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*Short communication:*

# Phase change in mangosteen (*Garcinia mangostana* L.) and its relationship to tree size and vigour

[Perubahan fasa dan hubungannya dengan saiz dan kesuburan pokok manggis (*Garcinia mangostana* L.)]

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Key words: tree size, phase change, juvenility, mangosteen

**Abstrak**

Mencapai saiz pokok yang minimum sangat penting bagi mengakhiri fasa juvenil tanaman saka. Bagi pokok manggis, tempoh matang yang panjang dianggap sebagai salah satu faktor penghalang dalam memajukan tanaman ini secara komersial. Oleh sebab strategi terbaik untuk memendekkan tempoh matang adalah dengan menanam pokok sehingga mencapai suatu saiz minimum sebelum mengaruh pembungaan, maklumat tentang saiz pokok dan hubungannya dengan pembungaan pertama sangat penting. Kajian telah dijalankan di Stesen Penyelidikan MARDI di Bukit Tangga dengan membandingkan saiz pokok yang berbunga dengan pokok yang tidak berbunga semasa pembungaan pertama. Hasil daripada kajian menunjukkan bahawa pokok manggis mula berbunga setelah mencapai peringkat 18 tingkat cabang pada batang utama. Kira-kira 70% bunga terdapat pada tingkat ke-8 hingga ke-11. Pokok subur yakni yang besar saiz batangnya didapati berbunga lebih awal. Bilangan bunga sepokok berkait secara positif dengan saiz batang.

**Abstract**

Attainment of a minimum tree size is important in completing the juvenile phase of many tree crops. In mangosteen, the long juvenile phase is considered one of the major limiting factors in its commercial development. Since the best strategy for reducing juvenility is to grow seedlings to a certain minimum size before applying appropriate flower inducing treatments, information pertaining to tree size and its relationship to first flowering in mangosteen is vital. A study was conducted at the MARDI Research Station in Bukit Tangga where size-related parameters of flowered and non-flowered trees were compared during their first flowering. Results showed that mangosteen seedlings flowered after attaining a minimum size of 18 main stem storeys. About 70% of the flowers were located on the 8th to 11th storeys. Vigorous trees as shown by bigger stems attained their first flowering earlier. The number of flowers per tree was positively correlated to stem size.

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## Introduction

The term juvenile phase of plant refers to the period which lapses before the seedling flowers for the first time. Seedlings in juvenile phase cannot be induced to flower by the normal flower-initiating treatments or conditions. During this phase, the seedlings are morphologically and anatomically different from trees in the mature phase (Visser 1964). When the ability to flower is achieved, the tree is considered to have attained the mature phase. Phase change therefore refers to the transition from the juvenile to the mature phase (Brink 1962).

There are considerable evidences to show that seedlings of tree crops must attain a certain size before they undergo phase change. Stephens (1964) and Zimmerman (1971) showed that achieving a minimum size is important in completing the juvenile phase. Visser (1964) demonstrated the importance of tree size in attaining the mature conditions. As seedlings grow at different rates under different environmental conditions, plant size at first flowering stage is a more useful measurement of the end of the juvenile period than the chronological age of a seedling *per se* (Snowball et al. 1994).

For mangosteen (*Garcinia mangostana* L.) trees, the long juvenile phase of 8–12 years (Downton et al. 1990; Rukayah and Zabedah 1992) is considered one of the major limitations to its development. Aldwinckle (1975) reported that the best strategy for reducing the juvenile phase in many tree species is to grow the seedlings to a certain minimum tree size before applying the appropriate flower inducing treatments. Thus, information pertaining to tree size during first flowering stage of mangosteen plants is vital for developing strategy to reduce the length of the juvenile phase.

## Tree size and first flowering

The attainment of flowering is a consistent criterion to assess the end of the juvenile phase of any tree species. Since phase change is closely related to tree size, measuring the size-related parameters during the first flowering stage may indicate the minimum tree size that must be attained by mangosteen seedlings for the termination of the juvenile period.

The number of main stem nodes has been used as an index of plant size by Snowball et al. (1994). They demonstrated that the node number of a seedling when it first flowered was a relevant measure of plant size. Zimmerman (1973) showed that the change in tea crabapple *(Malus hupenhensis)* seedlings from juvenile to adult phase was closely correlated with node number. Besides main stem nodes, stem girth also has been used to indicate plant size (Visser 1964).

For mangosteen, the number of main stem nodes may be referred to the number of storeys as each storey represents one node on the main stem. *Table 1* shows the number of storeys and stem girth during first flowering stage of mangosteen trees. The data indicated that mangosteen seedlings were able to attain first flowering at a minimum size of 18–19 storeys (mean 18.7). These results infer that attainment of at least 18 storeys on the main stem may indicate the minimum size for phase change in mangosteen. The fact that those seedlings that did not flower have only attained less than 18 storeys (mean 17.2) further supported the above hypothesis. It was presumed that the unflowered seedlings were slow growers thus obtaining the required number of storeys for flowering at later stages.

Table 1. Average number of main stem storeys and girth of mangosteen during first flowering

| Seedling | No. of storeys | Girth (cm) |
|---|---|---|
| Flowered | 18.7 ± 1.4a | 83.3 ± 5.2a |
| Unflowered | 17.2 ± 1.4b | 68.4 ± 5.7b |

Mean values in each column with different letter are significantly different ($p$ = 0.05) by t-test (n = 30)

Although the seedlings need to attain 18 storeys for first flowering, the distribution of flowers on different storeys showed interesting results. As shown in *Figure 1*, 70% of the flowers were located within the 8th–11th storeys and earlier formed storeys near the base did not flower. The data shows that node position is important in influencing the flowering capability of mangosteen seedlings. In citrus, although flowering branches are distributed evenly along the main stem, flowering does occur below node number 45 (Snowball et al. 1994). This phenomenon in mangosteen is believed to be related to the age and number of the flowering twigs. It was observed that the 8th to 11th storeys were among the earliest to produce secondary flowering twigs and not the lower storeys. Flowers are normally formed at the tip of twigs that are at least 2 years old. Similar results were observed in birch *(Betula verrucosa)* trees induced to flower early under conditions of maximal growth where branches near the base did not flower, whereas those less than 100 cm up the stem flowered quite profusely (Longman 1976).

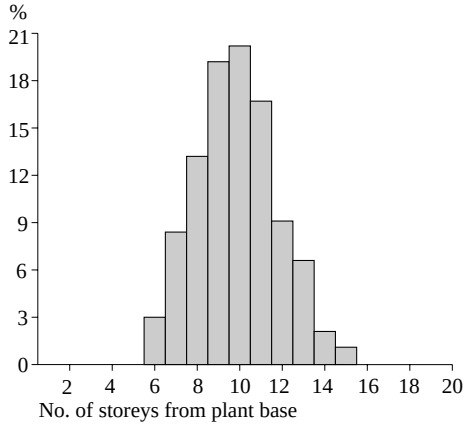


*Figure 1. Percentage number of fruit found on different storeys out of total number of fruit collected from 30 sampled trees*

**Tree size and flowering ability**

One of the indicators of growing ability of fruit trees is the size of the stem (Visser 1964). Bigger stem may correspond to better growth. The relationship between stem girth and number of flowers per tree is shown in *Figure 2*. The number of flowers per tree was positively correlated to stem girth. Trees with bigger stem had more flowers during their first flowering. Trees with a bigger stem not only attained their phase change earlier than smaller trees *(Table 1)* but their number of flowers per tree were also larger. These data may suggest that phase change in mangosteen is closely

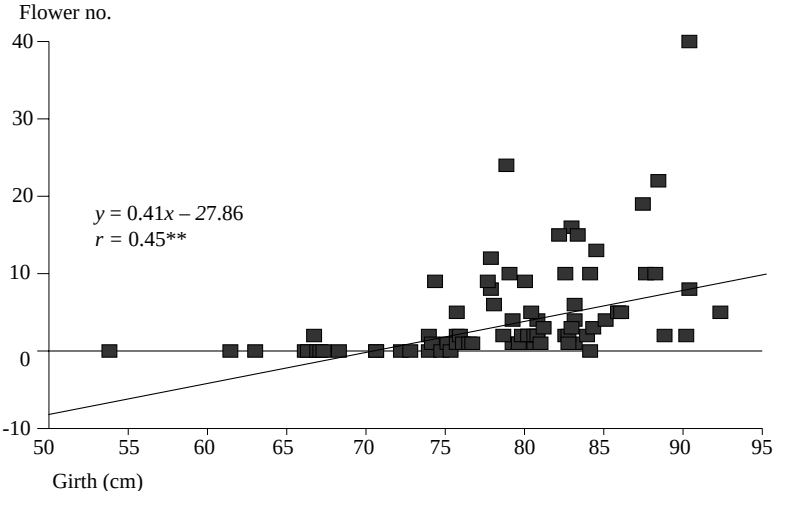


*Figure 2. Relationship between flower number per tree and girth of mangosteen seedlings during phase change*

related to attainment of a minimum tree size as well as vigour of the plant. If the best strategy to shorten the juvenile phase is to grow seedlings rapidly under optimum growing conditions and then apply flower induction as proposed by Aldwinckle (1975), then giving the same treatments to mangosteen may be the most practical way to shorten its juvenile period. Our earlier findings that flowering trees had bigger and taller stem as well as wider canopy spread than non-flowering trees (Masri and Omran 1993) were very much in support of the above strategy.

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