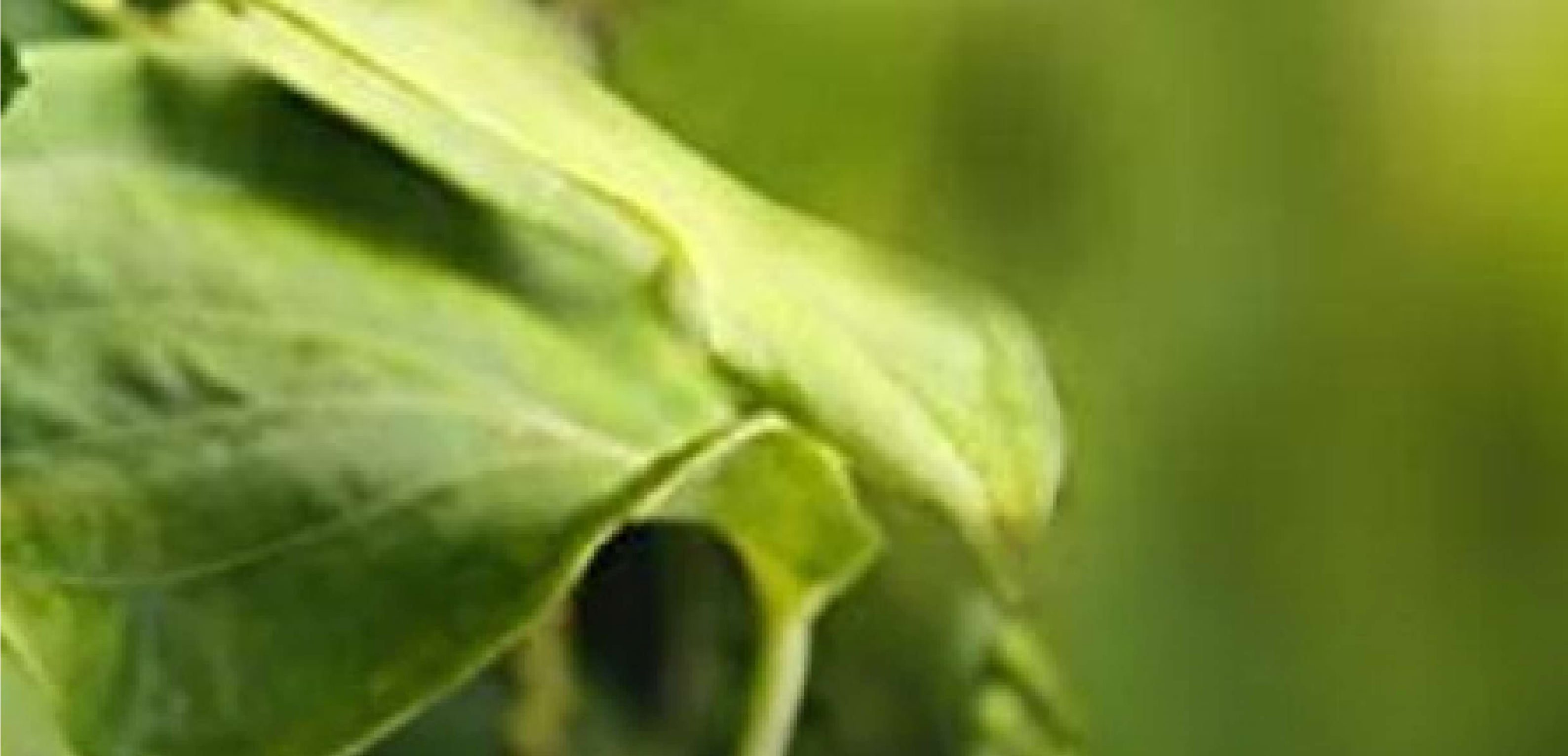

NPK NUTRIENT STATUS IN SOIL AND LEAVES OF *PIPER NIGRUM* L UNDER DIFFERENT GROWTH CRITERIA

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ABSTRACT

The White pepper (*Piper nigrum* L.) is Indonesia's leading spice commodity. As a production center, Bangka Belitungstill needs help in cultivation, including nutrient availability. Nutrients N, P, and K are macro elements that determine the growth of plants, including pepper. This research aims to identify the status of N, P, and K nutrient, in P. nigrum plants by observing leaf visuals, nutrient analysis, and plant tissue analysis. Significance of study: Knowledge regarding the absorption of nutrients by plants and their distribution in various parts of the plant (for example, leaves, branches, fruit, and roots) will be useful for agronomists in designing efficient fertilizer application strategies. The experimental methods used in this research were observation and laboratory analysis methods. The results of the observation data show that NPK nutrients in land with excellentgrowth criteria have an N-total of 0.22%, P_2O_5 available is 383.2 mg/kg and available K_2O of 6.4 mg/kg. Plant growth lacking nutrients criteria has a total N content of 0.20%, P_2O_5 of 115.1 mg/kg, and K_20 of 7.1 mg/kg. while plant tissue has an N-Total content of 2.41%, P-Total of 0.26%, and K-total of 2.47% for plants with excellent growth criteria and N-total, P-total, and K-total respectively 2.79, 0.32, and 3.95 mg/kg for plant tissue with poor growth criteria.

Keywords: Deficiency, Deficiency Symptoms, Potassium, Nitrogen (N), Phosphorus (P), White pepper

INTRODUCTION

Piper nigrum L has strategic value as the most popular spice and makes a very popular spice (Srinivasan et al., 2007). Piper nigrum L., a flowering vine from the family Piperaceae, is valued for its dried berries called peppercorns, which are known to have health benefits and are used as a spice and seasoning.

White pepper production tends to decline. Meanwhile, from the export side, fluctuating developments are visible. Based on the Revealed Comparative Advantage (RCA) value, Indonesian Piper nigrum appears to be competitive for export purposes to Germany, the Netherlands, France, Italy, and Belgium. Meanwhile, the Export Product Dynamics (EPD) value shows that the competitive position of Indonesian Piper nigrum in the Netherlands, Germany, and Belgium is in the Retreat position. On the other hand, Indonesian White pepper has the competitive position of Rising Star in Italy, Falling Star in France, and Lost Opportunity in America. Finally, based on the Trade Specialization Index (TSI) value, it can be shown that Indonesia is very competitiveness as an exporter of whole White pepper. Competitiveness analysis using Revealed Comparative Advantage (RCA), Export Product Dynamics (EPD), and Trade Specialization Index (ISP) (Balqis & Yanuar, 2021).

Yudiyanto et al., 2014; Ropalia et al., 2022, stated that one of the causes of the low productivity of Muntok white pepper recently, apart from increasing farming costs, is also due to the decline in soil fertility where White pepper farming is done. White pepper cultivation requires sufficient nutrients for growth and unfavorable environmental conditions, especially related to decreased soil fertility and unsuitable weather. Paduit et al. (2018) stated that the high response to N, P, and K, recommendations for effective fertilization, the need for plant nutrient absorption and disposal must be clearly understood to gain efficiency in white pepper cultivation. Large amounts of nutrients are required to produce and maintain economic yields of white pepper. To achieve high yields, farmers must apply nutrients in sufficient quantities to meet the total nutrient requirements of the plant.

Knowledge regarding the absorption of nutrients by plants and their distribution in various parts of the plant (for example, leaves, branches, fruit, roots, etc.) will be helpful for agronomists in designing efficient fertilizer application strategies. Another problem is related to the low price of P. nigrum, which encourages lower production costs and a cleaner environment (Sulok et al, 2020). P. nigrum is cultivated in various soil types with varying pH and fertility. Ideal conditions require loose soil rich in humus and important plant nutrients, with good drainage, sufficient water.

Among the nutrients consumed by black pepper, N uptake is the highest, followed by K and Ca, and the number of nutrients lost from the soil will follow the order: N>K>Ca>Mg>P>S>Fe>Mn>Zn (Srinivasan et al., 2007). Plants require the most significant amount of N among the three main/primary nutrients (the others are P and K). N, P, and K have many functions, including promoting rapid growth, increasing leaf size and quality, and enhancing fruit and seed development; they form a single component of many important components in plants, including amino acids, which are the building blocks of proteins and enzymes, which are involved in most biochemical process catalysts. So it is necessary to study the condition of Piper nigrum plants based on the growth status of to leaf visuals, soil N, P, and K nutrients, and leaf tissue nutrients, to determine the N, P, and K nutrient status on the two P. nigrum growth criteria.

MATERIALS AND METHODS

Two park conditions were determined using different criteria to be observed in depth. Two (2) adjacent garden locations were selected with good and low growth criteria, marked by the visual appearance of pepper growth morphology, production criteria of 2 to 4 tons per hectare to determine growth criteria (≤2 tons low production, 2-3 tons sufficient production and ≥ 4 tons produced well. Twenty trees were used, with each tree observing 20 symptomatic leaves on each tree. The leaf deficiency or toxicity criteria are observed in detail by comparing the visible symptoms with the table of toxic and nutrient deficiency symptoms (McCauley et al., 2011). Nutrient status assessment is carried out by analyzing the macronutrients N, P, and K and creating criteria for high, sufficient and low nutrient status (SRI, 2005). The detected nutrients are compared with those absorbed by the plant (analysis of old leaf plant tissue).

Table 1. Observation stages

Stages	Outer	Achievement indicators	Method
1. Determine the criteria for studying location gardens	2 criteria for good and bad growth of White	Plants with good and bad growth criteria can be distinguished	Visually based on morphological observation of plants
2. Observation of leaf symptoms. Using determinant keys to determine plant leaf symptoms (McCauley AM, Jones C, Jacobsen J. 2011. Plant Nutrient Functions and Deficiency and Toxicity Symptoms. Module. United States: Montana State University)	Observe the symptoms of young leaves and old leaves by comparing them based on the observation table for deficiencies and toxic macro and micro nutrients	Deficit and toxic nutrients are determined based on visible symptoms	Visual observation of leaves by comparing visual symptoms with a table of nutrient deficiency and toxic symptoms
3. Soil sample collection	macro micro nutrient status detected	analyzed for macronutrients N, P and K	Table Method Types of macro and micro nutrients
4. Plant tissue analysis Sampling old leaves	To observe mobile nutrient uptake and for immobile nutrients samples were used from old leaves.	Nutrient uptake calculations are carried out by comparing media nutrients with the nutrients contained in leaf plants	Nutrient uptake efficiency is calculated using the formula = amount of plant nutrients (top and roots) / amount of nutrients in the media

The criteria used to recognize the chemical fertility status of soil analysis results are based on standardized soil status criteria by the Indonesian Soil Research Institute (SRI, 2005). Table 2 below contains a table of soil criteria in the very low, low, fair, high, and very high range.

Table 2. Soil media status criteria standardized by the Indonesian Soil Research Institute (2005)

Soil Characteristic	Very Low	Low	Currently	High	Very High
C- Organik (%)	<1	1-2	2.01-3	3.01-5	>5
N-Total (%)	<0.1	0.1-0.2	0.21-0.5	0.51-0.75	>0.75
P2O5 Bray 1 (ppm)	<10	10-20	21-40	41-60	>60
K2O HCL 25% (me/100g)	<10	10-20	21-40	41-60	>60
pH H20 < 4.5	4.5-5.5	5.6-6.5	6.6-7.5	7.8-8.5	>8.5
very (acid)	(acid)	(slightly acid)	(neutral)	(slightly alkaline)	(alkaline)

Source : Soil Research Institute (2005)

RESULTS AND DISCUSSION

Detect deficiency and toxic symptoms in old leaves

Table 3. Results of visual observations of Piper nigrum leaves

Deficiency Symptoms	CGrowth No Good	Toxic Symptoms	Old Leaves	
			Good Growth Criteria	Growth No Good
Nitrogen*		Nitrogen**		
The color of the leaves becomes pale,	√	The plant is dark green and lush, but it usually has a small root system (shallow and limited). Burning symptoms occur on the edges of the leaves, and is followed by tissue death on the strands between the veins of the leaves.	X	x
Leaf tissue becomes dry and dies,	√			
Plant growth is stunted and stunted,				
Phosphor		Phosphor		
Leaf veins The color of the leaves is dark green and the surface looks shiny reddish.	√	Necrosis and death of growing points. Chlorosis on the leaf blades between the veins of young leaves and symptoms of scorching on the edges of old leaves.	X	√
Leaves are short – short.	√			
The edges of the leaves, branches, and stems become smaller and purplish red and gradually turn yellow.				
Potassium		Potassium		
Old leaves will shrivel or curl, turn brownish red, and dry out like they have been burned	√	Excess potassium (K) disrupts the absorption of Ca and Mg, stunting plant growth. Thus, the plant experiences a deficiency. At first, the leaves appear puckered, with edge leaf yellowing, visible spotting of dirty-colored chocolate, and leaf death.	X	x
Transparent yellow spots appear on the leaves.	√			
Susceptible to disease	√			
Magnesium ***		Magnesium		
Orange-yellow interveinal chlorosis on older leaves	x	Necrosis (tissue death) in plant leaves.	X	x

* (Wahyuni, Darma, & Wayahdi, 2017), ** (Wiraatmaja, 2017), *** (McCauley et al., 2011)

Symptoms of N, P, and K deficiency were detected in poor growth conditions, but toxic symptoms of P were also detected in good growth criteria (Table 3). Meanwhile, toxic symptoms are only found in phosphorus symptoms. Figure 1 below shows visuals of old plants and leaves.

(1a) (1b) (1c) (1d)

Figure 1. Piper nigrum growth conditions (1a) Good growth criteria and No Good Growth (1b), and leaf conditions with visible symptoms (1c and 1d)

Soil nutrient analysis, leaf tissue analysis and absorption efficiency

Table 4. Results of N, P, and K nutrient analysis based on Piper nigrum growth status

Soil Characteristic	Settlement Status	Method	Unit	Measurement	Criteria
pH H 2 O	Good	Extract 1 : 5 ICBB/ MU/11.004.2 (Potentiometry)	-	6.	neutral
	No Good			7.0	neutral
C Organic	Good	ICBB/MU/11.004.14 (Walkley & Black / Gravimetric)		4.05	high
	No Good			3.72	high
C/N	Good	calculation		18	
	No Good			19	
N-Total	Good	ICBB/MU/11.004.12 (Kjeldahl)	%	0.22	currently
	No Good			0.20	low
P_2O_5 Available	Good	ICBB/MU/11.004.4 (Olsen) ICBB/MU/11.004.5 (Bray I)	mg/Kg	383.2	high
	No Good			115.1	low
K_2O Available #	Good	DTPA – AAS	mg/Kg	6.4	very low
	No Good			7.0	very anxious

A low level of nitrogen is a criterion for poor growth, but nitrogen is relatively sufficient for good growth (Table 3). Another condition that can be seen is the phosphorus status, which is quite good for good growth criteria, but if the growth is not good, phosphorus is detected to be low. Meanwhile, the potassium content is relatively very low based on the criteria (Table. 2).

Table 2 is used to determine the adequacy of nitrogen, phosphorus, and potassium nutrients obtained based on soil analysis at the research location. The criteria used are based on the Soil Research Institute (SRI, 2005). Table 5 shows the results of N, P, and K nutrient analysis in old leaves. Nutrient content figures in White pepper leaves were compared with standard data for nutrient adequacy in corn.

Table 5. Results N, P and K tissue nutrient analysis leaf

Type Nutrient	Settlement Status	Method	Unit	Mark Results Observation	Standard Enough Nutrienton Corn	Unit
Leaf Old						
C- Organic	Good	Gravimetry		49.11	45	%
	No Good			47.12		
N	Good	ICBB/MU/11.003.2 (Kjeldahl, Titrimetry)	%	2.41	2.7-4.	
	No Good		%	2.79		
P	Good	ICBB/MU/11.003.3 (Spectrophotometer UV vis)	%	0.26	0.25-0.	
	No Good		%	0.32		
K	Good	ICBB/MU/11.003.4 (AAS)	%	2.47	1.70-3	
	No Good		%	3.95		

Organic C in P. nigrum leaves with good and bad growth criteria is 49.11 and 47.12% (Table 5). This value is within the criteria for normal carbon presence. According to Salisbury & Ross (1992), the range of carbon in the dry weight of plant tissue can reach 45%. Nitrogen makes up approximately 1-5% of the plant body. Observation results for corn with sufficient N criteria ranged from 2.70-4.00%, P= 0.25-0.05% and K 1.70-3.00%. Meanwhile, soybeans can reach enough in the range of N 4.00 to 5.50, Phosphorus 0.26-0.5%, and Potassium around 1.70-2.5%. (Plant Nutrition Manual) (Salak & Steinhilber, 2010). According to Salisbury & Ross (1992) the concentration of N in dry tissue can reach 1.5%, P 0.2%, and K 1.0%, while carbon can reach 45% of the dry weight of plant tissue.

Table 4 shows that P. nigrum with good growth has lower N, P, and K than leaf tissue with poor growth criteria. This is thought to be caused by the mobility nature of these nutrients. Nutrient analysis was only carried out on old leaves and was not observed on young leaves. Observations on old leaves based on the mobility characteristics of dead nutrients are classified as mobile nutrients so that the initial symptoms will appear on old leaves (McCauley, 2011). So, it is estimated that nutrient transport determines the nutrient content in old leaf tissue to young leaves, which are relatively faster to leaf and have good growth criteria. K+ plays a role in several physiological functions, including controlling cell growth and wood formation, xylem-phloem water content and movement, nutrient and metabolite transport, and stress responses (Sardans & Peñuelas, 2021). Soil nutrient conditions with good and bad growth criteria were detected to be very low.

Many symptoms are similar; for example, nitrogen (N) and sulfur (S) deficiencies can vary depending on the location, growth stage, and severity. Multiple symptoms of deficiency and poisoning (toxicity) can occur at the same time. More than one deficiency or toxicity may produce symptoms, or one nutrient deficiency may occur due to excess of another nutrient. For example, excess P can cause Zn deficiency. Types of plants, and even several varieties of the same type, differ in their ability to display symptoms of deficiency and poisoning.

The role of nutrients N, P, and K play in almost all metabolic processes. As determined by its function, N influences plant growth rate and quality (Njira and JNabwami, 2015; Njirah, 2015). Phosphate (Pi) is an important macronutrient for plant life. Several regulatory components involved in Pi homeostasis have been identified, showing great complexity at the cellular and subcellular levels. Determining the Pi content in plants is crucial to understanding this regulation (Kanno et al., 2016). A balanced supply of essential nutrients is one of the most important factors in increasing crop yields. A review of the nutritional management of black pepper has been comprehensively reviewed by (Srinivasan et al., 2007).

Potential factors that can cause pseudo-symptoms include disease, drought, excess water, abnormal genetics, herbicide and pesticide residues, pest attacks, and the effect of soil compaction. Hidden symptoms. Plants sometimes experience nutrient deficiencies without showing visual symptoms. Field symptoms that show different from ideal (actual) symptoms. When tested in the field or controlled for the role of certain elements, many plants did not produce the expected symptoms.

CONCLUSION

NPK nutrients in very good growth criteria have an N-total of 0.22% (medium), P_2O_5 available is 383.2 mg/kg (high), and available K_2O of 6.4 mg/kg (very low). Meanwhile, plant growth with poor growth criteria has an N-total content of 0.20% (Low), P_2O_5 of 115.1 mg/kg (Low), and K_20 of 7.1 mg/kg (very low). Meanwhile, plant tissue with good growth criteria has an N-total content of 2.41%, P-total of 0.26 percent and K-total of 2.47 percent. Meanwhile, for P. nigrum with poor growth, the leaf nutrient content of N-total, P-total, and K-total was 2.79%, 0.32%, and 3.95% respectively

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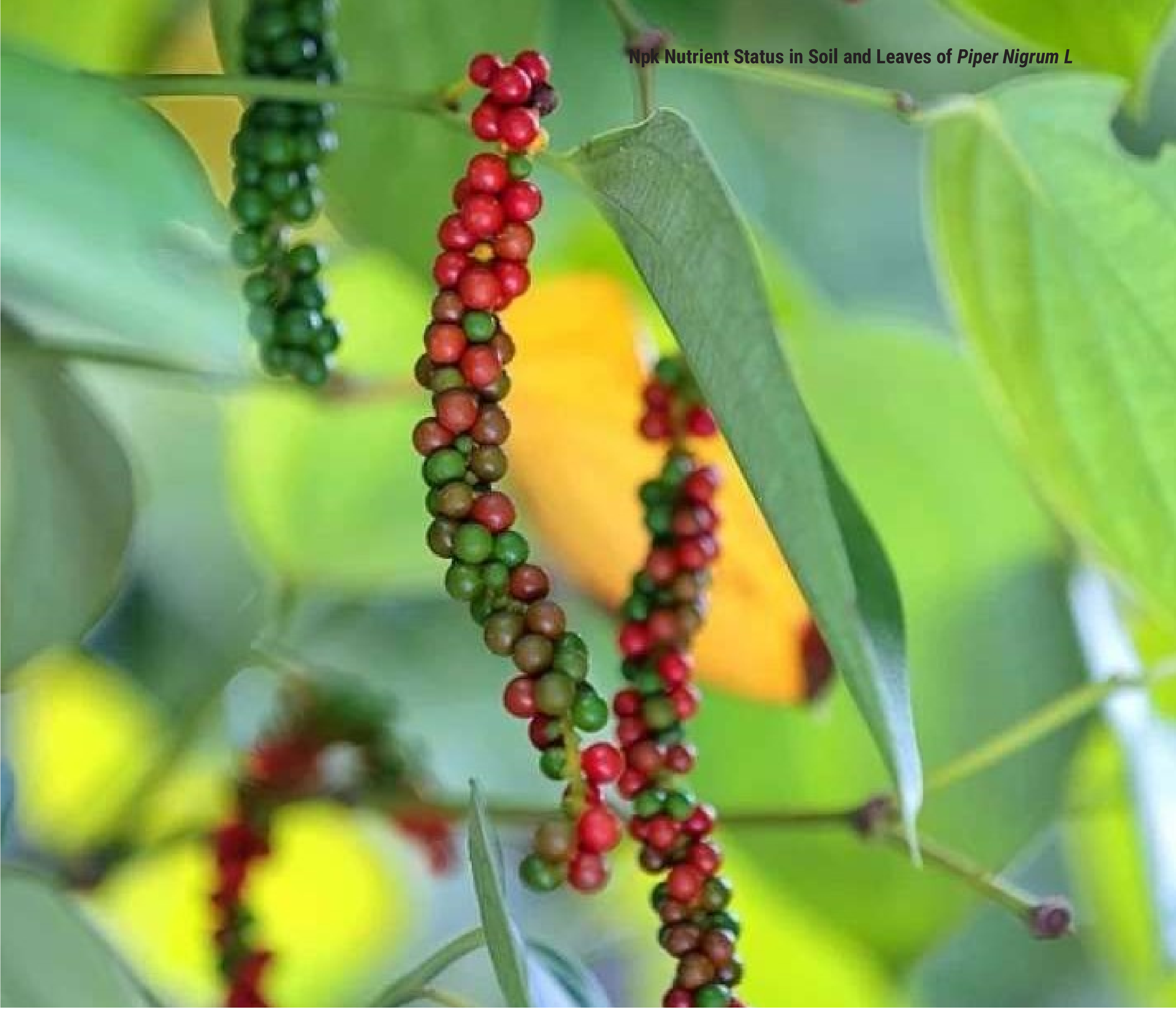

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