**Response of mature sapodilla (Manilkara zapota) trees to shoot heading**

[Gerak balas pemenggalan pucuk terhadap ciku (Manilkara zapota) matang]

M. Malip*

Key words: shoot heading, pruning, flushing, flowering, sapodilla

**Abstract**

Effect of shoot heading on flushing, flowering and fruit setting of sapodilla was studied in MARDI Kuala Linggi, Melaka. The study was carried out on five-year-old sapodilla trees cv. Jantung. At three months after heading the softwoods, semi-hardwoods of the current year, and hardwoods of the previous year, the shoot diameter showed a declining trend i.e. 5.10, 4.70 and 4.40 mm, respectively. However 6 months after heading, the reverse occurred when the shoot diameter of the softwoods, semi-hardwoods and hardwoods showed an increasing trend i.e. 5.4, 6.90 and 7.80 mm, respectively. The significant differences ($p < 0.05$) for shoot diameter and shoot length were only detected at 6 months, and not 3 months after heading. A positive and strongly linear correlation at 6 months after heading was established between shoot sizes and flush diameter ($y = 4.11 + 0.26x, r^2 = 0.98$) as well as shoot sizes and shoot (flush) length ($y = 10.61 + 2.01x, r^2 = 0.93$). Flowering shoots, fruit setting and fruit number were significant ($p < 0.05$) between softwoods, hardwoods and to that of semi-hardwoods. The number of floweringflushes, fruit setting and fruit number were highest for the semi-harwoods compared to the softwoods and hardwoods.

Subsequent experiment shortly after the secondary peak season with 25%, 50%, 75% and 100% degree of heading severity imposed on the semi-hardwoods of the current year showed that there is no significant difference ($p < 0.05$) in shoot number appeared immediately after heading.

However, significant difference ($p < 0.05$) between pruning severity was detected in flowering shoot number and fruit set per pruned shoot at 9 months after heading. Comparisons between total number of fruits from the flushes of the unpruned shoots showed that the 25% heading severity treatment had the highest fruit number (113.8 fruits).

**Introduction**

*Manilkara zapota* (L) Royen (*Achras zapota* L.) or sapodilla or locally known as ‘ciku’ is planted with other fruit types in a traditional farming. Recommended cultivars such as Subang and Jantung can be obtained in most fruit nurseries. The major sapodilla producing states in Peninsular Malaysia such as Pahang, Terengganu, Perak, Kedah, Kelantan and Melaka, are meant for domestic and overseas markets. Recent scenario indicated that sapodilla has a great potential for export market to Brunei, Hong Kong, Singapore and even to European

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Unions and Middle East countries. The growing areas have increased from 1,140 ha (1984) to 1,309 ha (1999) with the annual production for export reaching up to 284.8 t and valued at RM223,454.36.

In the tropics, sapodilla may flower throughout the year but the peak may vary over locations, usually coincided with the onset of rainy seasons. Sapodilla flowers 2–3 times a year (Nalawadi et al. 1974). In Johor, the primary and secondary flowering seasons occur in May and October respectively, but differ from the northern states where they have longer dry spell (Malip 1999). Flowers are produced in the leaf axils near the tip of young shoots. Similar flowering habits can be observed in guava and citrus where flowering occurs shortly after the emergence of new flush.

Flushing can be stimulated by means of irrigation after water stress, fertilization and even pruning. Pruning has been successfully adopted as a tool for the regulation and synchronization of flowering in the commercial guava farm in Kota Tinggi, Johor. Pruning alters the carbohydrate levels and substances within the tree and decreases starch and soluble sugars content in apple branches (Mika 1986), which is associated with flowering capacity. Severe pruning can upset flowering by increasing the vegetative growth and depress flowering (Robinson et al. 1990).

The setback resulting from the continuous flowering in sapodilla is the stiff competition with other major fruit types at certain times of the year due to the influx of local fruits and low marketable price. This paper reports the comparison in terms of growth of new shoots and flowering ability of woods of different ages (softwood, semi-hardwood and hardwood) after several heading severity treatments. These results will enable us to have a sound understanding of the flushing and flowering mechanisms of sapodilla. Therefore, it is very important to synchronise the removal of branches with the date of flowering. The removal of branches is termed as ‘heading’.

Materials and methods

Experiment 1

A total of 15 sapodilla trees (cv. Jantung) in MARDI Kuala Linggi were used for the experiment. Light maintenance pruning was done earlier, so that all treatment plants were almost homogenous in shape, followed by fertilizer application. Each tree was given 4.80 kg NPK 12:12:17:2 with four split applications in a year. Pest and disease control was uniform for all treated plants.

There were three pruning treatments, viz. pruning of softwoods of the current year (T1), pruning of semi-hardwoods of the current year (T2) and finally pruning of hardwoods of the previous year (T3). For each treatment, pruning was done on about 25% of the total type of each wood present on each plant. The types of wood were determined based on the external stem diameter and colour of woods (shoots). The external stem diameters of softwood, semi-hardwoods and hardwoods were 5.5–6.5 mm, 9.5–10.5 mm and 14.5–15.5 mm, respectively. The green light grey, grey and light brown woods were for softwoods, semi-hardwoods and hardwoods, respectively. The experiment employed a randomized complete block design (RCBD) with five single tree replications.

Data for shoot number, shoot diameter, shoot length, flowering flushes, fruit set and fruit number on each pruned shoot were recorded from 10 pre-determined shoot samples from each treatment plant. Significant differences were based on Duncan Multiple Range Test (DMRT) at $p<0.05$.

Experiment 2

The subsequent experiment followed was initiated with 20 five-year-old sapodilla trees (cv. Jantung) a month after the end of secondary flowering peak (June). The treatments [25% (Control), 50%, 75% and 100% degrees of pruning severity] were imposed particularly on the semi-hardwoods of the current year. Criteria for semi-hardwoods of the current year were
described as in Experiment 1. Each treatment was replicated five times with randomized complete block design (RCBD). Ten systematic data samplings as in the earlier experiment were taken from each treatment plant, making a total of 40 samples from each replicate. Fertilizer application and other crop management practices were similar to Experiment 1.

Data recorded were shoot (flush) number, flowering flushes and fruit setting from the pruned-shoots and finally the total number of fruits from the unpruned shoots at 3 months after pruning. The degree of significance was determined with Duncan Multiple Range Test (DMRT) at \( p < 0.05 \).

**Results and discussion**

Shoot diameter and length at 6 months after pruning differed significantly among softwoods, semi-hardwoods and hardwoods (*Table 1*). Alderman and Auchter (1916) and Gardner et al. (1922) proved that pruning stimulates new shoots growth. It was also supported by Maggs (1965) who found that increasing pruning (tipping to heading) is followed by an increase in shoot growth rate. Similarly, Jonkers (1962) and Mika (1982) also agree that as stem is pruned or shortened from 0–80% of their initial length, the new shoot formed will be longer with increasing pruning from tipping to heading. As pruning stimulates the growth of new shoots, it changes the proportion of tree parts, i.e. the weight relationship between new and old woods and between aboveground and underground parts. The hormonal status will change and basal leaves photosynthesis is increased so that the tree is able to rebuild the lost parts very quickly (Mika 1986).

The semi-hardwoods and hardwoods had higher shoot diameter and length at 6 months heading since they had larger cut area base to support the new shoots and probably less local competition when the number of new shoots for all wood type was almost the same (*Table 1*). Pruning stimulates the growth of young and vigorous shoots more for younger than older shoots (Mika 1982) and it depends on the type and time of pruning (Mika 1986). This can be seen in *Table 1* where the shoot diameter and length within 3 months after pruning the softwoods, semi-hardwoods and hardwoods were in the decreasing trend from younger (softwood) to older shoots (hardwood).

The response to shoot heading will depend on the type of pruning (Mika 1986). As degree of severity increases from softwoods to hardwoods, the average length of new shoot formed is always longer in hardwoods (Mika 1982). There was a strong correlation between stem diameter and shoot diameter as well as shoot length at 6 months after pruning (*Figure 1*). The supporting bases for new shoots in the hardwoods are larger and stronger with more available reserves compared to the softwoods and hence they have longer new shoots.

Axillary shoot growth arising from each zone along the stem differs after pruning or decapitation (Khayat and Zieslin 1982). The axillary shoot and flower number formed are increasing from apical to basal along the stem (Erwin et al. 1997). However in the case of sapodilla, the shoot number for all treatments was not significant. The number of flowering shoots increased only for the semi-hardwoods. This might be due to unavailable leaves along the hardwoods during pruning, the upset of photosynthesis activity along the stem.

Flowering shoots, fruit setting and fruit number for the semi-hardwoods were significantly higher \( p < 0.05 \) than other treatments (*Table 2*). Flowering and fruit setting are gradual processes that take place 8–9 months after the respective shoots are removed. Gardner et al. (1922) had proved that pruning stimulates new shoots, fruit bud formation, fruit set and yield. In rose, flowering was effectively delayed in accordance with pruning date due to the consequent development of axillary inflorescences beneath the pruning cuts. Maggs (1965) suggested that the influence of pruning, number of fruit buds, yield and
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Table 1. Shoot (flush) diameter and length at 3 and 6 months after heading

<table>
<thead>
<tr>
<th>Parameters</th>
<th>3 months after pruning</th>
<th>6 months after pruning</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Softwoods</td>
<td>Semi-hardwoods</td>
</tr>
<tr>
<td>Shoot diameter (mm)</td>
<td>5.10a*</td>
<td>4.70a</td>
</tr>
<tr>
<td>Shoot length (cm)</td>
<td>11.50a*</td>
<td>10.30a</td>
</tr>
</tbody>
</table>

*Values followed by the same letters are not significantly different at $p < 0.05$

Fruit quality are only side effects, secondary to the effect of pruning on shoot growth. The immediate and subsequent growth development relies heavily on the prevailing conditions of the pruned shoots.

When pruning the shoot basipetally (from younger to older ones), the softwood portion with unexpanded, immature leaves containing the unfunctional stoma are removed. The softwoods are young and when pruned, will leave the semi-hardwoods with leaves for photosynthesis for the assimilates to progress with stem development and new flushing. While pruning the semi-hardwoods will retain the full-functioning leaves allowing rapid development for new flushing only because semi-hardwoods need less growth. Subsequently, pruning the hardwoods will leave the leafless shoot. Probably it has to rely on the stored plant reserve assimilate for new flush growth. Based on these, the semi-hardwoods had greater chances of flowering and fruit setting. The result also supported by Heinicke (1975) who found that heading cuts (implying to pruning hardwoods of the previous year) decrease yield more than thinning cuts (pruning the softwoods and semi-hardwoods).

Removing excessive foliage from plant part may withdraw some disadvantages. Although the shoot number per pruned shoot...
was not significant \( (p<0.05) \) among treatments (Table 3), the flowering shoots and fruit setting showed significant difference \( (p<0.05) \) among pruning severity treatments. The highest flowering flushes and fruit setting were at 25% removal of the semi-hardwoods (Table 3). Severe pruning results in a reduction of total functional leaves and leaf area within the plant canopy leading to an overall lower photosynthesis rate (Mika 1986). The stored plant assimilate would be channelled for rebuilding torn tissues in the case of heavy pruning (75% and 100%) and could be less for flower development. This can be seen in Table 3 when the total number of fruit per tree appeared from the flushes of the unpruned shoots were highest at 25% pruning and lowest at 100%. This could also be the secondary effect of pruning as suggested by Maggs (1965). At the most severe pruning, the flush number was highest but yield was lowest and this was supported by Robinson et al. (1993) in their study with apple.

**Conclusion**

Excessive or severe removal of woods increased vegetative growth and less fruit in sapodilla. Although flushing from the headed shoots did not cause immediate flowering, flowering from the flushing of the unheaded shoots 3 months after that allowed heading to override the normal flowering peak.

Heading about 25% of the semi-hardwoods of the current year produced higher trend in the number of shoots compared to the other woods. This was followed by significantly higher flowering shoots, fruit set and fruit number. It is recommended that heading of about 25% semi-hardwoods to be practised for early and higher yield in sapodilla.

**References**


Table 2. Effects of shoot heading on different types of wood

<table>
<thead>
<tr>
<th></th>
<th>Softwood</th>
<th>Semi-hardwood</th>
<th>Hardwood</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoot number</td>
<td>3.6a*</td>
<td>3.8a</td>
<td>3.6a</td>
</tr>
<tr>
<td>No. of flowering shoots</td>
<td>1.0a*</td>
<td>1.8b</td>
<td>1.0a</td>
</tr>
<tr>
<td>No. of fruit setting/flowering shoots</td>
<td>1.6a*</td>
<td>2.1b</td>
<td>1.5a</td>
</tr>
<tr>
<td>Fruit number</td>
<td>1.6a*</td>
<td>3.8b</td>
<td>1.5a</td>
</tr>
<tr>
<td>Months of flowering after heading</td>
<td>9.1a*</td>
<td>9.1a</td>
<td>8.4a</td>
</tr>
</tbody>
</table>

*Values followed by the same letters are not significantly different at \( p<0.05 \)

Table 3. Effects of severity of heading on semi-hardwood

<table>
<thead>
<tr>
<th>Heading severity (% shoot removed)</th>
<th>25%</th>
<th>50%</th>
<th>75%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shoot number/pruned shoot</td>
<td>3.92a</td>
<td>4.04a</td>
<td>4.12a</td>
<td>4.60a</td>
</tr>
<tr>
<td>Flowering shoots/pruned shoot</td>
<td>3.50c</td>
<td>2.60b</td>
<td>2.40b</td>
<td>0.80a</td>
</tr>
<tr>
<td>Fruit setting/pruned shoot</td>
<td>2.30c</td>
<td>2.21c</td>
<td>1.60b</td>
<td>0.80a</td>
</tr>
<tr>
<td>Total fruit number per tree/unpruned shoot</td>
<td>113.80b</td>
<td>109.00b</td>
<td>28.80a</td>
<td>22.80a</td>
</tr>
</tbody>
</table>

*Values followed by the same letters are not significantly different at \( p<0.05 \)
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Serdang: MARDI


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**Abstrak**

Kesan pemenggalan pucuk ciku terhadap pertumbuhan pucuk, pembungaan dan pembentukan buah telah dikaji di MARDI Kuala Linggi, Melaka. Kajian dijalankan pada pokok ciku cv. Jantung berumur 5 tahun. Tiga bulan selepas pemenggalan pucuk hijau, separa hijau dan kayu perang, garis pusat pucuk yang tumbuh menunjukkan corak yang menurun, iaitu 5.10 mm, 4.70 mm dan 4.40 mm. Walau bagaimanapun, 6 bulan selepas pemenggalan, garis pusat pucuk yang tumbuh bertambah iaitu 5.40, 6.90 dan 7.80 mm masing-masing untuk pucuk hijau, separa hijau dan perang. Perbezaan yang ketara (*p* <0.05) untuk garis pusat dan panjang pucuk hanya dikesan pada 6 bulan dan tidak 3 bulan selepas pemenggalan. Korelasi positif 6 bulan selepas pemenggalan antara pemenggalan pucuk dengan garis pusat pucuk (*y* = 4.11 + 0.26*x*, *r*² = 0.98) dan pemenggalan pucuk dengan panjang pucuk (*y* = 10.61 + 2.01*x*, *r*² = 0.93) diperoleh. Perbezaan yang ketara (*p* <0.05) didapati antara pucuk hijau, perang dan separa hijau untuk pucuk berbunga, pembentukan dan bilangan buah. Bilangan pucuk berbunga, pembentukan buah dan bilangan buah yang tertinggi terdapat pada pucuk separa hijau dibandingkan dengan pucuk hijau dan perang.

Kajian berikutnya pada luar musim puncak kedua dengan 25%, 50%, 75% dan 100% keparahan (severity) pemenggalan terhadap pucuk separa hijau menunjukkan tiada perbezaan yang ketara (*p* <0.05) terhadap bilangan pucuk yang keluar selepas pemenggalan. Walau bagaimanapun, perbezaan yang ketara (*p* <0.05) antara keparahan pemenggalan hanya dapat dikesan pada bilangan pucuk berbunga dan pembentukan buah daripada pucuk yang dipenggal.

Perbandingan bilangan buah sepokok daripada pucuk yang tidak dipenggal 3 bulan selepas pemenggalan menunjukkan pemenggalan 25% mempunyai nilai tertinggi (113.8 buah).

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