RESPONSE OF *ANTHURIUM ANDREANUM* LINDL. TO DIFFERENT SHADE LEVELS IN SRI LANKA

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ABSTRACT

An experiment to determine the effects of 3 artificial shade levels, approximately 40% (low), 65% (medium) and 85% (high) on the growth and flowering in anthuriums at low and high elevation locations in Sri Lanka, showed that while enhanced growth rate was evident at the lower elevation, neither growth rate nor the total number of leaves per plant was affected by the shade levels. High shade at low elevations and low shade at high elevations were requisite for increased flower production. Spathe size and stalk length were positively related to shade levels at both locations. On an average, higher elevations produced larger spathes and low elevations produced longer flower stalks. Sucker production was significantly high at the higher elevations. Therefore while low elevations under high shade levels were suited for flower production, high elevations were more suited for the production of suckers.

KEY WORDS: *Anthurium andreanum*, Shade level

INTRODUCTION

Anthurium andreanum Lindl, an exotic tropical plant thrives well in the wet zone of Sri Lanka. This plant can be cultivated from sea level up to an elevation of 1400 m in the wet zone. The increase in demand for anthurium flowers for decorative purposes both locally and in the European countries, during the last decade has prompted growers in Sri Lanka to cultivate this plant on a commercial scale mainly as an export-oriented cut-flower industry.

Anthurium plant evolved as a small herb growing under trees in the tropical rain forests in South America, receiving only filtered light through the tree canopy for its growth, can be considered as a plant adapted to low levels of sunlight. The presently cultivated anthurium plant is known to be shade-loving requiring an optimum level of shade for efficient flower production. The shade requirement for anthurium has been investigated by many workers. In the Netherlands, Steen and Holsteyn (1975) showed that anthuriums produce more flowers when they are less shaded than was considered necessary. Griffioen (1980) stated that too heavy "greenhouse" shade reduced growth in anthuriums. Klapwijk and Speck (1984) observed a decline in average leaf number/m^2 after June till next March in the Netherlands, and suggested that since one bloom is produced for every leaf, as much light as possible in the glasshouse was essential for maximum leaf and bloom development after September till March. Nakasone and Kamemoto (1962) working in Hawaii showed that flower stem length was positively associated with degree of shade. The mean number of flowers produced per plant although increased with decrease in shade levels, they observed that under a low shade level of 30 — 47%, the plants were stunted with occasionally burnt leaves; and the spathe colour of flowers was affected with loss of glossiness at this shade level, compared to 60—75% shade.

Realising the importance of shade for anthuriums, growers in Sri Lanka adopt various methods of providing shade for their cultivation. Many growers cultivate anthuriums under shade trees in their garden. But natural shade has many disadvantages in commercial production such as fading of flowers due to uneven shade under the trees and spoilage of flowers by twig and leaf fall from the trees. The number of plants that could be grown are also limited by the size of the tree canopy. Some progressive cultivators however, have begun to provide shade using bamboo tats, saran cloth or coir matting indiscriminately, unaware of the optimum shade level required for the plant. Experimental evidence on the requirement of anthuriums for the different elevations in Sri Lanka is not available. This experiment was therefore designed to study the effect of three artificial shade levels on the growth and flower production of anthuriums at two elevations within the wet zone, where anthuriums thrive well.

MATERIALS AND METHODS

The experiment was laid out in a randomized complete block design with six replicates at each location. Beds measuring 3.05 m × 3.05 m × 2.3 cm were constructed for each treatment, separated by a 1.52 m space to prevent shade interference and lined at the base with 5 cm layer of brick pieces. A layer of growth medium (15-18 cm thick) consisting of 2:2:1 mixture of coconut husk, leaf mould and sand was placed above the brick pieces.

Twenty-five six-month old seedlings that were raised in nurseries under artificial shade were planted at a spacing of 61.0 cm × 61.0 cm in each bed. Coir mattings (12.5 to 25.0 mm mesh) in single or double layers were spread at 2.13 m above the plants on trusses erected above each bed, to provide the different shade levels. Watering was done with a fine nozzle when required to all treatments to maintain the required moisture for plant growth. Foliar fertilizer (Wauxal and Bayer 20:20:20) was sprayed (1.04g/1 water) alternatively every 14 days from planting to provide the necessary nutrients for plant growth. No fertilizers were added to the growing medium.

The experiment was carried out at (a) Hatton (Dickoya) (up country wet zone; elevation 1340 m above msl; mean annual rainfall > 1905 mm) and (b) Ehaliyagoda (Parakaduwa) (Low country wet zone; elevation 4572 above msl; mean annual rainfall > 2540 mm).

The following observations were taken:

(1) Light transmission value under different shade treatments to determine the shade level provided by the coir matting was measured only at Peradeniya with "Lux" meter.

(2) Number of leaves: Count of number of leaves at intervals from the 5th leaf onwards, the 5th leaf being designated L_1 and all the subsequent leaves as L_2, L_3 etc.

(3) Leaf size: The length from the point of attachment of the leaf blade to the stalk, to the top of the leaf and width (at the widest point on the leaf) were measured on the last expanded leaf. The leaf size was calculated as a product of the length and breadth.

(4) Number of flowers: Count of all unfurled flowers at each observation.

(5) Flower stalk length: Measured from the base of the stem to the point of attachment of the spathe.

(6) Spathe size: The length of the spathe from the point of attachment of the spathe to the stalk, to the top of the spathe and width (at the widest point on the spathe) were measured on the last fully-expanded flower. The spathe size was calculated as a product of the length and width.

(7) Number of suckers produced: The number of suckers (longer than 5 cm) were counted at every observation.

The experiment was terminated at 469 days after transplanting.

RESULTS

The light transmission through the different layers of coir mesh calculated as a per cent of the light intensity in the open is shown in Table 1. The high, medium and low shade levels represented by T_1, T_2 and T_3 differ by approximately 20% light transmission values (shade levels).

The total number of leaves produced per plant counted from the 5th leaf (L_1) in the different shade treatments at the two locations shows that shade levels do not affect the leaf number within either of the locations (Table 2). The combined analysis indicates significant mean location effect, with Ehaliyagoda producing more leaves than Hatton. Location × shade level interaction was not significant. A linear regression line fitted for the number of leaves and days after transplanting (Fig. 1) shows a higher value of the regression coefficient (b) at Ehaliyagoda and therefore a faster growth rate at this location than Hatton.

The effect of shade levels on the total number of flowers produced is shown in Table 3. At Hatton, medium and low shade levels produced significantly higher number of flowers than at the high shade level. At Ehaliyagoda higher number of flowers were produced in the medium and high shade levels, although statistically not significant.

The combined analysis shows significantly better flower production at Ehaliyagoda than at Hatton. The location × shade level interaction is significant confirming that at Ehaliyagoda medium to high shade levels, and at Hatton medium to low shade levels are required for increased flower production.

The mean stalk length of the 1st flowers (F_1) shows increase with increase in shade level at both locations (Fig. 2). In the 2nd flower (F_2) while increase in stalk length was observed from the low to medium shade levels at both locations high shade level did not show much increase over the medium shade level.

The mean spathe size of the 1st flower (F_1) that emerged was not greatly influenced by low and medium shade levels, but the high shade levels produced larger spathes at both locations (Fig. 2). The 2nd flower (F_2) was positively influenced by different shade levels showing increased spathe sizes with every step of increase in shade level at both locations (Fig.2). On an average the spathe sizes were larger at Hatton than at Ehaliyagoda. The data on spathe size and stalk length of the 2nd flower at Hatton could not be obtained as at the time of termination of the experiment, this flower did not emerge completely. The mean stalk lengths at Ehaliyagoda were greater than at Hatton at all shade levels, in both the F_1 and F_2 flowers.

The effect of shade on sucker production was significant only at Ehaliyagoda (Table 4). Low shade level is required for sucker production at this location. Although shade treatments do not show significant differences in the number of suckers produced at Hatton, the medium shade level appears to be marginally beneficial. Combined analysis shows a significant location effect with Hatton producing more suckers than Ehaliyagoda.

DISCUSSION

Rate of leaf emergence is one of the measures of growth rate in plants. The higher total number of leaves produced at the conclusion of the experiment, and the larger regression coeficient value at Ehaliyagoda indicate faster growth rate at this location than Hatton. Shade levels and therefore, the light intensity within each of these locations do not have any influence on leaf emergence. Since the mean temperatures are higher at low elevations, it could be inferred that keeping other factors such as growth medium, and cultural practices constant, higher temperatures cause a faster growth in this plant, which accounts for the higher growth rate at Ehaliyagoda (low elevation). Although it is known that shade reduces the direct exposure of the plant to light radiations and thus reduces leaf and plant temperature; the insignificant effect of such difference on the growth rate between shade levels may be that the ambient (air) temperatures alone were sufficient to promote growth in anthuriums irrespective of the difference in the plant temperatures.

The total number of flowers produced follows almost the same trend as the leaf production. Theoretically since each leaf axil produces a flower bud the higher leaf number at Ehaliyagodâ could be a contributory factor for higher number of flowers at this location. Differential response of shade on flower production within locations has been observed. The light intensity and sunshine hours are normally higher at lower elevations than at the higher elevations where frequent cloud cover hampers both light intensity and duration. It is probable that an optimum total light radiation is required for high net assimilation in anthuriums, and therefore high levels of shade that reduces excessive light radiation at the lower elevations and lower shade that allows more light to reach the leaf surface at higher elevations induce optimum net assimilation and therefore higher flower production. Insufficient net assimilation due to low photosynthetic activity under high shade at Hatton, and high photo-respiration under low shade (high light intensity) at Ehaliyagoda may have also caused degeneration of axillary bud primordia, accounting for lower flower production in these treatments.

High shade increases spathe and stalk size at both locations even though the influence was not very marked in the 1st flower (F_1). In the 2nd flower (F_2) even at medium shade levels large spathes are produced at Hatton compared to the high shade at Ehaliyagoda. The stalk length increased with increase in shade. The stalk length of the F_2 flower of the highest shade level at Hatton is almost the same as the lowest shade level at Ehaliyagoda.

The production of larger spathes at Hatton and longer flower stalks at Ehaliyagoda, and influence of shade levels on the size and length of these flower parts within the locations suggest that the growth of these are governed by the combined effect of light intensity and temperature. Light appears to be predominant for spathe expansion and temperature for flower stalk elongation. Further investigations are necessary to separate these effects.

Even though large spathes are produced at Hatton with low shade levels, yellowing and scorching of leaves and loss of glossiness of spathe were noticed in the low shade levels even at Hatton during Feb. — March and July—August when there was no cloud cover, indicating the damaging effect of high radiation on the plant parts.

Higher sucker production at Hatton compared to Ehaliyagoda could be attributed to the slower growth rate at Hatton. The partial suppression of apical dominance at Hatton could have induced the sprouting of more axillary buds at the ground level.

CONCLUSIONS

Higher number of flowers with acceptably large spathe sizes and longer stalks that are normally preferred by the consumers could be produced at the lower elevation locations under medium (about 65%) to high (about 85%) shade levels. High elevation locations produce flowers with large spathes and shorter stalks under medium shade, but if these are preferred, the growers have to sacrifice on the total number of flowers that could be obtained at these locations. On the other hand, high elevation location is highly suited for the production of suckers for use as planting material.

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Table 1. Shade treatment and per cent light transmission

Parameter	*Treatment*			*No Shade*
	T_1	*T_2*	*T_3*	
	Number of layers of coir mesh			
	1	*2*	*1*	
	Mesh size (mm)			
	12.7	*38.1*	*38.1*	
Mean light intensity (Lux)	1240	3245	5275	9000
Light transmission (% of no shade)	13.8	36.0	58.3	100
Shade (%)	86.2	64.0	41.7	0
Shade level	High	Medium	Low	

Table 2. Total number of leaves/plant counted from L_1 leaf (mean of 6 replicates)

Location	*Shade level*			*Mean*
	High	*Medium*	*Low*	
Hatton	5.3	5.5	5.6	5.5
Ehaliyagoda	7.5	7.2	7.2	7.3
Mean	6.4	6.3	6.4	6.4

Within Location

LSD (0.05) Shade levels — Hatton = n.s. CV = 7.9%

LSD (0.05) Shade levels — Ehaliyagoda = n.s. CV = 5.8%

Combined analysis

LSD (0.05) Location = 0.3

LSD (0.05) Shade levels = n.s.

LSD (0.05) Shade × Location = n.s. CV = 6.1%.

n.s = not significant

Table 3. Total number of flowers per plant (mean of 6 replicates)

Location	*Shade level*			*Mean*
	High	*Medium*	*Low*	
Hatton	0.83	1.10	1.06	1.00
Ehaliyagoda	1.98	1.99	1.81	1.93
Mean	1.40	1.54	1.43	1.46

Within Location

LSD (0.05) Shade levels — Hatton = 0.18 CV = 13.8%
LSD (0.05) Shade levels — Ehaliyagoda = 0.23 CV = 9.3%

Combined analysis

LSD (0.05) Location = 0.08
LSD (0.05) Shade levels = n.s.
LSD (0.05) Location × Shade levels = 0.20 CV = 8.2%

Table 4. Total number of suckers/plant (mean of 6 replicates)

Location	*Shade level*			*Mean*
	High	*Medium*	*Low*	
Hatton	1.09	1.38	1.25	1.24
Ehaliyagoda	0.96	0.90	1.17	1.01
Mean	1.03	1.14	1.21	1.13

Within Location

LSD (0.05) Shade levels — Hatton = n.s. CV = 23.0%
LSD (0.05) Shade levels — Ehaliyagoda = 0.20 CV = 15.5%

Combined analysis

LSD (0.05) Location = 0.15
LSD (0.05) Treatment = n.s.
LSD (0.05) Location × Treatment = n.s. CV = 19.5%

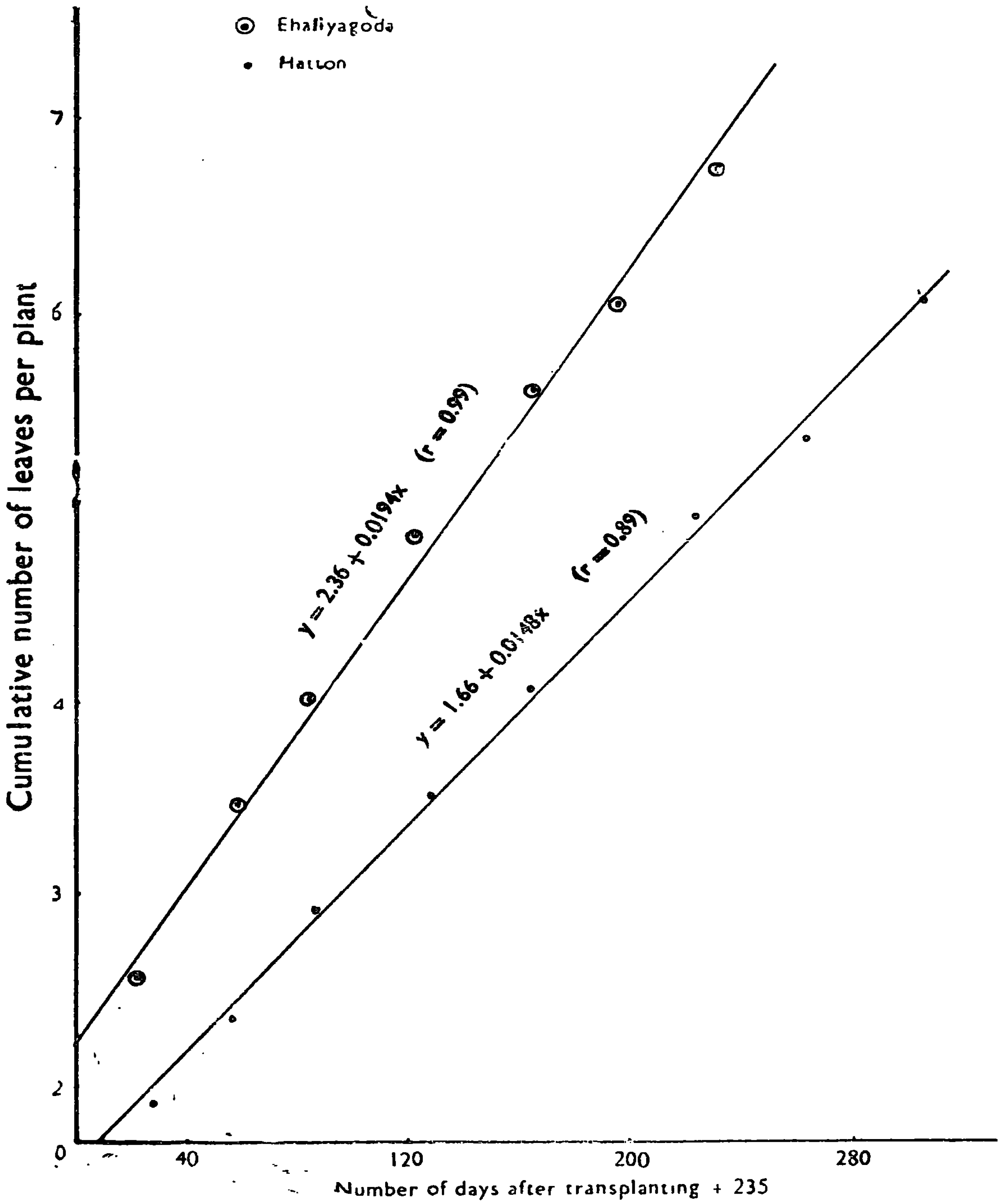

Fig. 1. **Regression of total number of leaves and number of days after transplanting in tw locations**

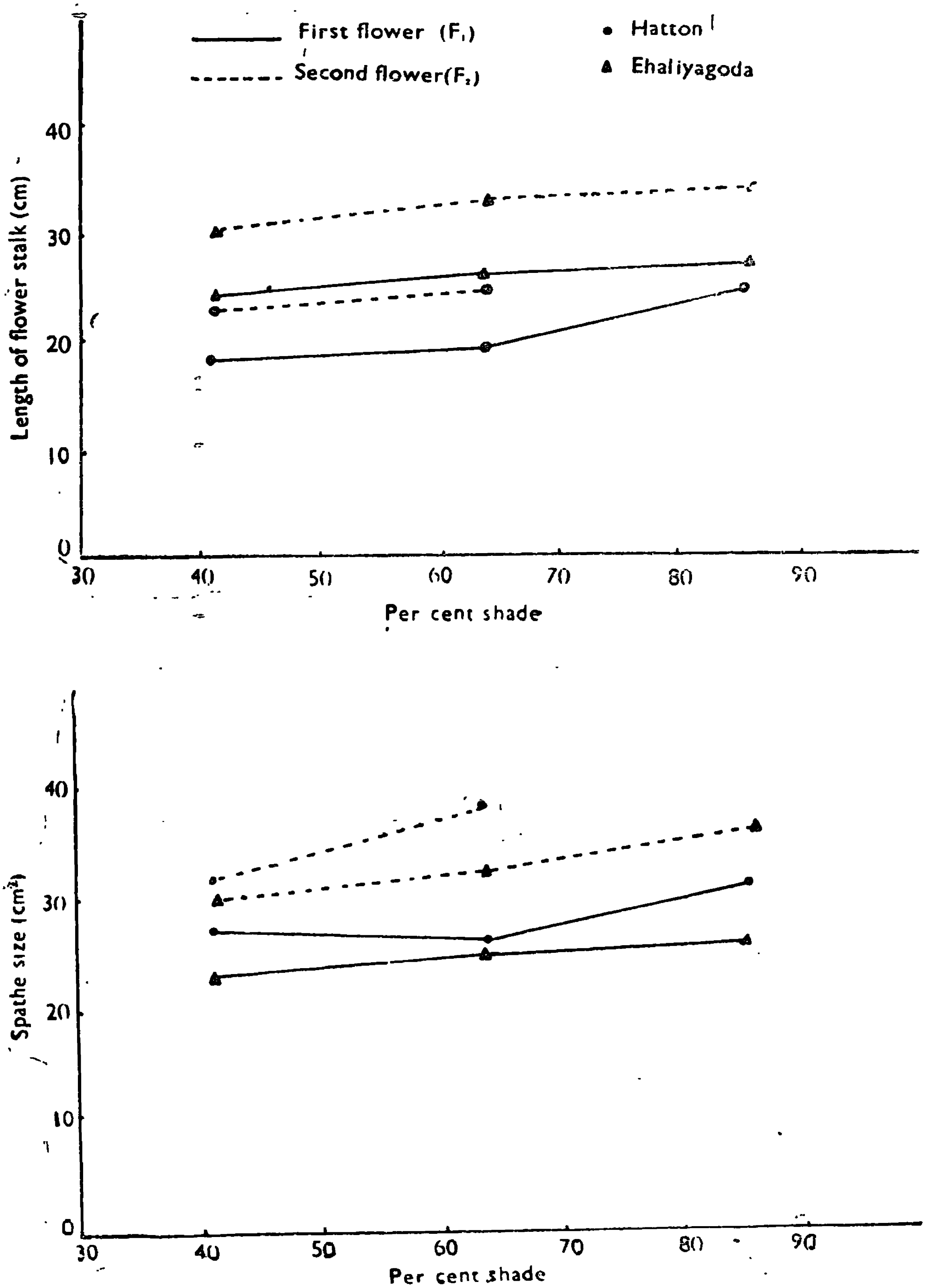

Fig. 2. Effect of shade levels on stalk length and spathe size