LEAF SENESCENCE IN KAPUR (*DRYOBALANOPS AROMATICA*, DIPTEROCARPACEAE) UNDER DIFFERENT CANOPY CONDITIONS

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NG, F. S. P. 1992. Leaf senescence in kapur (*Dryobalanops aromatica*, Dipterocarpaceae) under different canopy conditions. Seedlings of kapur were grown under three different canopy conditions and found to have very different leaf life spans. Leaves lasted eight to nine months in the open (100% Relative Light Intensity), 10 to 15 months under moderate canopy (38% RLI), and 25 to 34 months under dense canopy (4% RLI). The rate of leaf production was about 1.5 leaves per month at 38 and 100% RLI, but only 0.5 leaves per month at 4 RLI. From 4 to 38 % RLI, the shortening of leaf life span was more than compensated by increase in leaf production, so that plants at 38% RLI carried more leaves than those at 4% RLI. But above 38% RLI, there was no additional increase in leaf production to compensate for the continued shortening of leaf life span, with the result that plants at 100% RLI experienced a high turnover of leaves, but carried fewer leaves than those at 38 and 4%. This provides the physiological explanation for the observation that kapur grows best under moderate canopy conditions.

Key words: Senescence - leaves - kapur - dryobalanops - canopy - light

Introduction

Within a few weeks of seed fall, most dipterocarps germinate to form carpets of seedlings. These seedlings immediately bear one or two pairs of leaves immediately above the cotyledons (Ng 1991) as part of the germination process. Subsequent leaves are produced in alternate arrangement and their rate of production is profoundly affected by canopy conditions. When seedlings are grown under open or semi-open conditions, they grow a lot faster than their siblings on the densely shaded forest floor. This phenomenon is well known and provides the basis for silvicultural intervention to promote seedling growth in the forest.

During a general study of seedlings of dipterocarps, it was observed that seedlings under dense shade, while slow in producing new leaves, kept the original one or two pairs of leaves for as long as three years (Ng 1991). In contrast, seedlings of the same age under more open conditions not only produced new leaves faster, but also lost the older leaves faster.

This paper reports a simple experiment devised to define the relationship between leaf senescence, leaf production and growth, under various canopy conditions.

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Materials

Seedlings of kapur (*Dryobalanops aromatica*), of age three months, were available when the experiment was planned. The seeds (nuts) had ripened in July 1984, and had been germinated individually in polythene bags of soil, under open sky (100% light). From about 200 seedlings, 24 were selected which were of matching size and appearance. Each had eight expanded leaves consisting of the two initial pairs of leaves produced during germination, and four unpaired leaves produced after germination (Figure 1).

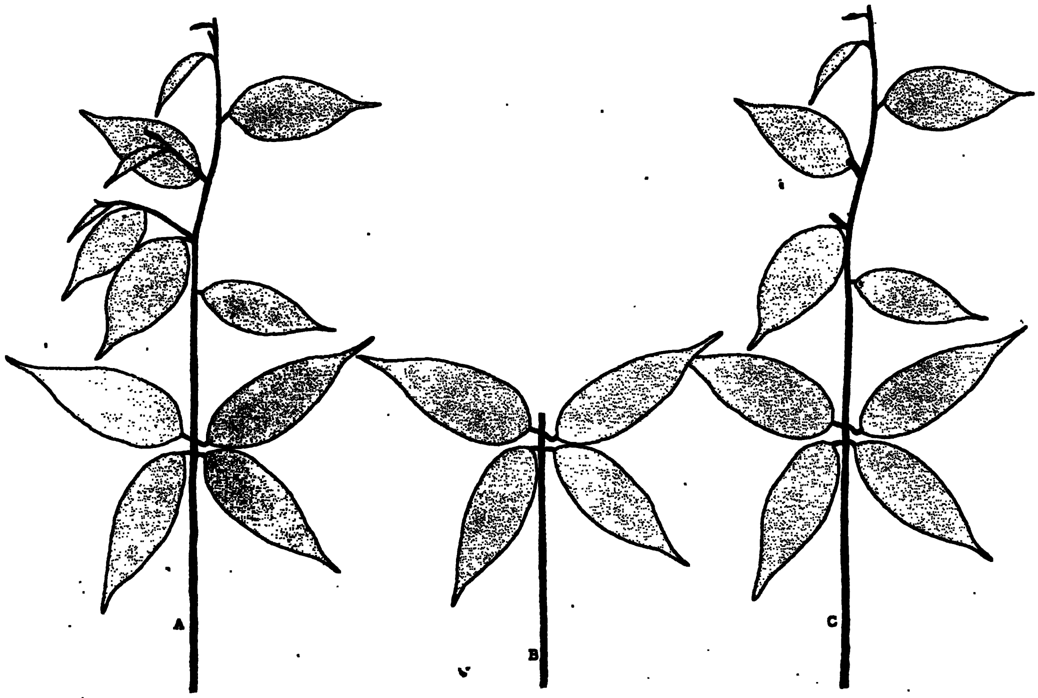

Figure 1. A: Seedling in the original eight leafed stage, B: Seedling decapitated above the first four leaves, C: Seedling with branches nipped off to make the growth unidirectional

Canopy conditions

Three canopy conditions were chosen, and eight seedlings were placed under each:

Lot 1: Under open sky, rated as 100% Relative Light Intensity (RLI)
Lot 2: Under the canopy of *Leucaena leucocephala*, rated as 38% RLI
Lot 3: Under the dense canopy of a bamboo thicket, rated as 4% RLI

RLI (Sasaki 1983) was measured by taking simultaneous light readings with light meters, under the three canopy conditions, at noon, and converting the readings to percentages, taking the reading under open sky as 100%.

Figure 2. Decapitated seedling at 100% RLI, 12 months from the start of the experiment, showing the repeated development of accessory shoots in response to the repeated removal of shoots

Treatments

Of the eight seedlings in each lot, four were 'decapitated' just above the initial four leaves. All subsequent regrowth, from axillary and accessory buds, were nipped off in the bud. This was done so as to eliminate any effect that additional leaves may have on the life span of the four leaves under observation.

The other four seedlings in each lot were allowed to grow, but only along the main (leader) axis. All branches were nipped in the bud. This was done to keep the growth uni-directional in order to avoid any complications that multi-directional growth may add to the experiment.

Monitoring

The initial four leaves on each plant were arbitrarily numbered 1 to 4, and monitored weekly for one year. After that, they were monitored monthly. For the non-decapitated seedlings, the life spans of leaves 5 to 8 were also monitored. The study was continued until nearly all the leaves under observation had been shed in the 42nd month. At this time, there were only six leaves left, distributed among leaves 5 to 8 on the plants under the dense bamboo thicket. These six leaves were arbitrarily given a life span of 42 months; although they could have lasted for perhaps another month or two, the conclusions of the study would not have been affected. The experiment had to be closed at 42 months because a contractor was waiting to clear the site for a new building.

At six months from the start of the experiment, the number of new leaves expanded during the study period were counted for the non-decapitated plants to obtain the rates of leaf production.

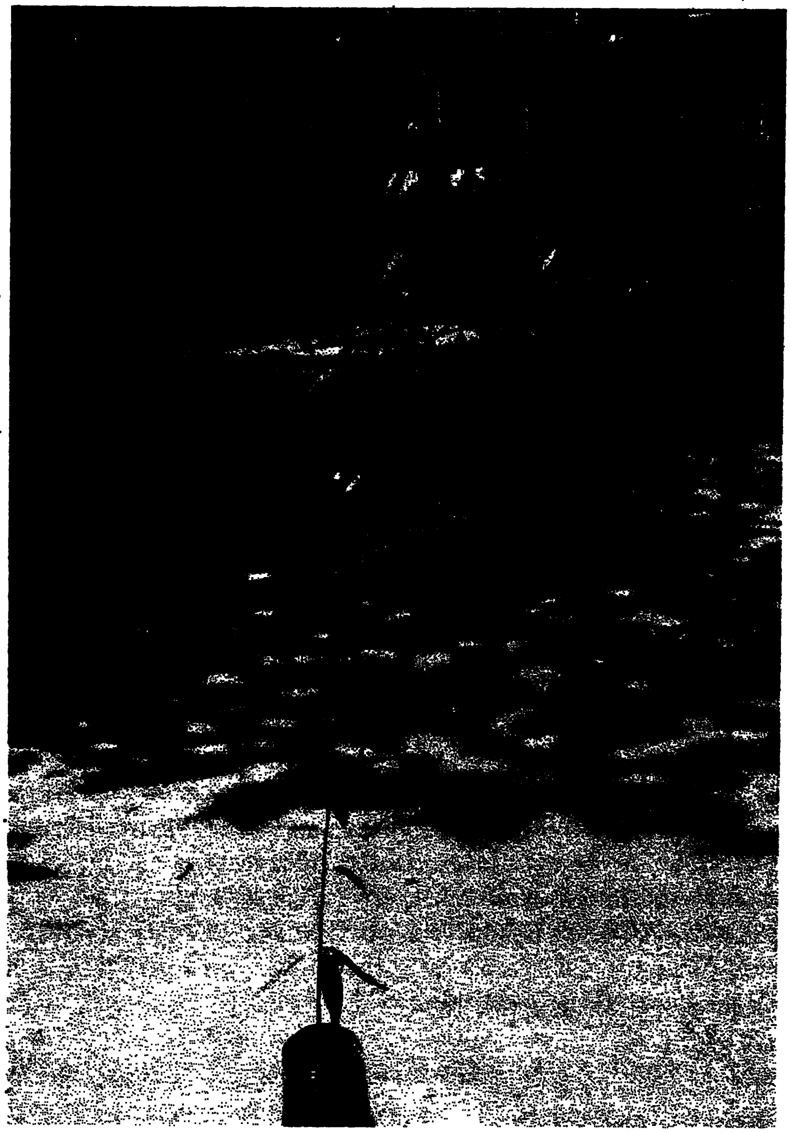

Figure 3. Seedling at 38% RLI, at 11 months from start of experiment, bearing the maximum number of extant leaves

Results and discussion

Table 1 gives the life span for the leaves in months from the start of the experiment.

Table 1. Average life span of leaves in months from start of experiment

	Decapitated plants	Non-decapitated plants	
RLI	Leaves 1-4 (N=16)	Leaves 1-4 (N=16)	Leaves 5-8 (N=16)
100%	7.7 (s.d. 1.9)	7.6 (s.d. 2.2)	9.4 (s.d. 2.2)
38%	13.5 (s.d. 3.5)	10.3 (s.d. 2.6)	14.8 (s.d. 1.3)
4%	27.9 (s.d. 6.2)	25.5 (s.d. 5.9)	34.4#(s.d. 10.3)

(N = total number of leaves; s.d. = standard deviation)
underestimate due to forced termination of experiment

Table 2 gives the rate of leaf production for the non-decapitated plants.

Table 2. Number of new leaves produced by non-decapitated plants during the first six months of the experiment

RLI	Number* of new leaves	Average per plant	Production per month
100%	7+5+ 9+12 = 33	8.25	1.38
38%	10+9+12+ 8 = 39	9.75	1.63
4%	3+3+ 2+ 4 = 12	3.00	0.50

* The number of new leaves per plant is given before the total

It is clear from the decapitated as well as the non-decapitated plants that leaves at 4% RLI had the longest life span, averaging between 25 and 34 months. At 38% RLI, the life span was reduced to about 10 to 15 months, and at 100% RLI, to about eight to nine months. The experiment shows that light has a powerful ageing effect on kapur leaves. Decapitation did not produce any notable effect.

Leaves 5 to 8 had a longer life span than leaves 1 to 4. This can be explained. When the experiment started, leaves 1 to 4 had already been under the ageing effect of three months at 100% RLI. Leaves 5 to 8, having been produced later, could therefore be expected to persist longer in the experiment.

Plants at 4% RLI produced new leaves at 0.5 per month, whereas plants at 38 to 100% RLI produced new leaves at about three times that rate.

The behaviour may be summarised as follows:

(a) At 4% RLI, the leaves lasted an average of 25 to 34 months but new leaves were produced at 0.5 per month. This meant that the shoot could accumulate 12.5 to 17 leaves. The 18th leaf would exceed 34 months and be shed. In 34 months, a shoot could produce 17 leaves, and not shed any;

(b) In the open (100% RLI), the leaf life span was reduced to about eight to nine months, but production of new leaves was about 1.5 leaves per month. Consequently, the shoot could accumulate 12 to 14 leaves. The 15th leaf would exceed nine months and be shed. In 34 months, a shoot could produce 51 leaves, retain 14 and shed 37;

(c) Under 38% RLI, the leaf life span was about 10 to 15 months, and the production of new leaves was about 1.5 leaves per month. Consequently, a shoot could accumulate 15 to 23 leaves. The 24th leaf would exceed 15 months and be shed. In 34 months, a shoot could produce 51 leaves, retain 23, and shed 28.

Plants at 38% RLI had the most leaves extant. Next were plants at 4% RLI. The plants with the fewest leaves extant were those in the open.

In 1960, Nicholson found that, for the several dipterocarp species that he tested, growth was much better at 50% than at or near 100% RLI. The present study shows that at 4 to 38% RLI, the rate of new leaf production is increased but above 38% RLI, there is no further increase to compensate for the continuing decline in leaf life span. As a result, plants exposed to full sun have the fewest extant leaves and the highest turnover of leaves, and this would account for the poorer growth.

This work suggests that the number of extant leaves on a shoot may be useful as a bioindicator of growing conditions, once a calibration has been carried out for a species under different growing conditions. Other possible bioindicators noted but not studied in this experiment are the state of the growing buds (actively growing plants have active buds) and leaf colour (leaves were yellowish when leaf turnover rates were high).

Since the conclusion of this experiment in 1987, we have transferred well grown saplings of a range of primary forest species from the nursery to the corridors in FRIM, where, under low light conditions, their foliage have persisted for three or more years. These include species of Dipterocarpaceae, Lauraceae, Leguminosae, Myristicaceae and other families. We can now recommend juvenile plants of timber trees such as sepetir, kekatong, medang, merbau and penarahan as indoor ornamental plants. The plants have to be grown first under moderate light to develop luxuriant foliage before they are moved indoors.

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