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Effects of Light Intensity and Nutrient on Growth and Electron Transport Rate of Tropical Tree Seedlings (*Bombax buonopozense, Khaya ivorensis* and *Cedrela odorata*) found in Ghana

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Summary: Tropical tree species vary in their requirements for light and nutrient for effective growth and physiological process. Actual levels of light and nutrient requirements for *Bombax buonopozense* and *Khaya ivorensis* tree species native of Ghana and *Cedrela odorata* (exotic) are not known. This study therefore attempted to find out the level of nutrient and light requirements as well as their interactive effect on growth and electron transport rate (a measure of photosynthetic process) of the species mentioned. Two-month old seedlings of the three species were grown for 14 weeks in five light regimes with three levels of nutrient treatments (i. e. 0 g, 5 g and 10 g of NPK) in each light regime and in replicates of two. The light treatments were: 1.00 RLI, 0.44 RLI, 0.15 RLI, 0.05 RLI and 0.01 RLI. Light and nutrient as well as their interaction significantly ($p<0.05$) influenced above and below ground growth of *B. buonopozense* and *C. odorata* seedlings while light treatment only significantly ($p<0.05$) influenced above ground growth of *K. ivorensis* seedlings. Growth parameters i. e. height increment (HI), diameter increment (DI), total growth increment (D^2HI) and root-shoot weight ratio (R/S) as well electron transport rate (ETR) increased with increasing relative light at higher nutrient supply for *C. odorata* and *B. bonopozense.* Where as in partial light treatment (0.44 RLI) growth and electron transport rate was high in the case of *K. ivorensis.* The nutrient treatments did not significantly ($p<0.05$) influence growth in *K. ivorensis.*

Key words: Growth increments, Electron transport rate, Nutrient, Relative light intensity, Tropical tree species

Introduction

Ghana is a tropical country and its total land area is estimated to be 23.9 million ha. 15 % of the land area of Ghana is under protection (wildlife and forest reserves). Identifiable ecological zones in the country include rain forest (3 %), moist forest (31 %), interior savanna (57 %), coastal savanna (5 %), and Volta Uke (4 %). It is estimated that 70 % of the original 8.22 million ha of closed forest in Ghana has been destroyed. Deforestation is one of the key environmental problems facing Ghana. Protected areas in the forest zone suffer increasing pressure from the demands of agriculture and forest products (Ntiamoah-Baidu 2001).

On the other hand reforestation programs

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have not been vigorously pursued to check this deforestation. The total area of planted sites in Ghana is put at 72,103 ha consisting of 71,629 ha plantation and 473 ha of naturally regenerated sites. This figure accounted for merely 0.8 % of Ghana's forest and 2.8 % of the total area of forest reserves (JAFTA 1999). Tree species planted include indigenous species such as *Terminalia ivorensis, Khaya ivorensis* among others. Exotics planted include *Tectona grandis, Cedrela odorata* and *Eucalyptus* species. The choice of species planted has been dependent upon the end purpose.

The new Ghana forest policy of 1994 fully recognizes the need for reforestation programs in order to increase the forest cover of Ghana. Accordingly a long-term strategic plan prepared by the Forest Service of Ghana recommends that degraded forest reserves should be put under reforestation and or rehabilitation.

However, successful reforestation programs require good knowledge of site factors such as soil, light, nutrients and available moisture which collectively influence tree physiology and growth as well as choice of species among other factors (Bockheim 1982). *Khaya ivorensis* and *Bombax buonopozense* are native Ghanaian timber species which are found in natural forests. *Khaya ivorensis* has been heavily logged from Ghana's forests over many decades because of its high commercial value and wood quality. It has therefore been classified as a " red star" species which means it requires a high priority conservation status (Hawthorne 2001). However, the Forestry Service Division of Ghana has made little attempt in planting *Khaya* tree species. This can be partly attributed to inadequate silvicultural knowledge of the tree species. *Bombax buonopozense* on the other hand has been little exploited in the past but now it is increasingly becoming important in the timber trade of Ghana as it is being used as the inner core material for veneer plywood production in Ghana. It is widely distributed in the forest zone of Ghana and known to regenerate in forest gaps (Hall and Swaine 1981).

Physiological processes such as photosynthesis in plants are highly sensitive and responsive to environmental stresses, as well as indicative of normal developmental and seasonal changes. Conventional measurement of photosynthesis using gas exchange is usually destructive to plants and time-consuming, and insufficiently diagnostic with respect to localizing photosynthetic system disturbances. Chlorophyll fluorescence is a non-destructive, fast alternative with considerable diagnostic potential. The utility of chlorophyll fluorescence in various applications is based on its relationship to photosynthetic processes. Fluorescence feature such as electron transport rate (ETR) have shown to reflect shade acclimation in tress (Mohammed *et al.* 1995).

This experiment aims:

1. to find out the effect of light and nutrient on growth and electron transport rate (ETR) of native Ghanaian tree species (*B. buonopozense* and *K. ivorensis*) and exotic tree species (*C. odorata*).
2. to build up growth and ecophysiological characteristics on *B. buonopozense, C. odorata* and *K. ivorensis* for use in reforestation programs.

Materials and Methods

Table 1. shows brief description of the species used in the experiment.

1. Plant material

On May 4, 2002, seeds collected from the Brong-Ahafo region of Ghana were germinated in plastic trays filled with "bora-tsuchi" (light, small porous stones produced from non-weathered substrate of volcanic origin). After two months when the first true leaves were fully expanded, seedlings were transplanted into Wagner's pot (19.5 cm in length and 17.5 cm in diameter) in July 2002. Akahoya soil (silt loam soil produced from weathered volcanic substrate) was used as the substrate because of its moderate texture and nutrient content (Kanda 2000). The transplanted

Table 1. Brief description of *B. buonopozense, C. odorata* and *K. ivorensis*

Species	Taxonomy & Silviculture	Local or Trade name	Natural occurrence & climate	Utilization
B. buonopozense	Family : Bombacaceae Deciduous, Buttressed and spiny tree. Size : 30-40m in height.	akonkodie	West Africa *M.a.r* : 1000-1750mm *M.a.t* : 20-33℃	light constructions works (e.g. boxes)
C. odorata	Family : Meliaceae Deciduous and Buttressed tree. Size : 30-40 m in height.	Cedar, cedro	Central/S. America *M.a.r* : 1600-2500 mm *M.a.t* : 22-32℃	Furniture and veneer plywood
K. ivorensis	Family : Meliaceae Evergreen and Buttressed tree. Size : 30-50m in height. Exceptional tree form.	African mahogany	Ivory coast to Gabon *M.a.r* : 1250-2000 mm *M.a.t* : 24-27℃	Heavy construction and furniture

Source : Hall and Swaine (1981) ; Pancel (1993).
M.a.r and *M.a.t* refers to mean annual rainfall and mean annual temperature respectively.

seedlings were conditioned under a tree (partial shade) for 10 days before transferring them into each of the shade houses and the open site (full sunlight).

2. Growth conditions and Treatment

The experiment site was at the nursery of Forestry laboratory of Miyazaki University. Aluminum metal frames of 1.6 m × 1.6m × 1.8 m covered with black polypropylene nets to provide different levels of shade were used as shade houses. The nets used provided good ventilation and therefore variation in air temperature inside and outside the shade houses was not large enough during the experimental period i. e. July to October. Sets of 6 seedlings of *B. buonopozense, C. odorata,* and *K. ivorensis* were randomly assigned and arranged within each of the four shade houses and in one open site.

Treatment represented five contrasting light regimes referred to by percentage of relative sunlight intensity : (1.00 RLI, 0.44 RLI, 0.15 RLI, 0.05 RLI and 0.01 RLI). Each of these was also subjected to three nutrient supply regimes i. e. 0g (control), 5g and 10 g of fertilizer. The fertilizer used had a 20 : 10 : 10 N-P_2O_5-K_2O_5 rating. The treatments were replicated twice. The average seedling height and basal stem diameter before the treatment were 5.1 cm and 2.5 mm, 6.2 cm and 1.8 mm and 5.1 cm and 1.9 mm for *Bombax, Cedrela* and *Khaya* respectively. Seedlings in the open site (full sunlight) were watered regularly to prevent water stress conditions from occurring. Meteorological conditions outside the shade house during the experiment period were as follows : 24.7 ℃, 28.9 ℃ and 21 ℃ as mean, maximum and minimum monthly temperatures respectively. Mean monthly relative humidity and mean monthly rainfall were 74.5 % and 171 mm respectively (Miyazaki Meteorological Agency 2002). The month of August recorded the highest mean monthly temperature of 32.1 ℃ whilst the month of October showed a minimum mean monthly temperature of 19 ℃ during the experiment period. The period of the experiment was from mid-July to the end of October, 2002.

3. Growth measurements

Seedling height and basal stem diameter of all seedlings in each of the four shade houses and one open house were measured with steel tapes and calipers respectively at the beginning and the end of the experiment. Furthermore, all the surviving seedlings were harvested and oven dried at 80 ℃ for 36 hours. Weight measurements of the shoot and root were then carried out for each set of species in the different shade houses and the open house. These were done to assess the above and below ground growth at the end of the three-month growing period.

4. Growth calculations

Growth was calculated as the respective increments in height (HI) and diameter (DI), i. e. the last measurement − the first measurement. The square of the stem diameter multiplied by the stem height was used as a surrogate for total seedling growth (D^2HI) as described by Elliot and Vose (1994). To compare above and below ground growth in each treatment, the ratio : oven-dry root weight/ oven-dry shoot weight (R/S) was calculated based on the measurements after harvest.

5. Electron Transport Rate (ETR) measurements

Three representative seedlings of each species in each of the four shade houses and one open house were selected. The ETR measurements were conducted to the upper leaves of each seedling weekly by using a portable chlorophyll fluorometer (Mini-PAM, Heinz Walz, Germany). Initial ETR measurements were made on July 17, 2002 for all the seedlings before treatments were applied. The Mini-PAM applies a pulse-modulated measuring light for detection of chlorophyll fluorescence yield. The formula, $ETR = 0.84 \times 0.5 \times PPFD \times (Fm' - F)/Fm$ (Schreiber *et al.* 1995 ; Mohammed *et al.* 1995) was used. Electron transport rates were calculated at PPFD=1000 $\mu mol\ m^{-2}s^{-1}$ for all upper leaves of each species in each treatment.

[Where ETR=electron transport rate (μmol electron $m^{-2}s^{-1}$) ; $(Fm' - F)/Fm$=yield]

6. Data Analysis

Variation in growth with changes in light and nutrient were tested by analysis of variance (ANOVA) for surviving seedlings. Responses of photosynthetic parameter ETR, to changes in light and nutrient treatments were described using light curves plotted from calculated ETR values during the experiment period July 17, to October 30, 2002.

Statistical analysis was made using the Excel Extension Statistics, 2002 Japan Version.

Results

1. Seedling survival in the 0.01 RLI (very deep shade house)

34 % of *B. buonopozense* seedlings survived up to the end of the experiment while 66 % died at different times during the experiment period. In the case of *K. ivorensis* 66 % of the seedlings survived up to the end of the experiment while 34 % died 2 months after the start of the experiment. 83 % of *C. odorata* seedlings survived up to the end of the experiment while 17 % died a week before the end of the experiment. In all cases the dead seedlings were found in the 10 g-nutrient treatment pots. In the other light treatments seedling survival ratios were above 83 % for all the three species.

2. Seedling growth

Analysis of variance and Fisher's LSD test (Table 2) and interactive effects of light and nutrient on growth parameters within species at each light regime (Fig. 1) are used as reference for the results.

The light and nutrient treatments had strong significant effects on HI, DI, D^2HI and R/S for *B. buonopozense.* Growth parameters (HI, DI and D^2HI) of *B. buonopozense* were at a minimum at 0.05 RLI and increased significantly at 0.44 RLI and decreased thereafter at 1.00 RLI. *B. buonopozense* seedlings did not survive in very deep shade (0.01 RLI). HI, DI and D^2HI were at a minimum at the 0 g nutrient supply level and increased significantly at the 5 g nutrient supply level. However, there were no significant differences on the growth parameters between the 5 g and 10 g nutrient treatment levels. Further analysis at each light level (Fig. 1) showed that HI, DI and D^2HI was greatest at 5 g nutrient application and 0.44 RLI. Significant differences among the nutrient treatments on HI, DI and

D^2HI were found in the light treatments at 0.44 and 1.00 RLI. The R/S was nearly constant at 0.15 and 0.05 RLI while it increased significantly at 0.44 and 1.00 RLI (full sunlight). R/S tended to decrease with nutrient application in the light treatment above 0.44 RLI. At 1.00 RLI and 0 g nutrient (control) level *B. buonopozense* showed the highest root-shoot ratio.

C. odorata seedlings on the other hand survived in very deep shade (0.01 RLI). Light and nutrient, as well as their interactions significantly influenced HI, DI and D^2HI.

Growth parameters (HI, DI and D^2HI) for *C. odorata* were at a minimum at 0.01 RLI but increased significantly at 0.44 and 1.00 RLI. HI, DI and D^2HI of *C. odorata* were at a minimum at the 0 g nutrient supply level and increased with increasing nutrient supply (Table 2). At 1.00 RLI, high nutrient supply (10 g) showed significant increase effects on HI, DI and D^2HI for *C. odorata* (Fig. 1). R/S was constant at 0.01 and 0.05 RLI while it increased significantly at 0.44 and 1.00 RLI. R/S for *C. odorata* tended to decrease with increased nutrient application (Table 2).

K. ivorensis like *B. buonopozense* did not survive completely in very deep shade (0.01 RLI) although the proportion of *K. ivorensis* seedlings that survived was more than that of *B. buonopozense* but less than that of *C. odorata.* In the case of *K. ivorensis* only light had significant effect on the growth parameters. Growth parameters (HI, DI and D^2HI) for *K. ivorensis* were minimum at 0.05 RLI and maximum at 0.44 RLI. Unlike *B. buonopozense* and *C. odorata, K. ivorensis* did not show significant differences among the nutrient treatments as well as the nutrient-light interaction. Relative light intensity as a treatment did not show significant difference for R/S of *K. ivorensis* but further analyses among the RLI levels using the Fisher's LSD test showed significant differences between 1.00 and 0.15 RLI & 1.00 and 0.15 RLI (Table 2). Nutrient treatments did not significantly influenced R/S for *K. ivorensis.*

Table 2. ANOVA and means for the effects of light and nutrient on height growth (HI), diameter growth (DI), total growth (D^2HI) and root-shoot weight ratio (R/S) of *B. buonopozense, C. odorata* and *K. ivorensis seedlings*

Treatment	*B. buonopozense*				*C. odorata*				*K. ivorensis*			
	HI[1]	DI	D^2HI	R/S	HI	DI	D^2HI	R/S	HI	DI	D^2HI	R/S
Relative light intensity												
1.00	13.1a[2]	5.4a	14.6a	1.6a	23.7a	8.4a	56.2a	0.6a	7.8a	1.7a	2.2a	0.5a
0.44	34.0b	6.4a	39.0b	0.8b	31.4b	9.2b	58.8a	0.4b	14.3b	3.2b	5.7b	0.32ab
0.15	10.3a	2.6b	4.0c	0.3c	9.9c	1.8c	1.9b	0.3c	7.0a	1.2a	1.2a	0.28b
0.05	8.6a	1.7b	2.1c	0.3c	8.1c	1.9c	1.5b	0.3c	3.8a	0.6a	0.3a	0.26b
0.01	–	–	–	–	1.7d	0.5d	0.1b	0.3c	–	–	–	–
Nutrient supply												
0g(control)	9.2a	2.5a	3.6a	1.2a	10.4a	3.3a	6.6a	0.5a	7.3a	1.6a	2.2a	0.4a
5g	20.5b	4.9b	22.4b	0.5b	15.4b	4.1b	22.7b	0.4b	8.0a	1.5a	1.6a	0.3a
10g	19.8b	4.8b	18.7b	0.6c	18.9c	5.7c	41.9c	0.3b	9.4a	2.0a	3.2a	0.3a
ANOVA, F-values[3]												
light (L)	34.92**	26.53**	29.26**	186.80**	76.28**	281.77**	31.76**	27.91**	9.39**	8.40**	5.88*	2.84
nutrient (N)	13.45**	13.60**	13.47**	85.90**	15.84**	41.16**	17.36**	14.70**	0.71	0.64	0.99	0.89
LXN	4.32*	4.10*	6.26**	17.50**	18.67**	44.19**	15.85**	4.87**	1.30	1.09	0.81	0.28

1) HI (cm) ; DI (mm) ; D^2HI (cm^3) ; R/S
2) Means within a column followed by the same letter are not significantly different at $P<0.05$, according to Fisher's LSD test.
3) Significant effects are indicated by asterisks : * and ** denoting $P<0.05$ and 0.01 respectively.

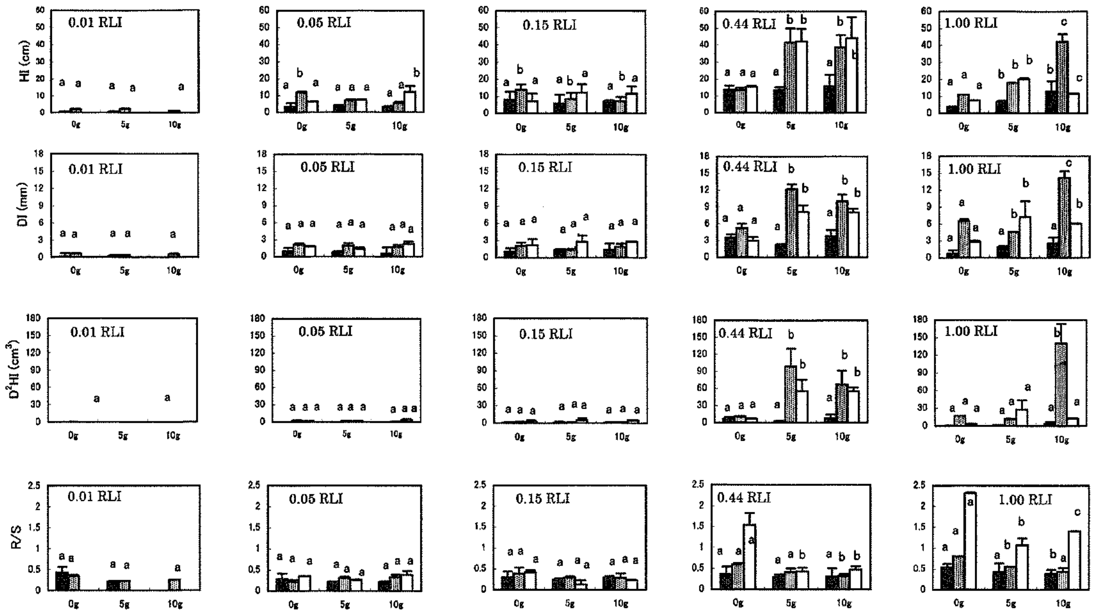

Fig. 1. Interactive effects of light (RLI) and nutrient (g) on stem height growth (HI), diameter growth (DI), total growth (D^2HI) and root-shoot ratio (R/S) of *B. buonopozense* (open bars), *C. odorata* (dotted bars) and *K. ivorensis* (solid bars) seedlings. Bars show means + standard deviations. Bars with different letters indicate significant differences of means $p<0.05$ among nutrient treatments within species at each light regime.

3. Electron transport rate (ETR) response

At lower light treatments (<0.15 RLI) ETR response was low for *B. buonopozense* with the minimum response occurring at 0.01 RLI while it increased at higher light treatments (>0.44 RLI). The maximum (peak) response occurred at 1.00 RLI (full sunlight); this peak ETR response for *B. buonopozense* was evident in early and late September at the 5 g nutrient treated level. ETR responses for 0 g nutrient (control) and 10 g nutrient treated *B. buonopozense* seedlings were lower at light intensities above 0.44 RLI (Fig. 2).

C. odorata like *B. buonopozense* showed low ETR response at lower light intensities (<0.15 RLI) with the minimum response occurring at 0.01 RLI while it increased at higher light treatments (>0.44 RLI). The peak response occurred at 1.00 RLI (full sunlight); this peak ETR response for *C. odorata* was evident in mid August and the end of September at the 10 g nutrient treatment level (Fig. 2). *C. odorata* unlike *B. buonopozense* showed increased ETR response with increasing nutrient supply at light intensities above 0.44 RLI (Fig. 2). At lower light treatments (<0.15 RLI) ETR response for *C. odorata* and *B. buonopozense* showed no clear differences among the nutrient treatments.

K. ivorensis on the other hand showed low ETR response at very low light intensities (<0.05 RLI) with the minimum ETR response occurring at 0.01 RLI. In the 0.44 RLI (partial shade) *K. ivorensis* showed maximum (peak) ETR response at the 10 g nutrient treatment level, however, the peak ETR response for the 0 g nutrient (control) was slightly higher than the 5 g nutrient treatment at 0.44 RLI (Fig. 2). The peak ETR response for *K. ivorensis* was evident in mid-August and early September. Unlike the other two species mentioned, *K. ivorensis* indicated low ETR response at 1.00 RLI (full sunlight) in all the nutrient treatment levels.

At lower light intensities (<0.15 RLI) there seem to be no differences in the ETR responses among the nutrient treatments for all the three species. In all the light and nutrient treatments ETR response declined to a minimum at the end of October for all the three species. All the

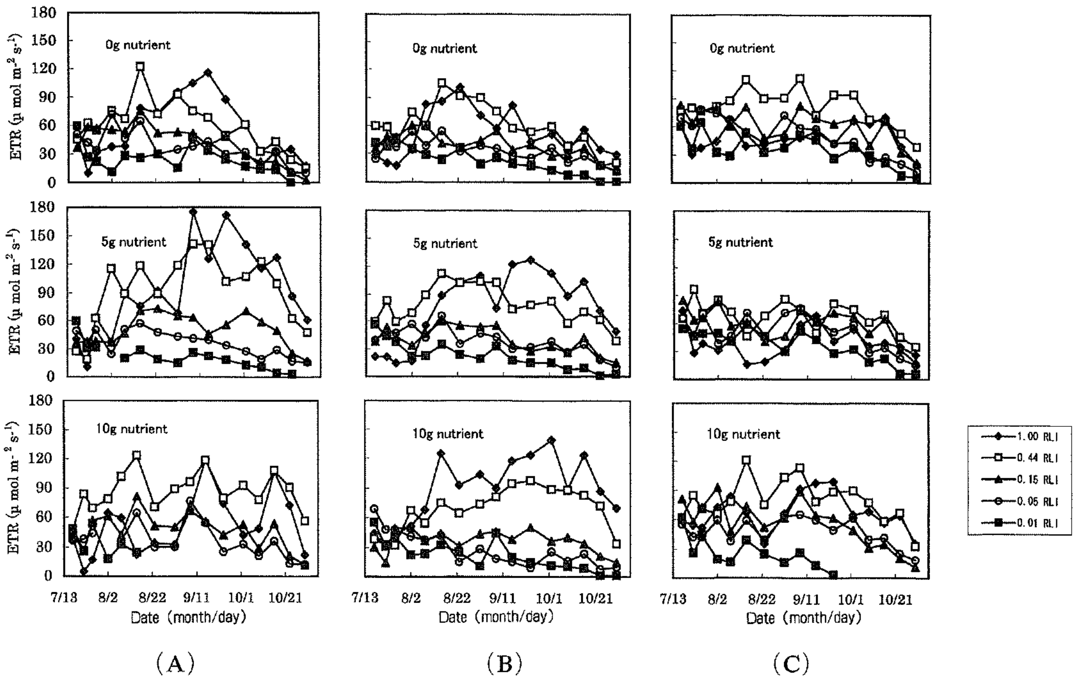

Fig. 2. Electron Transport Rate (ETR) response within (A) *B. buonopozense,* (B) *C. odorata* and (C) *K. ivorensis* seedlings grown in pots with 0g, 5g and 10g nutrient treatments under five relative light intensities (RLI) respectively.

three species showed an early decrease in ETR at the 1.00 RLI (full sunlight) treatment level (Fig. 2).

Discussion

1. Interactive effects of light and nutrient

Previous studies by Canham *et al.* (1996); Sharew *et al.* (1996) suggested that soil nutrient availability could influence plant growth depending on light levels in an environment. Nutrient supply has been found by Wong *et al.* (1985) to affect leaf morphology and physiology and hence leaf photosynthetic capacity at high irradiance (Thompson *et al.* 1988).

In this study, seedling growth (HI, DI, and D^2HI) in *B. buonopozense, C. odorata* and *K. ivorensis* were responsive to light environment during the growing stage (Table 2). Minimum and maximum total growth (D^2HI) were at 0.05 RLI and 0.44 RLI respectively for both *B. buonopozense* and *K. ivorensis.* In full sunlight (1.00 RLI) total growth for *B. buonopozense* and *K. ivorensis* significantly decreased. *C. odorata* unlike *B. buonopozense* and *K. ivorensis* survived in very deep shade (0.01 RLI). In *C. odorata* D^2HI increased with increasing RLI at the 10 g nutrient supply level. Seedling growth responses in all the three species were not dependent on nutrient supply under low light availability (0.01, 0.05 and 0.15 RLI) as shown in Fig. 1. Similar results have been reported by Elliot and White (1994) who studied the effects of high nitrogen supply on total biomass of red pine grown under shade conditions.

As light levels increased from 0.44 to 1.00 RLI, nutrient amendment enhanced growth in the three species (Fig. 1). Growth of *C. odorata* increased significantly in full sunlight at high nutrient supply (10 g). In contrast, growth in *B. buonopozense* and *K. ivorensis* increased significantly at 0.44 RLI (partial shade) with medium nutrient supply (5 g) while they decreased in growth at full sunlight and high nutrient supply (10 g) (Fig. 1).

Many hardwood species show better height growth under partial shade conditions as well as under full sunlight. However, regardless of whether above ground growth is increased or decreased by shaded conditions there seems to be little doubt that root (below ground) development is sharply impaired. At low irradiance levels, seedlings of most forest trees have relatively shallow and poorly developed root systems (Barnes *et al.* 1998). This study indicated same results as the root-shoot weight ratio for all the three species increased with increasing light treatment while the ratio decreased with increasing nutrient at all light treatments. Under a growing forest, root competition substantially reduces the amount of soil water available to seedlings. At low light irradiance plants develop reduced root size and therefore are not able to compete effectively for soil water and nutrients which frequently leads to the death of seedlings. The R/S ratio allows a comparison of how the species allocated available photosynthates (Table 2). In the same table it could be observed that R/S for *B. buonopozense* was notably dependent on light and R/S of *B. buonopozense* was larger than that of *C. odorata* and *K. ivorensis* at light levels above 0.44 RLI. Larger values in R/S indicated more allocation of photosynthates to root growth rather than to shoot growth (Barnes *et al.* 1998), and it is thought to be a morphological adaptation in shade intolerant species. Low light level limits photosynthesis and carbohydrate production, even when soil resources are abundant. In such a situation, carbohydrate allocated to meet the demand of new leaves and roots occur at the expense of lower priorities of storage, stem growth, and the production of defense chemicals (Barnes *et al.* 1998). As a consequence, growth declined in all the three species at low light levels below 0.15 RLI and hence R/S was accordingly low.

Several studies indicated that under strong light conditions, the photosynthetic apparatus of plants receiving a low nutrient supply was less efficient than that of plants receiving a high nutrient supply (Thompson *et al.* 1988, 1992). In this study similar results were found for *C. odorata* and *B. buonopozense* which showed peak ETR response at 1.00 RLI (full sunlight) with nutrient treatment at 10 g and 5 g respectively. Further, the peak ETR response was detected in summer (August-September) (Fig. 2). *K. ivorensis* on the other hand showed peak ETR response at 0.44 RLI and high nutrient supply (10 g).

When the seedlings were transferred from the conditioning site (partial shade) into the full sunlight in early summer, a combination of high light and high temperatures may have affected the photosynthetic efficiency of the leaves of the seedlings leading to photo inhibition with a corresponding decrease in the ETR. From mid to late summer, *B. buonopozense* and *C. odorata* seedlings became acclimated to high irradiance and temperatures at 1.00 RLI and ETR steadily increased. ETR is affected by the foliage position on a tree as well as leaf age. In a comparative sun and shade leaf physiological studies, Mohammed *et al.* (1995) reported that fluorescence decrease ratio; R_{fd} (a vitality index for overall photosynthetic function of a plant) for *Picea* was highest in the youngest needles and decreased in the older dark green needles. In this experiment as the leaves of the seedlings grew older in autumn the ETR correspondingly decreased. This was confirmed in the report by Mohammed *et al.* (1995).

Growth and ETR responses for all the three species were not dependent on nutrient supply at low light treatments.

2. Species characterization in relation to light and nutrient requirements

B. buonopozense was the shade intolerant species which required moderate nutrient supply (5 g) and light intensity above 0.44 RLI for effective growth and photosynthetic process. Best total growth for *B. buonopozense* was observed at 0.44 RLI.

C. odorata thrived in a wide range of light conditions but best total growth and photosynthetic process was observed under full sunlight (1.00 RLI) and high nutrient (10 g) condition.

In the case of *K. ivorensis* partial light condition (0.44 RLI) was critical for effective growth and photosynthetic process. Growth was more dependent on light than on nutrient. *K. ivorensis* survived to some extent under very low light condition (0.01 RLI).

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光強度と養分がガーナ産熱帯樹（*Bombax buonopozense, Khaya ivorensis* and *Cedrela odorata*）苗木の成長と電子伝達速度に及ぼす影響

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要 約

熱帯樹種の成長や生理的反応での最適光条件及び養分条件は樹種により異なっている．ガーナの郷土種であるボンバックス（*Bombax-buonopozense*）やカヤ（*Khaya ivorensis*），導入樹種のセドレラ（*Cedrela odorata*）の現実の光要求度や養分要求性についてはわかっていない．この研究では3樹種の成長および光合成速度（電子伝達速度ETR）への光および養分の影響を明らかにすることを目的とした．ボンバックス，カヤ，セドレラの2ヶ月苗を5段階（1.00 RLI, 0.44 RLI, 0.15 RLI, 0.05 RLI, 0.01 RLI）の相対照度下で3段階の施肥処理（0g，5g，10g/苗木）を行って14週間生育させた．ボンバックスとセドレラ苗木の地上部及び地下部の成長には光，養分およびその相互効果で有意な影響が認められた．カヤの地上部成長には光処理だけが有意な影響を及ぼした．ボンバックスとセドレラ苗木では，成長パラメータの高さ（HI），直径（DI），体積（D^2HI）および地下部/地上部比は光合成速度（ETR）と同様に高施肥条件下で増大した．それに対し，カヤではやや被陰条件下で成長と光合成速度が大きくなった．

キーワード：成長量，電子伝達速度，養分，相対照度，熱帯樹種