. In Indonesia, *Uncaria gambir* Roxb. is commonly used as component for thomsoniae, which in its development, Gambier oftenly used for mixed medications, such as burns, headaches, diarrhea, dysentery, gargles, canker sores, sore skin, to smooth the process of digestion in the stomach and intestines, tanners and textile dyes[2,3]. Currently, Gambier is developed to be used as the main raw material for plywood and particle board, also created as a tea bag material and refreshing beverages such as juice and other food[4].

The main producing area of Gambier in Indonesia are Central and Southern Sumatra, and commonly known as West and South Sumatra Regency[5]. Gambier is generally cultivated on land with an altitude from 650 m to 800 m a.s.l. with a flat to topographical hillside. Usually, the Gambier plant is found as a crop plantation in the yard or garden on the edge of the forest. The cultivation is usually semi intensive, rarely given the fertilizer, but cleaning up and pruning remain implemented.

In these areas of production center, planting of Gambier is generally done on land that is surging up the hill with a very simple management. The appearance of the plants at glanze is no similar each other, there are advanced 50 years old plants. Some Gambier are newly planted, as well as the morphology of the plants that shapes shrubs and climbing slightly with permanent stand, because only the shoots are harvested, and can be utilized to sustain Gambier plant. With a distance of planting line and arranged in such a way and following the contour lines can play the role of surface runoffand erosion control which in turn can act as plant rehabilitation[6].

Furthermore, as well in West Sumatra, Gambier is also widely developed in North Sumatra[3,7]. The producer of Gambier in North Sumatra is North Tapanuli Regency, Central Tapanuli Regency, Deli Serdang Regency and Pakpak Bharat Regency. In Pakpak Bharat, Gambier is one of the leading commodities after coffee, patchouli and incense. Gambier in Pakpak Bharat is most or even almost entirely developed on hills and sloping land. Gambier plantation area in Pakpak Bharat in 2009, which is entirely a plantation, of 700 ha with production reaching 400 000 $kg \cdot yr^{-1}$[8].

In 2012, the government of Pakpak Bharat Regency had opened over 100 ha cultivation of Gambier plantation, starting from December 2012 to March 2013. The location was at Penanggalan Mbinangaboang Village, Salak Sub District. The plantation of Gambier in Pakpak Bharat was prepared to become one of the companies in the area of Pakpak Bharat, opened in a critical area (abandoned land), and as a model and pilot project for farmer to support the effort of rehabilitating critical land and modernizing the techniques of cultivation.

2. Materials and methods

This research was carried out by descriptive observation of nutrient status and other soil chemical substances as well as Gambier plant growth planted simultaneously at the department of agriculture and Gambier plantations-UPT Pakpak Bharat in the of Mbinangaboang Village, Salak Sub-District since January 1995 to December 2013.

The land used was a critical area of dry land of 100 ha and its vegetation was dominated by reeds (*Imperata cylindrica*) (Fig. 1). Tractors were utilized on tillage and seeds were planted with planting distance of 2 m × 2.5 m with rows of parallel contour plant. Treatment of the plants in the first 3 mo was started with planting to clearing the weeds around the circular base of the stem to form a dish of around 15 cm to 20 cm from the base of the stem. After 4 mo, old plants and weeds at the base of the stem and land were controlled by means of in-stream use cutting tripe and let the rest of the plants (weeds) remain on the ground surface covering the stump weed itself which then acting as a mulch. At this stage the base of the stem did not create dish again but cleared by the morphology of the root development from the surface of the area, spreadingon Gambier line around the base of the stem. Basic fertilizer used was compound of NPK (15: 15: 15) and KCl fertilizer with doses of 100 g each and 25 g per tree which applied one day after planting. Dolomite was given as ameliorant materials applied into planting holes (1wk before planting) as much as 1 kg per hole.

The evaluation of soil fertility through soil sampling was carried out in the first mo of planting (January 2013). Soil samples were taken at a depth of 0 cm to 20 cm and 40 cm to 60 cm for the first mo (January). Each sample reached 12 points at the top of the hill, 12 points on its flanks, and 12 points on the bottom (the valley) area. From 12 points of this composite were divided into four soil samples (as Deuteronomy) which mean that any repeat of a composite is three points.

The observations were made to the soil nutrient elements such as N, P, K, Ca, Mg, Na and other soil chemical substances of C-organic, ratio C/N, saturation of bases (BS), Cation Exchange Capacity (CEC), the pH and the saturation Al. Observation of plants was done to high plant and calculated the number of branches (shoots) that were formed as the image of productivity due to Gambier plant production (harvesting) to quote parts of the set.

3. Result and discussion

3.1. The evaluation of the level of soil fertility and nutrient analysis results

The equivalent substances of chemical soil samples from the site of the study at first capture (January 2013) are presented in Table 1 and Table 2. Table 1 showed the equivalent soil pH of Gambier in Pakpak Bharat ranged from pH 5.12 to pH 5.53 on top soil and pH 5.44 to pH 5.78 on lower layer. The range of soil pH like this was appropriate for growth and production of Gambier plant as mentioned in the Standard Operational Procedure (SOP) Gambier published by Department Research and Development Ministry of Agriculture Agencies[4].

Table 1.The analysis of chemical properties and soil nutrient N and P in Gambier plantation at Pakpak Bharat

Position and layer		Parameters						
		pH	Saturation Al (%)	C-org. (%)	N-total (%)	Ratio C/N	P-total (%)	P-av. (mg/l)
Top	(0 to 20) cm	5.53 (A)	10.87 (M)	2.86 (M)	0.25 (M)	11.84 (M)	0.014 (VL)	4.36 (VL)
	(40 to 60) cm	5.44 (A)	1.9 (VL)	2.17 (M)	0.15 (L)	14.44 (M)	0.012 (VL)	4.43 (VL)
The slope	(0 to 20) cm	5.12 (A)	9.23 (R)	2.89 (M)	0.38 (M)	7.41 (L)	0.014 (VL)	4.34 (VL)
	(40 to 60) cm	5.50 (A)	0.7 (VL)	2.18 (M)	0.16 (L)	13.78 (M)	0.013 (VL)	4.42 (VL)
Valley	(0 to 20) cm	5.44 (A)	9.26 (L)	3.19 (M)	0.28 (M)	9.42 (L)	0.023 (VL)	4.38 (VL)
	(40 to 60) cm	5.78 (SA)	1.3 (VL)	2.25 (M)	0.17 (L)	13.96 (M)	0.013 (VL)	4.45 (VL)

Note: A = Acid; SA = slightly acidic; VL = Very Low; M = Medium; L = Low (Source : Ref.[6])

Table 2. The analysis of exchange bases and CEC soils in Gambier plantation at Pakpak Bharat

Position and layer		Parameters					
		K-dd (me/100g)	Na (mg/100g)	Ca-dd (mg/100g)	Mg-dd (mg/100g)	KTK (mg/100g)	Bases saturation (%)
Top	(0 to 20) cm	0.477 (M)	0.407 (M)	0.571 (VL)	0.183 (VL)	18.08 (M)	9.12 (VL)
	(40 to 60) cm	0.150 (L)	0.094 (VL)	0.645 (VL)	0.088 (VL)	12.33(L)	8.09 (VL)
The slope	(0 to 20) cm	0.520 (H)	0.391 (L)	0.584 (VL)	0.223 (VL)	23.20 (M)	7.60 (VL)
	(40to 60) cm	0.112(L)	0.277 (L)	0.554 (VL)	0.080 (VL)	13.48 (L)	7.74 (VL)
Valley	(0 to 20) cm	0.292(L)	0.243 (L)	0.432 (VL)	0.135 (VL)	19.15 (M)	6.073 (VL)
	(40 to 60) cm	0.101 (L)	0.166 (L)	0.506 (VL)	0.071 (VL)	13.70 (L)	6.34 (VL)

Note: M = Medium; H = High; L = Low; VL = Very Low (Source : Ref.[6])

Interchangeable of aluminium levels (dd) on the ground of Gambier in Pakpak Bharat was pertained into low to moderate on the top layer of soil, while it was very low in the lower layer of soil (Table 1), which means that solubility of Al is at a level which does not harm (not cause toxic/inhibitor) for the growth and production of Gambier plant in study area in Pakpak Bharat, North Sumatra. The higher of Interchangeable of aluminium levels (dd) on the top layer than in the lower layers related to soil properties, namely "andik". Topsoil has a high “andik” property where the properties of this “andik” built by allophonic amorphous mineral composed of basic compounds Al_2O_3 and Fe_2O_3. Both of these compounds are easily hydrolyzed to $Al(OH)_3$ and $Fe(OH)_3$ which then dissociates into Al^{3+} and Fe^{3+}. Al and Fe solubility is then caused the ground to become acidic (low pH)[9].

The Table 2 recorded the levels of soil organic matter of Gambier in Pakpak Bharat pertained into medium to high which means it is enough to support growth of Gambier plant production so that the providing of organic fertilizer/manure for a while does not/has not yet needed to be done. The value of the ratio C/N was low to moderate which illustrates mineralized soil organic matter (humus formation) of Gambier in Pakpak Bharat.

The levels of nitrogen (N), which were currently high on the top layer of soil and low on the lower layer ground illustrates that the providing of fertilizer N (Urea or ZA) is only half doses but Gambier plant needs or even can not use N solely (preferably in the form of compound fertilizer), at least not on the plants of immature stadia which will not produce. Nutrient levels P, both available P-average and P-total were very low, both on the top layer and the bottom layer (Table 1). P-total were very low in the Gambier plant, Pakpak Bharat as a source of P is derived from the mineral soil is also low. The soil in Gambier plant, Pakpak Bharat is derived from the dust volcanic of Toba (Toba Tuff) poor elements of P and then led to the formation of ground that has “andik” properties (thixotropic). This “andik” properties which also causes the P-available to be very low because of the high fixation properties of minerals contained in the soil allophonic is “andik”[9]. This illustrates that the phosphate fertilization (P) is indispensable to the cultivation of *Uncaria gambir* Roxb. in Pakpak Bharat. The providing of this P fertilizer should be optimal on Gambier plant according to the needs if want to good results. SP36 fertilizer provided of 60 g per tree per semester for the first year and 70 g per tree per year for second and the following year are already sufficient in supporting growth and Gambier plant production at the Gambier in Pakpak Bharat.

Table 2 shows that levels of exchange able bases (K, Na, Ca, and Mg) in soil of Gambier in Pakpak Bharat are various from low, medium to high for K in the soil top layer, low to very low for Na, and very low for Ca and Mg whereas on the lower layer of soil all levels bases of exchange belong from the low to very low. Based on the levels of Exchange bases, then fertilizing is required to meet basic levels of such exchange, especially Ca and Mg, which is also a macro nutrient elements, it can be used with a dose of optimum dolomite (doses 300 kg to 400 kg ha^{-1} yr^{-1}). The providing of these replacement materials at once can increase saturation alkaline soil that is very low, both on land and on the upper layers of soil layer under it. CEC soil crusts currently on the top layer of soil have described the response (response) to the pruning, which contain ingredients from the alkaline compounds (cation).The need of Kalium (K) at the Gambier in Pakpak Bharat can be met by providing fertilizer KCl (MOP) as much as 3 g per tree per semester in the first year and 5 g per tree yr^{-1} in the second and the following year already good enough in supporting the growth and production of optimal Gambier in Pakpak Bharat.

3.2. Growth and development of Gambier

Growth and development of Gambier in Pakpak Bharat were very good. This can be seen from the development of plant growth at intervals of 4 mo to 5 mo, as shown in Fig. 1, Fig. 2, and Fig. 3. Gambier can only be grown at certain condition, which plant must be grown at 200 m to 800 m a.s.l. with rainfall around 3 300 mm yr^{-1} and humidity around 70 % to 85 %. Any types of soil can be used for Gambier plantation with the pH range from 4.8 to 5.5[10].

Fig. 1. The land condition in Pakpak Bharat

Fig. 2. The Gambier trees in Pakpak Bharat

Fig. 3. The Gambier cultivation condition in Pakpak Bharat

From Fig. 1, Fig. 2, and Fig. 3 it is known that the growth of Gambier in Pakpak Bharat with interval of 5 mo is good, although up to observation in October 2013 there was still a growing crop which did not similar each other, that can be sorted into good/thrives plants of which growth categorized into medium and growing less crops/infertile, which can be seen from the high indicators of plant and the amount of branch, as presented in Table 3 and Table 4.

Table 3. The height (cm) of Gambier in different land position and growth level of Gambier in Pakpak Bharat

Growth level of Gambier	Land position			Average	Standard deviation
	Top	The slope	Valley		
Good/thrives	73.07	70.80	62.83	68.90[a]	48.01 ± 17.008
Medium	44.00	48.10	45.10	45.73[b]	
Bad	30.90	28.90	28.43	29.42[c]	
Average	49.32	49.27	45.46		

Note: Figures in each treatment followed by the same letter are not significantly different at 5 % level according to different test average of DMRT (Duncan Multiple Range Test)

Table 4. The Gambier plant branches in different land position in Pakpak Bharat

Growth level of Gambier	Land position			Average	Standard deviation
	Top	The slope	Valley		
Good/thrives	7.67	7.67	6.33	7.22[a]	4.70 ± 2.447
Medium	6.33	4.67	3.33	4.78[b]	
Bad	2.33	2.00	2.00	2.11[c]	
Average	5.44[a]	4.78[ab]	3.89[b]		

Note: Figures in each treatment followed by the same letter are not significantly different at 5 % level according to different test average of DMRT (Duncan Multiple Range Test)

From Table 3 it can be deduced that the highest average plant height is at the plant that sits at the top of the hill, followed later on the slopes and low average height on the plant that grows in the valley/lower slopes. Plant growth

has quite striking difference (more than 2.36 times of plant height and more than 4.06 times of branch amount) compared between good plants and bad plant (Table 3 and Table 4), which describing the Gambier plant growth in the study not in one form due to differences in levels of soil fertility, especially factors of physical soil, such as fertility and humidity of soil.

Table 4 shows the mean number of Gambier plants in Pakpak Bharat in October 2013 observation ranged from 2.00 branches (plants that grew in less fertile/non good), while score 7.04 showed up in branches (of plants that grow thrives/good). While the plants that grow on the slopes of the peak average number of branches have more than 5.19 branches, in the slope have more than 4.58 branches and on the valley of the average of 3.9 branches. Less Gambier plants grow on the bottom of the slope, either obtained from plant height or number of branches (Table 3 and Table 4), proving that the tree needs more ground with Gambier condition, high fertility of soil compared to the land with low fertility of soil with a high soil moisture. As it known that land on the summit and slopes of the ridge, its soil is more conducive for fine fraction (clay and organic material) than the soil eroding into the lower layers/valley (high selective process of erosion) which causes the land at the summit and the slope becomes more conducive, then the soil in the valley/lower slopes becomes more solid. In order to maintain the levels of organic matter and soil pH that become key factors in cultivating, applying techniques of soil and water conservation is absolutely necessary. Soil and water conservation action is also to prevent/control erosion due Gambier plant that grows at the bottom of the slope/valley is less satisfied due to its high sedimentation from erosion on the upper part. Parallel contour resulted by planting and cleaning weeds using the tripe machine as much as on the surface of the soil is formed by soil and water as conservation measures that are effective in the core of Gambier in Pakpak Bharat.

Fertilization of N was performed by providing compound fertilizer by as much as 5 g per tree per semester in the first year of planting and 8 g to10 g per tree per plant is in the second year and so on. Fertilization of K can be done with the providing of KCl (MOP) with doses of 3 g per tree per semester in the first year and 5 g per tree yr^{-1} in the second year and so on. P-Fertilization should be done with the optimum dose of asmuch as 60 g per tree per semester for the first year and 70 g per tree yr^{-1} for year two and so on. Needs of Ca and Mg, as well as improving soil bases saturation at the Gambier in Pakpak Bharat can be done with a dose of Dolomite fertilizing 300 kg to 400 kg ha^{-1} yr^{-1}.

4. Conclusion

Organic fertilizer (compost or manure) is required on the cultivation of *Uncaria gambir* Roxb. In Pakpak Bharat. The providing of dolomite to raise the pH of the soil in the Gambier plantation in Pakpak Bharat no need to be done in the first year due the pH of the soil is still suitable for the growth and production of Gambier. P-fertilization and the providing of a fertilizer containing Ca and Mg is absolutely necessary because the P-levels available (and even the P-total) and the levels of Ca and Mg can be exchanged relatively very low. In Pakpak Bharat, it would be better to plant Gambier on the peaks and slopes rather than on the valley.

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