PRELIMINARY ASSESSMENT OF GROWTH AND LEAF NITROGEN OF *HOPEA ODORATA* ESTABLISHED IN TWO DIFFERENT SOIL CONDITIONS

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ABSTRACT

A study was conducted to assess the growth, leaf chlorophyll and leaf nitrogen content of *Hopea odorata* planted at different site conditions at an expressway. Measurements recorded were overall tree height and stem diameter at breast height (dbh), relative leaf chlorophyll and foliar nitrogen content. Fully developed leaves were sampled for foliar nitrogen analysis while portable chlorophyll meter, SPAD-502, was used for in-situ quantification of relative leaf greenness. Statistical analysis was carried out using Statistical Analysis System (SAS). The growth of *Hopea odorata* was found to be affected by soil conditions at the study site. Significant differences in overall height and dbh were observed between two soil conditions, namely disturbed and undisturbed soils. Similarly, significant differences were seen in relative leaf chlorophyll content, foliar and soil nitrogen (N) between the two site conditions. Trees planted on undisturbed soil contained higher foliar N content and displayed higher SPAD value for relative chlorophyll content. Limited availability of nitrogen due to poor soil condition was suggested as one of the reasons for unsatisfactory growth of *Hopea odorata* on disturbed and cut soils. A positive significant correlation between leaf nitrogen content and SPAD value was observed indicating a direct relationship. This preliminary observation suggests that SPAD-502 chlorophyll meter is potentially useful as an alternative to assess leaf chlorophyll as well as leaf nitrogen content of *Hopea odorata.*

Keywords: Hopea odorata, disturbed soils, relative chlorophyll content, foliar nitrogen, growth

INTRODUCTION

Hopea odorata is a landscape and ornamental tree commonly planted along roadsides, highways, in parks, gardens and open spaces within city areas. As one of the native forest species, it presents a unique character and form which makes it different from other common exotic landscape species. The tree shows uniformity in growth and crown form making it an attractive avenue tree for roadsides and

highways. It is also an excellent tree for large avenues or boulevards. The lofty and healthy crown is so characteristic that provides a sense of boldness in urban landscape. A row of *H. odorata* along roadsides can impart a distinct feature, giving a formal appearance. This tree is also suitable for public parks and large gardens. *H. odorata* is suitable to be planted outside their natural habitat and is one of the few Malaysian dipterocarps that can grow in the open as it is a hardy species. It can be used for shading, effective visual screening, wind breaking as well as aesthetic value.

Due to its hardiness, it is suitable to be planted in urban environment. This species can grow reasonably fast in harsh urban condition and can reach a height increment of 4 m in 3 to 4 years (Adnan 1986; Ahmad Azaruddin et al. 2003). In any landscaping and urban beautification programme, other than the functional aspect of the trees planted, the aesthetic aspect is of equally importance. Foliage quality such as form and greenness contributes greatly to the aesthetic value of ornamental and landscape trees. Chlorophyll has been known to be one of the most vital green pigments involved in the photosynthetic activity and nitrogen is one of the key elements found in chlorophyll molecules (Bidwell 1974). Nitrogen, being a major nutrient element will not only affects tree vitality but also contributes to the greenness and quality of the tree foliage

MATERIALS AND METHODS

A study was conducted to assess the growth, leaf nitrogen content and relative chlorophyll content of *Hopea odorata* trees planted along an urban expressway. In addition, a relationship between foliar nitrogen and relative chlorophyll content was observed to investigate the use of SPAD meter as an alternative in determining foliar nitrogen content. The trees were planted on soil that has been disturbed by the construction of the expressway. During the construction of the highway the original site has undergone massive soil disturbance such as cut and fill operations, land leveling and soil compaction. This has altered the natural soil condition and making it less fertile. In some locations, however, the natural slope was not removed or disturbed to suit the design of the expressway. At such sites, the topsoil was still intact and can support tree growth.

An observation was carried out on the growth of *H. odorata* tress found at both locations; the cut and disturbed soil as well as the undisturbed areas. A number of 53 trees were observed. The six years old *H. odorata* trees were planted in line planting in 3 rows with planting distance of 6 m. Measurements recorded were total tree height, stem diameter at breast height (dbh), relative leaf chlorophyll and foliar N content. Total tree height was measured using Vertex III Hypsometer (Haglof, Sweden) while stem dbh was taken with the help of digital caliper. SPAD-502 (Minolta, Japan) portable chlorophyll meter was used for *in situ* quantification of relative leaf greenness and its value has been reported accurate in predicting chlorophyll content and nitrogen levels (Loh et al. 2002; Wood et al. 1992). Ramlan et al. (1999) also found a strong correlation between non-destructive measurement

using SPAD and the conventional acetone-extractable method for chlorophyll determination. Leaves sample were taken from branches closest to the apex to determine leaf nitrogen content. Soil samples were collected for soil nitrogen analysis following established procedures (Wan Rasidah et al. 1989). Analysis of variance (ANOVA) was carried out and simple linear correlation was determined using Statistical Analysis System (SAS).

RESULTS AND DISCUSSION

Although *H. odorata* has been reported to survive on a wide variety of soils including disturbed and degraded soils (Wan Razali & Ang 1991), its growth performance at the study site varied significantly with soil condition. *H. odorata* trees appear to be site-sensitive and perform considerably well on site with good soil. Comparing the growth between trees on disturbed and undisturbed area, tree growth in former was affected. In locations where the soil was cut and altered, the growth was moderate and in some instances the growth was poor with some reduction in its aesthetic look. The crown was less dense with smaller leaf size and somewhat lesser green foliage. Means of total tree height and stem dbh showed a significant difference ($p \leq 0.05$) between the healthy growing trees on undisturbed soil and poor growing trees on disturbed soil (Table 1).

In both growing conditions, growth of *H. odorata* tends to relate with leaf nitrogen concentration as well as relative leaf chlorophyll content. Healthy looking *H. odorata* with good growth established on undisturbed terrain were found to contain significantly ($p \leq 0.05$) higher foliar concentration of nitrogen (Table 1). According to Pirone et al. (1988), nitrogen range of between 2.0 % - 4.0 % can be considered as sufficient and typically found in healthy plant leaves in urban soils. Value above or below the range may be deficient or in excess. Similarly, significant different was seen in relative chlorophyll content with good growing trees established on undisturbed terrain having a significantly ($p \leq 0.05$) higher SPAD value than the moderately growing trees on cut areas (Table 1). SPAD meter is measuring the relative greenness of leaves (Loh et al. 2002) and higher SPAD value indicates relatively greener leaves thus suggesting better foliage quality. The soil analysis further indicates that soil found at the undisturbed terrain contained significantly ($p \leq 0.05$) higher total nitrogen than soil on disturbed and cut areas.

Nitrogen (N) is the most important growth-limiting factor for many soils (Mengel & Kirby 1979) especially for problematic urban soil. Significant difference found in this particular element between both tree conditions indicates that nitrogen plays a vital role in contributing the good growth and excellent foliage quality of *H. odorata* at the expressway. Good growth in trees on the undisturbed terrain could also be attributed to the extensiveness of their root system as the soil was loose and fertile. Good soil offers deep rooting and ease of penetration due to the presence of macropores and high degree of aggregation (Craul 1992). Conversely, soil at the altered terrain was possibly compacted and this has restricted the root development thus might have impeded the overall tree growth. Poor soil condition and limited

availability of nutrient especially nitrogen is suggested as one of the reasons for the poor and unsatisfactory growth of some *H. odorata* trees along the expressway. However, further study on soil compaction as well as root distribution would be beneficial for better understanding of factors contributing to the unsatisfactory growth on disturbed areas.

Table 1. Mean total height, stem diameter at breast height (dbh), leaf nitrogen content, relative chlorophyll content and soil nitrogen.

Location	Height (m)	Stem dbh (cm)	Leaf N content (%)	Relative chlorophyll content	Soil N (%)
Undisturbed	8.28^a	13.72^a	2.14^a	47.57^a	0.14^a
Disturbed	6.80^b	11.44^b	1.73^b	34.27^b	0.06^b

Means with same letter are not significantly different ($p \leq 0.05$)

A positive significant correlation between foliar N content and SPAD value was observed ($n=53$, $r=0.59$, $p \leq 0.01$) indicating a direct relationship. The regression line as shown in Figure 1, described a linear relationship for the two parameters in *H. odorata* where leaf N content (%) = 0.5027 + 0.0315 SPAD value (chlorophyll content). The linear relationship may suggest the importance of a critical value in lieu of an optimum value for SPAD reading which corresponds to the sufficient range of leaf N content.

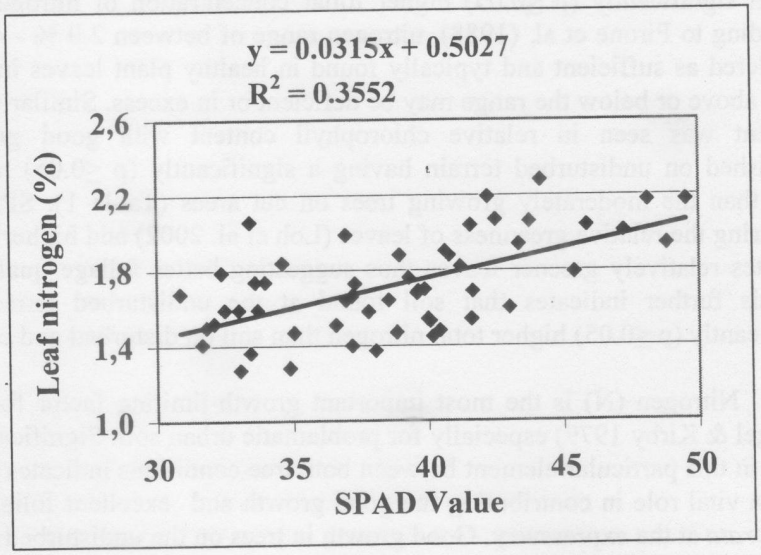

Figure 1. Relationship between leaf nitrogen content and SPAD value in *H. odorata*.

A close relationship has been reported elsewhere between the chlorophyll content and the increase in nutrient uptake especially nitrogen in plant. Leaf chlorophyll is often found to be well correlated with leaf nitrogen status (Evans 1983). Loh et al. (2002) found a significant linear correlation of leaf N content with corresponding SPAD values for *Ficus benjamina* and *Populus deltoides* (Table 2). Kowalczyk-Jusko and Koscik (2002) observed that the measurement with SPAD-502 chlorophyll meter proved to be closely related to the nitrogen content in leaf-blades of tobacco (*Nicotiana tabacum*) with positive coefficient of correlation. SPAD readings from selected leaf on a number of tillers of various rice (*Oryza sativa*) genotypes were also found to be highly correlated with shoot nitrogen content (Ladha et al. 1998). Wood et al. (1992) reported that chlorophyll readings were significantly correlated to leaf-blade nitrogen concentration of cotton. According to Fridgen and Varco (2004), total chlorophyll content increased as leaf nitrogen concentration increased regardless of potassium nutrition in cotton. Netto et al. (2005) concluded that SPAD-502 meter can be used to analyze total nitrogen content as well as diagnose the photosynthetic system of coffee leaves. All these studies indicated a close link between relative chlorophyll content (SPAD value) and foliar N content which is sensible as majority of leaf N is contained in chlorophyll.

Higher nitrogen supply may affect the leaf nitrogen status and thus have an effect on leaf chlorophyll content, photosynthetic activity, growth and subsequently the aesthetic appearances of *H. odorata*. Therefore, nitrogen can be mostly required by landscape trees and leaf nitrogen content should be of interest to landscape managers in maintaining quality foliage. Over fertilization of nitrogen, however, may lead to insect and pest occurrence. Fertilization can be a labour intensive and costly maintenance activity. Thus, fertilization programme should incline towards applying enough nitrogen to avoid deficiency and to promote growth with quality foliage.

Table 2. Relationship between leaf nitrogen content and SPAD values for five plant species.

Species	Equation	Correlation coefficient	References
Hopea odorata	y = 0.0315x + 0.50	0.59	This study
Platanus occidentalis	y = 0.036x + 0.55	0.75	Chang and Robison (2003)
Ficus benjamina	y = 0.016x + 0.3	0.73	Loh et al. (2002)
Populus deltoides	y = -0.98 + 0.068x	0.51	Loh et al. (2002)
Zea mays	y = 0.0366x + 1.81	0.34	Bullock et al. (1995)

Note: y = leaf nitrogen (%); x = SPAD value.

Foliar sampling and analysis can be an important tool to determine leaf nutrient status and deficiency. Foliar analysis provides more definitive information on leaf nitrogen content and its requirement. However, although this analysis provides accurate information for diagnosing plant nutrient status, it can be costly and time-consuming. As leaf chlorophyll content is often well correlated with leaf nitrogen content, non-destructive measurement using portable chlorophyll meter can be potentially useful as quick diagnostic tool to assess chlorophyll content as well as foliar nitrogen of landscape trees. It can be a reliable method to rapidly assess nitrogen status, detect early deficiency and prescribe fertilizer application. Wood et al. (1992) suggests that this SPAD-502 hand-held tool is as reliable as leaf chemical analysis for predicting nitrogen fertilization of cotton. Chang and Robison (2003) suggested that SPAD meter can be efficient in decision making and nutrient management for hardwood species.

Current observation suggests that SPAD-502 chlorophyll meter can be used as an alternative to determine the foliar nitrogen status of *H. odorata*. However, more study will have to be carried out if it is to be used in landscape management decisions as several factors may influence the measurement such as species, leaf age and position besides sampling procedure. Relative chlorophyll content reading can also be influenced by many factors other than nitrogen alone as leaf greenness can be altered by other nutrients deficiencies, diseases and environmental stresses.

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