

**EFFECTS OF DEFOLIATION ON *PERICOPSIS ELATA* (HARMS) VAN MEEUWAN
BY THE LEAF TYING MOTH, *LAMPROSEMA LATERITALIS* HAMPSON
(LEPIDOPTERA: PYRALIDAE).**

S.K.N. ATUAHENE

FORESTRY RESEARCH INSTITUTE OF GHANA, UNIVERSITY P. O. BOX 63, KUMASI, GHANA.

ABSTRACT

The effects of defoliation by *L. lateritalis* on six month old seedlings of *P. elata* were studied at the Forestry Research Institute's (FORIG) nursery at Mesewam, near Kumasi. Thirty-one per cent of seedling mortality was directly attributed to the repeated defoliation by the caterpillars over a one-year period.

In two separate experiments at Asenanyo River and Bia-Tano Forest Reserves, two-year old saplings of *P. elata* were subjected to different levels of mechanical defoliation to simulate *L. lateritalis* attack for a period of 10 months. The results in both localities were remarkably similar indicating different responses to height and girth growth at various levels of defoliation. Whereas a relatively small foliage reduction of about 25 per cent significantly ($P < 0.05$) decreased girth growth among the saplings, a much higher level of foliage reduction (<50%) was needed to effect any significant change in mean height increment of the plants during the same period. Possible reasons for the disparity in girth and height increment responses to defoliation are discussed. It is concluded that any future efforts to establish plantations of *P. elata* must address the problem of defoliation by *L. lateritalis*.

Key words: *Pericopsis elata*, Afromosia, defoliation, seedling mortality, girth increment losses, leaf-tying moth, *Lamprosema lateritalis* Hamps.

INTRODUCTION

In West Africa, little is known about the impact of defoliation on height growth and girth increment of forest plantation trees. Caterpillars of *Lamprosema lateritalis* Hamps (Lepidoptera : Pyralidae) are very common and often abundant on *Pericopsis elata* (Kudler 1967, Roberts 1969, Atuahene 1983), but the quantitative effect of damage on the plant is unknown.

P. elata is one of the most important timber species of the Papilionaceae family. With its hard, strong and durable wood, it is an excellent substitute for teak for use in ship rails and decks, shop fittings and first class joinery (Irvine 1961). In spite of sufficient quantities of seeds produced annually by the species, there is paucity in its regeneration and therefore has a

sparse recruitment (Anon 1979). While the extraction rate of the species from the reserved forest has been around 7000 m³ annually, the annual growth per year has been almost zero (Alder 1989). *Pericopsis elata* is therefore an endangered species, and reforestation is perhaps the only answer to save this valuable timber species from extinction in Ghana.

Of all the pests collected on the plant, the leaf-tying moth, *L. lateritalis* is the most important (Atuahene 1983). Caterpillars of this insect feed gregariously on the leaves which are skeletonized and wither. This study was undertaken to determine seedling survival, height and girth increment responses of *P. elata* saplings to different levels of foliage loss caused by *L. lateritalis*.

MATERIALS AND METHODS

Three locations were selected for various investigations. Experiments on the effect of defoliation on survival of *P. elata* seedlings were done at FORIG's Main Nursery at Mesebam, near Kumasi. The second and third studies to find the influence of defoliation of *P. elata* saplings on height and diameter growth were conducted simultaneously within the Asenanyo River Forest Reserve (Ashanti Region)(Latitude 6° 17' to 6° 36'N and longitude 2° 03', 2° 16'W) and the Bia-Tano Forest Reserve (Brong Ahafo Region)(Latitude 6° 49' to 7° 06'N and longitude 2° 40' to 2° 31'W) where two-year old *P. elata* plantations had been established at a spacing of 3.0 m x 3.0 m. Both forest reserves are described as being of the moist semi-deciduous vegetation type (Taylor, 1960).

Effect of defoliation on seedling survival

Seeds for this experiment were collected from natural stands of *P. elata* at Bia-Tano Forest Reserve and raised on seed beds in the nursery at Mesebam. After germination in 5-8 days, the seedlings were pricked out at two-leaf stage into black polythene bags 18.5 cm x 12.5 cm filled with top soil. The seedlings were kept at the nursery shed for about 2 weeks before they were sent out to the open and watered regularly.

Six month-old seedlings were used to investigate the effect of defoliation on survival of the plants. Four treatments were employed, each consisted of 40 seedlings arranged in 4 rows of 10 seedlings at an espacement of 15 cm. In the first treatment, the seedlings were protected from *L. lateritialis* attack by a weekly inspection of individual seedlings and removal of all insect eggs and caterpillars from the plants. The second treatment consisted of seedlings exposed to the natural infestation by *L. lateritialis*. In addition to natural rains, seedlings in the first and second treatments were watered whenever necessary in the morning with water from a sprinkler can. To investigate the combined effect of defoliation by the insect as well as the hot, dry conditions of the

"harmattan" weather, the third and fourth treatments were similar to the first and second respectively, but unlike the latter experiments, these seedlings were rain-fed and were never supplemented by artificial watering.

The experimental layout was a completely random design with 5 replicates. Each set of treatment was separated from the other by a distance of 2 m, and the whole experiment was set up in an open place about 50 m from a 5-year old *P. elata* plantation which served as a source of natural infestation by the insect.

Weekly records of insect damage and seedling mortality were kept during the experimental period between April 1977 and March 1978. The data was subjected to a two-way analysis of variance. Weather conditions prevailing at the nursery were monitored from the meteorological station at Kumasi Airport, about 4 km away from the experimental site.

Effect of defoliation on height growth and girth increment

For the investigations into the effect of defoliation on height and girth increment in *P. elata* saplings, a latin-square design was used within each of the two plantations at Asenanyo River and Bia-Tano Forest Reserves. There were five treatments : 0, 25, 50, 75 and 100 per cent defoliation, each of the 5 treatments was applied to a block consisting of 1 row of *P. elata* saplings replicated 5 times. The plants were tagged and the number of leaves on each plant was counted at the beginning of each assessment period. Foliage was removed mechanically by means of a pair of scissors to the desired degree of defoliation (Turnipseed 1972). Weekly inspection of the plots was carried out to remove any eggs or caterpillars from the experimental plants. At the sapling stage, *P. elata* has only very few 'over-mature' leaves (Cobbinah *et al.* 1982) so the leaves were removed randomly from all over the plant. Defoliation was repeated every 6 weeks to simulate *L. lateritialis* damage in the field (Atuahene 1983), and the experiment was terminated after 10 months. Initial height and

girth measurements of each tree at Asenanyo were taken on September 22, 1976; a second reading was taken on March 1, 1977 and the final reading was taken on July 29th, 1977. Those at Bia-Tano were taken on September 24, 1976; March 11 and July 28, 1977 respectively. Height measurement was done with a builders tape while girth measurement was obtained using a pair of calipers equipped with a direct reading Vernier scale, accurate to 0.1 mm.

The data was subjected to analysis of variance and Duncan's test was used to test differences between treatment means (Cochran and Cox 1957).

RESULTS AND DISCUSSION

Figure 1 shows the effect of defoliation on mortality of *P. elata* seedlings and rainfall distribution at Mesewam nursery over the one-year period. The rains failed in 1977/78 and the distribution pattern indicated in Fig. 1 is abnormal for Mesewam. Seedling mortality in all treatments was negligible during the first couple of months of the experiment. However, mortality of seedlings which were not protected from caterpillar attack increased steadily with the short spell of dry weather in July/August. Seedling mortality reached a peak in January/February 1978 after the intervention of the long, dry "harmattan" conditions between November 1977 and January 1978. Highly significant differences ($P < 0.01$) existed among seedling survival under the various treatments.

About 93 per cent of the seedlings exposed to insect defoliation and which were not artificially watered during the harmattan had died at the end of the year. In comparison, 35 per cent of the seedlings which were watered but subjected to repeated insect attack had died while only 5 per cent seedling mortality was recorded in those which were watered regularly and protected from insect attack. Atuahene (1983), observed that *L. lateritialis* has 6-7 generations in a year at Mesewam, and the insects are particularly abundant throughout the rainy season of May through October of each year. Thus the

mortality of the seedling was attributable to repeated defoliation by the insects. The hot dry weather conditions which prevailed throughout the country between November 1977 and January 1978 clearly aggravated seedling losses. (Fig.1)

It is estimated that about 30 per cent of seedling mortality at Mesewam is directly attributed to *L. lateritialis* attack.

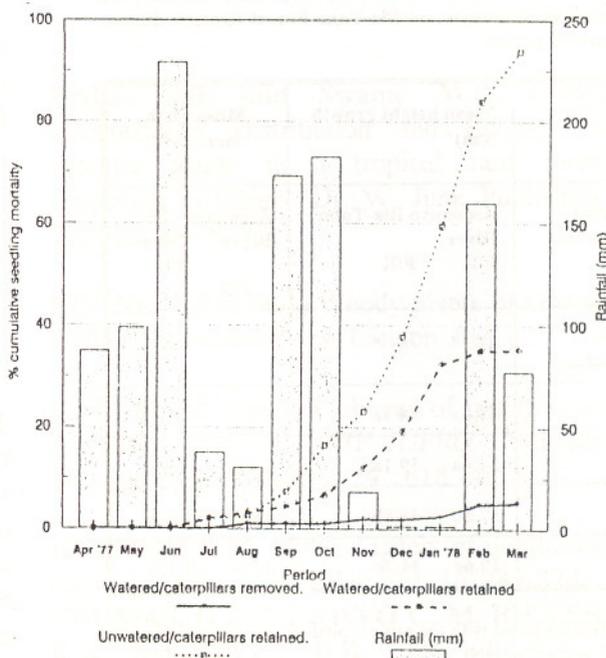


Fig. 1: *P. elata* seedling mortality at Mesewam nursery under different defoliation treatments over a one year period .

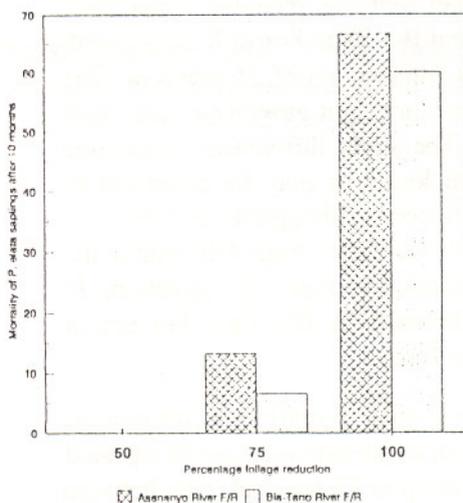


Fig 2: Mortality of *P. elata* after various levels of repeated defoliation during a 10-month period.

Table 1 indicates that defoliation has a marked adverse effect particularly on girth increment in young *P. elata* trees. The control plants increased in height by an average of 69.5 cm at Asenanyo and 77.4 cm at Bia-Tano during the 10-month period. There were no significant differences ($P>0.05$) in height growth between the control plants and those with 25 or 50 per cent foliage losses. However, at the 75 per cent level and above, significant ($P<0.05$) reduction in height growth was recorded.

Table 1: Height and Girth increment responses of *P. elata* saplings after different levels of repetitive mechanical defoliation at Asenanyo and Bia-Tano Forest Reserve during a 10 - month period

Per cent foliage loss	Mean height growth (cm)*		Mean girth increment (mm)*	
	Asenanyo River F/R	Bia-Tano F/R	Asenanyo River F/R	Bia-Tano F/R
0 (No defoliation)	69.5a	77.4a	4.68a	4.75a
25	63.6a	74.3a	3.28ab	2.98b
50	51.4a	59.1ab	2.00b	1.90c
75	32.8b	48.8b	0.96c	1.63c
100	19.6c	34.7b	0.73c	1.13c

*Mean heights/girths with the same alphabets are not significantly different at the 5% level

A significant reduction ($P<0.05$) in girth growth of 29 and 37 per cent was recorded respectively at Asenanyo and Bia-Tano Forest Reserves with only a modest foliage loss of 25 per cent. The comparative loss in height growth was a meagre 4-8 per cent. The slight differences in the tree growth at both locations may be attributed to soil and other factors. Although the two reserves Asenanyo and Bia-Tano, both fall within the moist semi- deciduous type of vegetation, *P. elata* grows naturally at Bia-Tano but not at Asenanyo river forest.

Figure 2 shows tree mortality in relation to defoliation. Even at the extreme case of repeated foliage losses of up to 75 per cent, only between

6 - 13 per cent of the plants died in both localities, and a further 6 per cent of them were observed to have suffered partial mortality in the form of death of a branch tip or a twig especially at Asenanyo. However in the very extreme cases of repeated total defoliation of the saplings over 60 per cent mortality was recorded in both localities. Dead trees had signs of insect borer attack, mainly from the genus *Xyleborus* (Coleoptera : Scolytidae) on stems and twigs.

Insect damage simulation has been a popular technique in agriculture and has been used to establish crop damage-yield relationships independent of economic pest populations (Turnipseed 1972, Thomas *et al.* 1974). The feeding of caterpillars of *L. lateritalis* merely causes mechanical injury and no pathological effects have been reported (Atuahene 1983), thus justifying the methodology of this study. The most important effects from insect defoliation are tree mortality, growth loss, rotational delays and increased susceptibility to secondary insect and diseases (Kulman 1971).

Turnipseed (1972) reported that moderate foliage losses at below 33 per cent may have significant improved effects on plant growth and mortality as this treatment allowed additional light penetration to the lower leaves which results in compensation by increased photosynthate production in the leaves. This study is largely in agreement with Turnipseed's (1972) observation. However the critical responses in girth growth to defoliation observed in this study may be explained by the fact that longitudinal growth in plants is due to elongation of derivatives from the apical meristem while girth growth is attributed to radial expansion of derivatives of the cambium and interfascicular cambium. Under stresses of defoliation the apical meristem still draws up most nutrients due probably to the phenomenon of apical dominance. These cells then continue to form derivatives that elongate leading to substantial height growth which equals that of the control experiments. Cambial activity is thus considerably reduced due to lower nutrients and therefore fewer derivatives are formed.

It is concluded that any future efforts at establishing *Pericopsis elata* plantations must address the problem of *L. lateritialis* as repeated attack by this insect may not

necessarily cause significant tree mortality but could seriously effect total crop yield by reducing girth growth of the plants.

ACKNOWLEDGEMENT

I wish to thank Prof. Ray Kumar formerly of the University of Ghana for the interest expressed in this study. Dr. Carol Markwei of the University of Ghana offered valuable suggestions during the preparation of the manuscript. Technical assistance given by Messrs S.A. Nkrumah, J. Appiah-Kwarteng and A. Osei-Nkrumah is gratefully acknowledged.

REFERENCES

- ANON (1979) The panel of the Advisory Committee on Technology Innovation on Tropical Legumes, National Academy of Sciences, Washington D. C., p 25 - 27.
- ALDER, D. (1989) Natural Forest Increment, Growth and Yield. In : *Proceedings Ghana Forest Inventory Project Seminar*. Accra, 29-30 March 1989.
- ANDERSON, R.F. (1964) Forest and shade Tree Entomology, John Wiley and Sons, Inc. New York.
- ATUAHENE, S.K.N. (1983) The biology of *Lamprosema lateritialis* (Lep., Pyralidae) a pest of *Pericopsis elata* (Harms) van Meeuwen. Ph.D. Thesis, University of Ghana.
- COBBINAH, J.R.; MORGAN, F.D., and DOUGLAS T.J. (1982) Feeding responses of the Gum Leaf Skeletonizer *Uraba lugens* Walker to extracts of Eucalyptus leaves. *J. Aust. ent. Soc.* 21.: 225-236.
- COCHRAN, W. G. and COX, G. M. (1957) *Experimental designs*, 2nd ed., Wiley, New York, 1957.
- HALL, J.B. and Swaine M.D. (1981) Geobotany - Distribution and Ecology of vascular plants in a tropical rain forest vegetation in Ghana. Dr. W. Junk Publishers. The Hague. 382 p.
- IRVINE, F.R. (1961) Woody plants of Ghana. Oxford University Press, London. 868 p.
- KUDLER, J. (1967) Problems of forest insect defoliation in Ghana. *XIV IUFRO Congress, Munich. Paper V* Section 24 : 618 - 627.
- KULMAN, H.M. (1971) Effect of defoliation on tree growth. *Annual Rev. Ent.* 16: 289-324.
- THOMAS, G.D. IGNOFFO C. M. BIEVER, K.K. and SMITH, D.B. 1974 Influence of defoliation and deposing on yield of soyabeans. *J. econ. ent.* 67 : 683 - 685.
- TURNIPSEED, S.G. 1972. Response of soyabeans to foliage losses in South Carolina. *J. econ. ent.* 65 : 224 - 229.