Nutrient Concentration of N, P and K in the Components of *Eucalyptus pellita* F. Muell Tree in East Kalimantan, Indonesia

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ABSTRACT
Eucalyptus pellita F. Muell is one of the species developed in industrial forest plantations that has the potential for pulp and paper. Therefore, this research aims to determine the concentration of N, P, and K nutrients in the *Eucalyptus pellita* F. Muell tree components. This research was conducted on two locations in plantation in East Kalimantan, Indonesia, which included 1, 3, and 5-year-old plants on Ultisols soil and 13-year-old plants on Spdosols soil. There were 3 plots made in a circular form with an area of 0.05 ha for each plant age for the tree inventory. Furthermore, the census of inventory tree diameters was conducted and 24 representatives were harvested to determine nutrient concentrations for each tree component at a specific age. The method used for the analysis of N, P, and K nutrients were the Kjeldahl, Spectrophotometer, and Flamephotometer, respectively. The results showed that: 1) at the age of 1 year, the highest and lowest concentrations of N were in leaf (11.03 mg/g) and stem wood (5.57 mg/g), while P was showed in branch+twig bark (0.30 mg/g) and branch+twig wood (0.17mg/g), and K was in branch+twig bark (14.05 mg/g) and branch+twig wood (3.56 mg/g). 2) At the plat age of 3 years, the highest and lowest concentrations of N were in leaf (13.63 mg/g) and stem wood (3.21 mg/g), while P was in leaf (0.40 mg/g) and stem wood (0.17 mg/g) and K was in leaf (12.12 mg/g) and stem wood (2.07 mg/g). 3) At the plant age of 5 years, the highest and lowest concentrations of N were in leaf (12.92 mg/g) and branch+twig wood (4.92 mg/g), while P were in branch+twig bark (8.65 mg/g) and branch+twig wood (3.15 mg/g), and K was showed in leaf (6.66 mg/g) and stem wood (2.38 mg/g). 4) At the plant age of 13 years, the highest and lowest concentrations of N was in leaf (13.13 mg/g) and branch+twig wood (4.90 mg/g), while P were in stem bark (1.27 mg/g) and stem wood (0.50 mg/g), and K were in leaf (9.83 mg/g) and stem wood (2.33 mg/g). These differences in nutrient concentrations of *Eucalyptus pellita* F.muell components are influenced by species, age, and soil type factors.

Keywords: *Plant Nutrients, N, P, K, Ultisols, Spodosols, Eucalyptus*

1. INTRODUCTION

Enhancement of people's livelihoods and national economies by successful tree planting can be achieved through industrial plantations, social forestry planting, agroforestry, and land rehabilitation. In these strategies, eucalyptus can play an important but it is mostly used in industrial and social forestry. This plant provides sawn timber, mine props, paper pulp, fiberboard, poles, firewood, charcoal, essential oil, honey, tannin, shade, and shelter [1].

Eucalyptus pellita F.Muell plant is one of the fast-growing species with a short rotation, which can be developed using tissue culture methods, shoot cuttings, and seeds [2]. The key to managing the nutritional status of eucalyptus in plantations is to have reliable information on macronutrient of the trees and the soil [3]

Plant nutrition is one of the most important factors influencing the yield and quality of crop plants. Similarly, a study on the importance of plant nutrition in yield enhancement and quality up-gradation showed that each essential element influences growth and development of plant [4].

The analysis of plant material showed a different approach in determining the availability of nutrients in the soil. Moreover, a previous study stated that there is a basic relationship between the content of plant nutrients and the growth or yield. The plant nutrients are divided into two, namely, macro and micronutrients. Meanwhile, macronutrients are present in plants in relatively higher amounts than micronutrients. Nitrogen (N), which is one of the most widely distributed elements in nature together with P, K are included in macronutrients [5].

Meanwhile, nitrogen is an element that is widely considered to be present in all parts of the plant for growth. Especially accumulating in leaves and seeds [6][7] stated that the green part of the plant contains the most protein and covers 70-80% of the total N. Also, the average nitrogen content in plant tissue ranges from 2 to 4% dry weight [5];[7]. Phosphorus (P) is considered the key to life. Although it is an element needed in large amounts (macronutrients), its amount in plants is smaller than nitrogen and potassium. Since the P content is abundant in organ-phloem tissues, therefore it is often considered to have the function of plant nutrient translocation. Furthermore, potassium (K) is the third major nutrient after N and P, which is absorbed in form of K^+ ions. This nutrient forms and transports carbohydrates and strengthen thestem to make the plant less prone to collapse. In most plants, the lack of potassium showed symptoms of weak stems which leads to easy felling. Meanwhile, high K absorption causes the absorption of Ca, Na, and Mg elements to decrease [7].

In plants, nitrogen (N) functions as a constituent of amino acids, proteins, chlorophyll, nucleic acids, and coenzymes. Also, phosphorus (P) functions as a constituent of many proteins, phospholipids, coenzymes, nucleic acids, and metabolic substrates, which are important in energy transfer, while potassium (K) functions as a carbohydrate translocation. These nutrients N, P, and K concentrations in plants range from 1.5%, 0.1%-0.5%, and 0.5-0.8%, respectively [8]

The Ultisols of the Sasamba, East Kalimantan area are very acidic and have low natural fertility. Moreover, Ultisols are a major group of marginal soils that is extensively present in the upland area of Indonesia [9]. Spodosols land are marginal land with spodic harizons and coarse texture [10].

Therefore, this research aims to determine the concentration of N, P, and K in the *Eucalyptus pellita* F. Muell tree components.

2. MATERIALS AND METHODS

The research was conducted in Industrial Plantation Forest, Sebulu Sub-district, Kutai Kartanegara Regency, East Kalimantan Province, Indonesia, from March to April 2020. The soil type at the site was Ultisols and Spodosols, where 1, 3, and 5-year-old *Eucalyptus pellita* F.Muell were on Ultisols soil and 13-year-old plants were on Spodosols soil. In this research, 12 plots were made in form of a circle with an area of 0.05 ha and a radius of 12.6 m [11]; [12]; [13]. Furthermore, 9 sample trees (1 tree from each plot for 1, 3, and 13-year-old *Eucalyptus pellita* F.Muell) and 15 sample trees for 5-year-old plants were set. Each sample was determined based on the distribution of tree diameter at breast height (dbh). The inventory data of tree diameter were sorted from smallest to largest.

The tree component was divided into 10 equal parts with a size of 10% of the total stem length. These samples were determined by drawing a stem disk with a thickness of 5 cm at the base, middle, and top at 20%, 50%, and 80% of the stem length from the base. The three stem samples were later skinned. Furthermore, the wood and bark samples were brought to the laboratory into small pieces and dried at a temperature of 60^{o}C to constant weight. These samples were ground to pass through a 60 mesh sieve for further laboratory analysis.

All branch and twig components were collected according to size and placement. The branches with a size of < 2cm were categorized as twigs. Similarly, branch and twig samples were drawn following the stem sampling procedure, while the leaf components were collected and taken to the laboratory.

The analysis of N, P, and K were carried out in the Soil Science Laboratory, Faculty of Agriculture, Mulawarman University using the Kjeldahl method, Spectrophotometer, and Flamephotometer, respectively.

The materials and tools used in this research were components of 1, 3, 5, and 13-year-old *Eucalyptus pellita* F. Muell trees, which include stem, branch+twig, stem bark, branch+twig bark, leaf, meter tool, digital scale, hanging scale, stationery, raffia rope, and phiband.

3. RESULTS AND DISCUSSION

Figure 1 showed variations in N, P, and K concentrations. The results showed that at the plant age 1 year, the highest N was in leaf (11.03 mg/g), followed by branch+twig bark (8.93 mg/g), stem bark (7.80 mg/g), branch+twig wood (6.60 mg/g), and stem wood (5.57 mg/g). Similarly, the highest P was in branch+twig bark (0.30 mg/g), followed by stem bark (0.27 mg/g), leaf (0.23 mg/g), stem wood (0.23 mg/g), and branch+twig wood (0.17 mg/g). Meanwhile, the highest K was found in branch+twig bark (14.05 mg/g), followed by leaf (12.46 mg/g), stem bark (9.54 mg/g),

stem wood (5.26 mg/g), and branch+twig wood (3.56 mg/g).

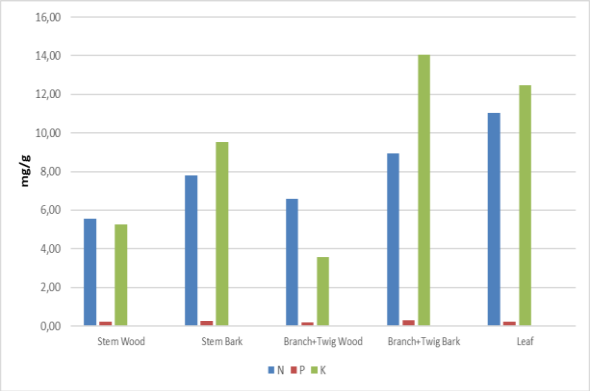

Figure 1 Average Concentration of N, P and K in The Tree Components of *Eucalyptus pellita* F.Muell aged 1 years.

Furthermore, in 3-year-old *Eucalyptus pellita* tree (Figure 2.), the highest concentration of N was in leaf (13.63 mg/g), followed by branch+twig bark (9.03 mg/g), stem bark (7.70 mg/g), branch+twig wood (5.90 mg/g), and stem wood (3.21 mg/g). Meanwhile, P was in leaf (0.40 mg/g), followed by branch+twig bark (0.37 mg/g), stem bark (0.37 mg/g), branch+twig wood (0.23 mg/g), and stem wood (0.17 mg/g), while the highest K was shown in leaf (12.12 mg/g), followed by branch+twig bark (12.05 mg/g), stem bark (9.06 mg/g), branch+twig wood (3.50 mg/g), and stem wood (2.07 mg/g).

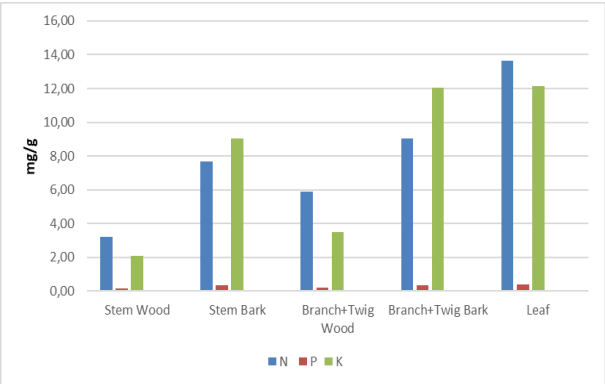

Figure 2 Average Concentration of N, P and K in The Tree Components of *Eucalyptus pellita* F.Muell aged 3 years

At the plant age of 5 years, the highest concentrations of N was in leaf (12.92 mg/g), followed by stem wood (7.31 mg/g), stem bark (7.05 mg/g), branch+ twig bark (5.25 mg/g), and branch+twig wood (4.92 mg/g). Furthermore, the highest P was in branch+twig bark (8.65 mg/g), followed by stem bark (4.16 mg/g), leaf (3.59 mg/g), stem wood (3.28 mg/g), and branch+twig wood (3.15 mg/g), while K was in leaf (6.66 mg/g), followed by branch+twig bark (6.39 mg/g), stem bark (5.18 mg/g), branch+twig wood (3.16 mg/g), and stem wood (2.38 mg/g) (Figure 3).

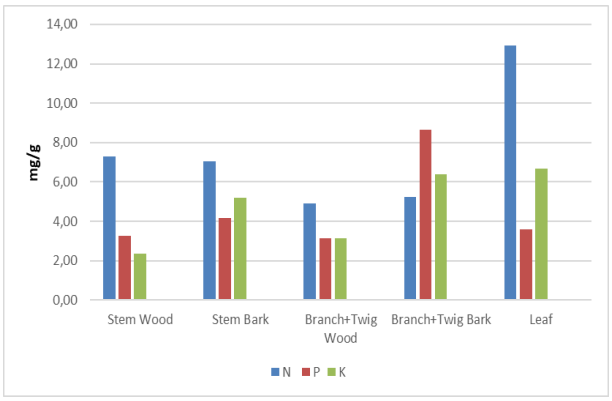

Figure 3 Average Concentration of N, P and K in The Tree Components of *Eucalyptus pellita* F.Muell aged 5 years.

Eucalyptus pellita F. Muell aged 13 years (Fig. 4.) showed that the highest N was in leaf (13.13 mg/g), followed by branch+twig bark (7.23 mg/g), stem bark (6.77 mg/g), stem wood (6.67 mg/g), and branch+twig wood (4.90 mg/g), while P was in stem bark (1.27 mg/g), followed by leaf (0.90 mg/g), branch+twig bark (0.87 mg/g), branch+twig wood (0.60 mg/g), and stem wood (0.50 mg/g). Meanwhile, for K, the highest was in leaf (9.83 mg/g), followed bybranch+twig bark (7.00 mg/g), stem bark (4.70 mg/g), branch+twig wood (3.43 mg/g), and stem wood (2.33 mg/g).

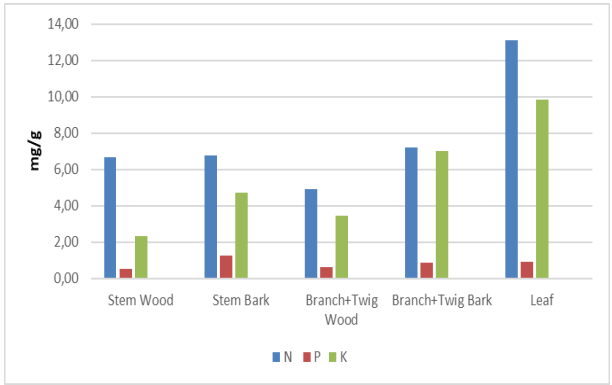

Figure 4 Average Concentration of N, P and K in The Tree Components of *Eucalyptus pellita* F.Muell aged 13 years.

Table 1 showed the various comparison of the average nutrient concentration in leaf components of *Eucalyptus deglupta* (mg/g) From the table, the nutrient P remained at a certain concentration at various age levels, while N increased in 13-year-old plants.

In this research, the comparison of average nutrient concentration in the leaf components of *E. pellita* with *E. deglupta* in the same age class (1 and 3

Table 1. The Average of Nutrients Concentration of The leaves of Some Eucalyptus spp Stands (mg/g)

Species	Age (year)	N	P	K	Type of Soil	Location	Source
E.pellita	1	11.03	0.23	12.46	Ultisols	Sebulu, East Kalimantan	This Research
	3	13.63	0.4	12.12	Ultisols		
	5	12.92	3.59	6.66	Ultisols		
	13	13.13	0.9	9.83	Spodosols		
E.deglupta	1	21.33	1.17	12.41		ITCI, Kalimantan Timur	[11]
	3	22.76	0.85	12.61			
E.deglupta	17	26.50	2.10	2.40	Dystrustepts	Inhutani I UMR Gowa, South Sulawesi	[14]

years) at different locations was similar to the results of Syahrinudin [11] , which showed that the concentration of K was 12 mg/g, while N was significantly lower and P was slightly lower than *E. deglupta*.

The comparison of average nutrient concentration in the leaf components of E. pellita with *E. deglupta* in different age classes (17 years) at various locations as conducted by Hartati [14], showed that the N concentration at plant ages of 1, 3, 5, and 13 years was much lower than 17-year-old *E. deglupta* (26.50 mg/g). Meanwhile, P at plant ages of 1, 3, and 13 years were lower but showed higher concentration at 5 years (3, 59 mg/g) compared to *E. deglupta* at 17 years (2.10 mg/g), and K at plant ages of 1, 3, 5, and 13 years was higher than 17-year-old *E. deglupta* (2.40 mg/g). These differences in nutrient concentrations of the *Eucalyptus pellita* F. Muell components are caused by variations in species, age, and growing place (soil type).

4. CONCLUSION

The results showed that: 1) at the plant age of 1, the highest and lowest concentrations of N were shown in leaf (11.03 mg/g) and stem wood (5.57 mg/g), while P was in branch+twig bark (0.30 mg/g) and branch+twig wood (0.17mg/g), and K was in branch+twig bark (14.05 mg/g) and branch+twig wood (3.56 mg/g). 2) In 3-year-old *Eucalyptus pellita* trees, the highest and lowest concentrations of N were in leaf (13.63 mg/g) and stem wood (3.21 mg/g), while P was shown in leaf (0.40 mg/g) and stem wood (0.17 mg/g), and K were in leaf (12.12 mg/g) and stem wood (2.07 mg/g). 3) At the age of 5 years, the highest and lowest concentrations of N were in leaf (12.92 mg/g) and branch+twig wood (4.92 mg/g), while P was in branch+twig bark (8.65 mg/g) and branch+twig wood (3.15 mg/g), and K were shown in leaf (6.66 mg/g) and stem wood (2.38 mg/g). 4) At the plant age of 13 years, the highest and lowest concentrations of N were in leaf(13.13 mg/g) and branch+twig wood (4.90 mg/g), while P was in stem bark (1.27 mg/g) and stem wood (0.50 mg/g), and K were in leaf (9.83 mg/g) and stem wood (2.33 mg/g). Meanwhile, these differences in nutrient concentrations in the *Eucalyptus pellita* F. Muell components are influenced by species, age, and soil type factors.

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