Light Acclimatization Potential of *Leea coccinia* and *Leea rubra* Grown under Low Light Flux

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Abstract. Two foliage plant species, *Leea coccinia* L. and *Leea rubra* L., exhibited lower light compensation points and faster rates of acclimatization than *Ficus benjamina* L. when moved from full sun to dense shade, i.e., from 15.7 to 0.26 or 0.09 mol·m⁻²·day⁻¹. Light compensation points were reduced up to 75% for *L. coccinia* and 71% for *L. rubra* after 25 days under these conditions. Uptake of CO₂ increased from 65% to 179% and 34% to 118% for *L. coccinia* and *L. rubra*, respectively, while respiration rates were reduced from 73% and 76% to 59% to 68%, respectively. *Ficus benjamina* plants died under similar conditions.

There has been a dramatic increase in the use of large foliage plants in indoor living and working spaces. However, there are few large plant species suitable for interiors, the predominant species currently being *Ficus benjamina*. Plants for interior use must be able to acclimatize to interior environmental conditions. Two attractive species that may be suitable for use as interior plants are *Leea coccinia* and *L. rubra*, both multi-stemmed, bi- and tri-pinnately compound leaved plants that may attain heights of 4 m (Liberty Hyde Bailey Hortorium, 1977).

Plants in general have the ability to adjust to changes in environmental conditions by undergoing morphological and physiological changes including in leaf morphology, chloroplast structure, stomatal resistance, ratio of chloroplast components, and capacity of chloroplast reactions (Boardman, 1977). The capacity to acclimate varies with plant species and genotype. Indoor and outdoor environments often differ in many respects, most notably in temperature, humidity, and light intensity. The ability of foliage plants to acclimatize rapidly to dim light is vital to their survival and use (Collard et al., 1977; Conover and Poole, 1975; Fails et al., 1982b; Larson, 1979). The rate of acclimatization of four species of tropical foliage plants over 15 weeks from full sun to low light intensity

(4.9 mol·m⁻²·day⁻¹) indicated that species possessed different rates of acclimatization under identical conditions (Fonteno and McWilliams, 1978). Similar results were obtained by Pass and Hartley (1979) with three tropical foliage species under four light levels. All species displayed an increase in net CO₂ uptake efficiency with a decrease in dark CO₂ evolution (Fails et al., 1982a, 1982b; Fonteno and McWilliams, 1978; Pass and Hartley, 1979).

The objectives of this study were to determine the degree of acclimatization under simulated interior lighting conditions (SIL) of *L. coccinia* and *L. rubra* when compared with *Ficus benjamina*.

All cuttings were propagated between 8 Jan. and 15 Feb. 1986. Leaf/bud cuttings of *L. coccinia* and *L. rubra* were propagated in 1 peat : 1 vermiculite (v/v) with bottom heat and mist. Cuttings of *F. benjamina* consisting of three to five leaves were treated basally with 0.3% 1 *H*-indole-3-butyric acid (IBA) in talc and rooted in 2 peat : 1 perlite (v/v) with bottom heat and mist. All plants were grown under greenhouse full sun conditions and were repotted twice between the propagation date and 5 May 1986 resulting in 350 *L. coccinia*, 410 *L. rubra*, and 350 *F. benjamina* plants, all grown in 3-liter plastic pots.

A 3 × 3 × 3 repeated measure factorial design experiment-three photosynthetic photon flux levels, three measurement dates and three species-was started in the greenhouse on 4 July 1986. Each photosynthetic photon flux light treatment was achieved by placing one layer or a combination of layers of silver foiled reflective cloth, 92% black polypropylene shade cloth, and 63% black polypropylene shade cloth to create treatments of 98.7% (0.26 mol·m⁻²·day⁻¹) and 99.8% (0.09 mol·m⁻²·day⁻¹) shade, respectively, to simulate moderate to low light interior conditions. The control plants (full sun) were covered with one layer of 0.025-mm-thick clear polyethylene film to obtain air

temperatures similar to the shade treatments. Cooling and air circulation in the shaded treatments were provided by greenhouse inflation blower fans. Light flux and temperature within each treatment were continuously recorded using 190 SB quantum sensors (LICOR, Lincoln, Neb.) and copper-constantan thermocouples attached to a Campbell CR-7 data logger (Campbell Scientific, Logan, Utah). Plants for the experiments were selected for uniformity in plant height and width, leaf count, size, age, and canopy density and, in addition, for *F. benjamina*, number of growing points and number and angle of the branches. Each treatment consisted of four plants of each species. Photosynthetic and respiration rates were recorded with a portable infrared CO₂ gas analyzer (ADC Corp., Hoddesdon, U.K.) on 4, 18, and 28 July 1986 for each plant while being kept in a growth chamber with controlled light (fluorescent/incandescent) and at 30 ± 2°C. The portable leaf chamber (area 6.25 cm²), located 76 cm from the light source, was clamped onto the first fully developed leaf from the apex of the plant. Each leaf was subjected to six levels of photosynthetically active radiation of 125, 80, 44, 11, 4, and 0 μmol·m⁻²·s⁻¹ to obtain light compensation points (LCP; net CO₂ uptake = net CO₂ evolution). Data were analyzed using linear regression methods to calculate light compensation points. Light compensation points were calculated by substituting y = 0 into each respective regression equation. Data were then analyzed using the General Linear Models procedure and Duncan's multiple range test.

Leea coccinia. Light compensation points for control plants remained fairly stable until day 25, when a sharp decrease was recorded

Table 1. Light compensation points of *Leea coccinia*, *L. rubra*, and *Ficus benjamina* grown under three light levels in the greenhouse.

Species	Shade level (%) ^a	Light compensation point (μmol·m ⁻² ·s ⁻¹)		
		No. days		
		0	14	25
<i>Leea coccinia</i>	0	88.1	73.1 a ^y	51.6 a
	98.7	88.1	36.7 b	21.3 b
	99.8	88.1	27.5 b	33.6 b
Significance				
Shade		NA	**	**
<i>Leea rubra</i>	0	83.8	84.0 a	67.1 a
	98.7	83.8	— ^x	48.7 a
	99.8	83.8	48.3 b	24.5 b
Significance				
Shade		NA	*	**
<i>Ficus benjamina</i>	0	72.1	75.3 a	69.6
	98.7	72.1	144.0 a	Dead
	99.8	72.1	162.6 a	Dead
Significance				
Shade		NA	NS	NA

^a0% = 15.74, 98.7% = 0.26, 99.8% = 0.09 mol·m⁻²·day⁻¹.

^yMean separation in columns by species using Duncan's multiple range test, *P* > 0.05.

^xMissing plot; not measureable due to stomatal closure.

NS,*,**Not significant or significant at *P* = 0.05 and 0.01, respectively.

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Table 2. Net photosynthesis and dark respiration of *Leea coccinia*, *L. rubra*, and *Ficus benjamina*, after 0, 14, and 25 days under three light levels in the greenhouse.

Species	No. days	Shade level (%) ^a		
		0	98.7	99.8
<i>Leea coccinia</i> Pn ^b	0	1.39 b*	1.39 b	1.39 b
	14	2.24 b	2.27 b	3.52 a
	25	3.21 a	3.83 a	2.23 ab
Significance, days		**	**	**
Rd ^c	0	-3.91 b	-3.91 b	-3.91 b
	14	-3.54 ab	-1.30 a	-1.17 a
	25	-2.75 a	-1.02 a	-0.95 a
Significance, days		NS	**	**
<i>Leea rubra</i> Pn	0	1.39 a	1.39 a	1.39 a
	14	1.31 a	---	1.96 ab
	25	1.75 a	1.86 a	3.03 b
Significance, days		NS	NS	*
Rd	0	-3.14 b	-3.14 b	-3.14 b
	14	-2.88 b	---	-1.31 a
	25	-2.28 a	-1.29 a	-1.01 a
Significance, days		**	**	**
<i>Ficus benjamina</i> Pn	0	3.14 a	3.14 a	3.14 a
	14	2.61 a	-0.12 b	-0.21 b
	25	2.35 a	Dead	Dead
Significance, days		NS	**	**
Rd	0	-3.93 ab	-3.93 a	-3.93 a
	14	-4.36 b	-1.20 b	-1.01 b
	25	-3.50 a	Dead	Dead
Significance, days		NS	**	**

^a0 = 15.74%, 98.7% = 0.26, 99.8% = 0.09 mol·m⁻²·day⁻¹.

^bmg CO₂/dm² per hour; measured at 125 μmol·m⁻²·s⁻¹.

^cMean separation in columns by species using Duncan's multiple range test, *P* > 0.05.

^dmg CO₂/dm² per hour; measured at 0 μmol·m⁻²·s⁻¹.

^eMissing plot; not measurable due to stomatal closure.

NS,*,**Not significant or significant at *P* = 0.05 or 0.01, respectively.

Fig. 1. Light acclimatization rates of *Leea coccinia* (Δ), *L. rubra* (□) and *Ficus benjamina* (○) grown under 98.7% (0.26 mol·m⁻²·day⁻¹) (top) and 99.8% (0.09 mol·m⁻²·day⁻¹) (bottom) shade.

(Table 1). The reason for this change is unknown but may have been caused by several days of very cloudy weather resulting in a shading effect. Plants grown under 98.7% shade for 25 days exhibited a reduction in LCP of 76% over initial values, while those grown under 99.8% shade exhibited a reduction of 62% (Table 1). By 25 days, up take of CO₂ had increased 276% for plants grown under 98.7% shade and 160% for those grown under 99.8% shade compared with initial values (Table 2). Respiration rates decreased by 74% over initial values for 98.7% shade plants and by 76% for plants grown

under 99.8% shade (Table 2). The continuing decrease in LCP for plants under 98.7% shade indicates that the lowest LCP point for this group had not been reached during the 25-day experimental period (Fig. 1). Plants under 99.8% shade, however, displayed a slight increase in LCP; possibly indicating that the limit of the decline in LCP had been reached (Fig. 1).

Leea rubra. Plants in full sun maintained relatively stable LCP until day 25, when a decrease similar to that observed for *L. coccinia*, was recorded. Plants under 98.7% shade for 25 days exhibited a reduction in LCP of 42% compared with the initial value (Table 1). A reduction in LCP of 71% from the initial value was exhibited for the 99.8% shade group (Table 1). Light compensation points for plants of the 98.7% shade group could not be calculated for day 14 due to stomatal closure. Pass and Hartley (1979) recorded similar periods of apparently low stomatal apertures while conducting LCP experimentation on the species *Epiprinum aureum* (Linden & Andre). Uptake of CO₂ after 25 days for plants grown under 98.7% shade increased 134% from the initial value, while those grown under 99.8% exhibited an increase of 218% (Table 2). The respiration rate had decreased 59% for the 98.7% shade group after 25 days and 68% for those under 99.8% shade (Table 2). Light compensation points after 2.5 days continued to decrease for plants under 98.7% and 99.8% shade (Fig. 1), possibly indicating that the minimum LCP for this species had not been reached after 25 days.

Ficus benjamina. Light compensation

points of plants in full sun remained fairly constant for the three measurement dates (Table 1). Plants in the 98.7% and 99.8% shade treatments began to drop mature green leaves, immature leaves, and growing points after only 5 days. At day 14, LCP for plants in the 98.7% shade group had increased 200%, while for plants grown under 99.8% shade it had increased 226% compared with initial values (Table 1). We suspect that the increase was due to maintenance respiration costs exceeding photosynthetic capacity. After 25 days, responses could not be measured because the plants had died. Leaf drop of sun-grown *F. benjamina* in response to reduced light during acclimatization is well documented (Collard et al., 1977). Conover and Poole (1975) reported severe leaf drop when plants grown in full sun in Florida with no acclimatization were placed under 40% or 80% shade. Fails et al. (1982a), however, reported no deterioration in plant quality of *F. benjamina* when first grown in Virginia under full sun and then moved to 75% shade for 12 weeks. While the LCP for acclimatizing *F. benjamina* reported here were inconsistent with several previously reported results, the degree of shading we used was much greater than those used by others, making direct comparison inappropriate. The inability of the older leaves to compensate for the drastically reduced light intensity by increasing their photosynthetic efficiency in this study and high respiration costs may have resulted in the leaf drop, lack of regrowth, and the inability to acclimatize, as indicated by the pattern of LCP changes. Consequently, the LCP increased rather than declined (Fig. 1). Soil moisture content also may have been a contributing factor. Under reduced PPF, soil moisture is maintained through reduced evaporation and, indirectly, through reduced evapotranspiration as affected by leaf drop. Johnson et al. (1981) reported more leaf drop under simulated interior lighting conditions for *F. benjamina* plants previously watered at 3-day intervals than for plants watered at 6- or 9-day intervals.

Both *L. coccinia* and *L. rubra* displayed decreasing LCP with decreasing light. Respiration after 25 days, regardless of the degree of shading, was reduced a minimum of 74% and 59%, respectively, for *L. coccinia* and *L. rubra*, while CO₂ uptake increased a minimum of 65% and 34%, respectively. In comparison, Fonteno and McWilliams (1978), reported a 50% to 70% reduction in dark CO₂ evolution in each of four foliage species after 15 weeks of acclimatization. The ability of *L. coccinia* and *L. rubra* to acclimatize rapidly by lowering their LCP with minimum leaf abscission may have resulted in older leaves increasing their photosynthetic efficiency (Fails et al., 1982b; Pass and Hartley, 1979). Since both *Leea* spp. exhibited a continuing decrease in LCP after 25 days, the possibility exists for even further reductions in LCP over an extended time. The implication is that *Leea* may be able to be grown under light levels lower than those used in this study.

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