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Effects of different sizes of planting material on the establishment and precocity of durian

(Kesan pelbagai saiz bahan tanaman terhadap kemandirian dan prekositi durian)

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Key words: durian, precocity, initial tree size, tree growth, survival, D24, D99, flowering

Abstract

The growth and reproductive performance of different sizes of durian planting material (0.64–2.53 cm calliper size) aged between 6 and 30 months old was studied. The suitable size of planting material for improving durian precocity and thus reducing the juvenile phase was determined. The trial was carried out at MARDI Research Station, Jerangau in 1992 using clones, D24 and D99. Growth was monitored and data recorded were the girth size increment, flowering and fruit yield, for a period of 6 years after field establishment.

Both D24 and D99 had vigorous growth, but D99 had significantly better survival rate after one year of planting and higher yield than D24 during reproductive phase. Initial tree calliper size had a negative influence on tree survival in durian. As the tree calliper size increased, the rate of tree survival was reduced. First flowering was detected 3 years after field planting in some of the trees but without fruit set. After 5 years in the field, all trees flowered and bore fruits. Results indicated that 2.0 cm planting materials had the highest growth rate and tree vigour, and was the optimum size for improving precocity. It also significantly produced highest mean fruit number (23 fruits).

Introduction

In perennial crops like durian, precocity is one of the prime factors that may enhance crop expansion and development. Tree precocity influences productivity and juvenility in durian. Reid (1990) defines precocity as the ability of a crop to bear fruits at an early age. Precocity is the characteristic of early development or earliness in the life of tree to begin flowering and fruiting (Barritt 1992).

Methods and ways for enhancing tree precocity have been widely discussed and investigated in apples. The use of rootstocks (dwarfing and semi dwarfing) has been extensively studied and practised by growers for improving apple precocity and early yield (Palmer 1996). Precocity in oil palm trees was also investigated by Carlos et al. (1998). The use of oil palm advanced planting materials (18-month) was able to increase fresh fruit yield compared to younger (13-month) planting materials.

Durian precocity is equally important because under normal condition, durian tree starts bearing flowers after 5 years but with minimal fruit set (Rushidah 1999). It takes 2–3 years after first flowering for the trees to bear many fruits. If durians could be made to flower early, as early as 3 years

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after planting, a 5-year-old tree is mature enough to reach its high and stable production level. Using older or bigger size planting materials to enhance and improve precocity is rarely reported. Kamariah and Mohamad Isa (1992) reported that there is a potential of using older or advanced planting materials in durian cultivation and the need to be exploited further. This paper evaluates and compares the performance of different ages of grafted durian planting material and the efficiency of the trees to produce early high yield. The main objective of the study was to determine the suitable size and age of planting material for improving durian precocity.

Materials and methods

The study was carried out in a split plot design at MARDI Research Station, Jerangau. Two prominent clones, D24 and D99 were the main plots, while the sub-plots were the different sizes of planting material. The sizes of the planting material ranged from 0.64–2.53 cm in diameter (calliper size), which were equivalent to 6-month, 12-month, 18-month, 24-month and 30-month-old grafted seedlings. Each treatment plot consisted of three experimental trees and was replicated six times.

Seedlings for rootstocks were raised in the MARDI nursery at intervals of 6 months, between October 1989–1991. The seed-stock *(Durio zibethinus)* was collected from all sources of variation in Peninsular Malaysia and they were raised for 3 months before rootstocks were grafted. Bud graftings were carried out at intervals of 6 months in January 1990, June 1990, January 1991, June 1991 and January 1992 so that different sizes of planting material were produced. Scions of D24 and D99 were taken from the budwood nursery at MARDI Jerangau and were taken from the same mother plant. Grafted materials were raised in the nursery for 6–30 months beginning from January 1990 until January 1992. For planting materials that were grafted in January 1990 and kept longer (i.e. more than 18 months) in the nursery, polybag sizes were changed accordingly. The summary for the different treatment dates of grafting and polyethylene sizes are shown in *Table 1.*

Field planting

All treatment trees were field planted in July 1992 and given equal management practices. Prior to field planting, tree calliper size was taken and by August 1992, their initial girth size measurements (circumference) were recorded. The subsequent tree girth size measurements were recorded at 4 monthly intervals until December 1997 so that tree growth rates (cm/month) of both clones were calculated from the monthly increments of tree circumference. The number of trees that flowered and set into fruits were also monitored. Flowering dates were recorded in May while fruiting dates in August for the years 1995–1998. The number of trees that survived after field establishment was recorded in August 1993, i.e. 12 months after planting. All the data collected were statistically analysed using Analysis of Variance (ANOVA) using SAS statistical analysis package.

Table 1. Individual age of durian planting material, rootstock preparation, grafting date and polybag size

Treatment (age of planting material)	Rootstock raising (date)	Grafting date	Planting date	Polybag size (cm)
6 months	Oct. 1991	Jan. 1992	July 92	22 x 29
12 months	Mar. 1991	June 1991	July 92	22 x 29
18 months	Oct. 1990	Jan. 1991	July 92	32 x 37
24 months	Mar. 1990	June 1990	July 92	32 x 37
30 months	Oct. 1989	Jan. 1990	July 92	37 x 44

Table 2. Tree initial size and survival of durian trees at 12 months after field establishment

Variables		Initial tree calliper size[1] (cm)	Tree survival (%)
Clone	Treatment		
D24	6-month	0.64	100.0a
	12-month	1.10	88.7a
	18-month	1.93	77.7a
	24-month	2.45	61.0b
	30-month	2.43	88.7a
	Mean	1.71	83.2
D99	6-month	0.71	100.0a
	12-month	0.97	94.3a
	18-month	1.40	100.0a
	24-month	2.01	88.7a
	30-month	2.53	100.0a
	Mean	1.52	96.60

[1]Diameter of tree trunk measured at 2 cm above tree union
Values with the same letter are not significantly different at $p \leq 0.05$

Results and discussion

Tree survival

The survival rate of D99 was significantly higher as compared to D24, although the initial girth of D24 was bigger than D99 *(Table 2)*. Regardless of initial calliper sizes, Zainal Abidin and Nik Masdek (1992) reported that D99 has good field establishment characteristics compared to other cultivars, which is only 50%, and possesses better ability to withstand prolong water stress than D24 (Masri 1992). Moreover, the percentage of tree survival was also significantly lowest in the 2.45 cm calliper size (24-month planting materials) in D24 but not in D99, again indicating the establishment difficulty in D24 (Ghani 1988). Thus, these factors probably explain the higher survival rate of D99.

Askew et al. (1994) reported that a suitable range of tree size for most tree transplanting is probably between 1.2–2.4 cm calliper sizes. If a tree calliper size is allowed to grow more than 2.4 cm, then the tree establishment will be unsatisfactory because the root system was inevitably damaged during transportation and transplanting. Similarly, Ghani (2000) reported that durian planting materials with tree calliper size of 1.5 cm has a very good survival rate of 100% in the field.

In this study, there was a negative trend between survival rate and tree calliper size of planting materials for D24 during establishment *(Figure 1)*, the bigger the tree calliper size, the lower the survival rate. Indeed, small plant survived almost 100% for both D24 and D99, but the trend was very weak ($R^2 = 0$) for D99. In contrast to studies by Ghani (1988), the survival rate of smaller planting materials of less than 2.50 cm girth size (equivalent to 0.80 cm calliper size) was 35% while those bigger than 3 cm girth size (0.96 cm calliper size) was 75% after 18 months of establishment.

The planting materials accessed in the study were from the same age group. Smaller tree are actually weaker and naturally will not survive as good as bigger tree within the same age category. Abd. Jamil and Ghani (1991) stressed that smaller plant within a similar plant age group should be omitted for field planting in durian.

Besides tree size, there are some other factors which could influence tree survival, such as quality of planting material, nursery management practices, soil and weather

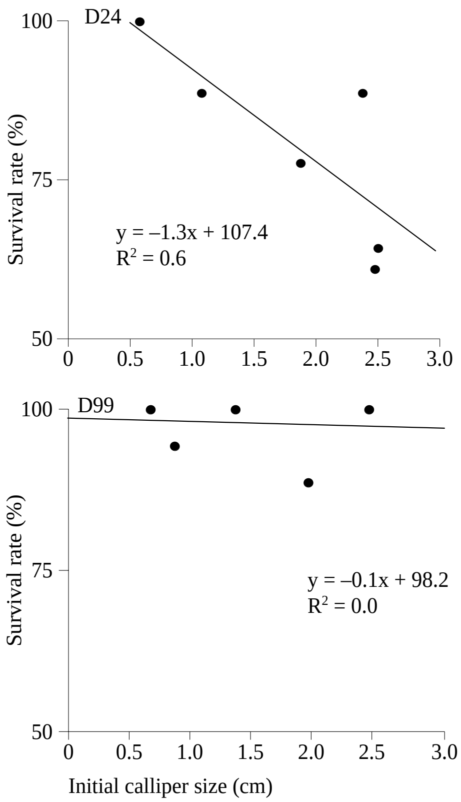

Figure 1. Correlation of tree calliper size to survival rate for D24 and D99

conditions as was widely discussed by Ghani (1988), Abd. Jamil and Ghani (1991) and Rushidah et al. (2002). Anon. (2001) reported that most tree deaths are water related. In durian, too much or too little water are both detrimental (Abd. Jamil and Ghani 1991). Therefore, understanding of water requirement is essential for successful tree establishment.

Tree growth

Tree growth for both D24 and D99 clones as affected by the various sizes of planting material, was calculated as the monthly increments of tree circumference (cm/ month) *(Table 3)*. The growth rates of both clones were of no significant difference at all stages although at the beginning of the study the calliper size of D24 was bigger than D99, as indicated by their respective sizes of 1.71 and 1.52 cm. Although not significant, in all the growing periods observed, the growth rate of D24 showed a trend of higher values than D99 after 24 months of establishment, thus expressing the vigorous growing characteristics of D24.

For D24, the highest growth rate was achieved from 2.0 cm calliper size tree (18-month planting materials) beginning from

Table 3. Crop growth rates for D24, D99 and various planting materials at 12 monthly intervals (Aug.1992–Dec. 1997)

Variables	Tree calliper size (cm)	Initial girth size (cm)	Total girth increment (cm)[1]	Tree growth rates at time interval (months after planting)				
				12	24	36	48	60
*Clone								
D24	1.71	5.37	44.50	0.44a	0.73a	0.74a	0.75a	0.75a
D99	1.52	4.77	44.90	0.49a	0.66a	0.70a	0.72a	0.69a
**Treatment								
6-month	0.68	2.12	49.98	0.51ab	0.76ab	0.78ab	0.81a	0.78a
12-month	1.04	3.25	47.98	0.47abc	0.69bc	0.73bc	0.78a	0.75a
18-month	2.00	5.05	53.57	0.59a	0.82a	0.86a	0.87a	0.84a
24-month	2.23	7.00	41.37	0.42bc	0.64dc	0.66c	0.66b	0.65b
30-month	2.48	7.79	38.3	0.36c	0.56d	0.56c	0.58b	0.57b

Values with the same letter are not significantly different at $p \leq 0.05$
*Means of 30 observations
**Means of 12 observations
[1]At Dec. 1997

16 months after planting (MAP), became highest at 32 MAP and then constant onwards *(Figure 2)*. In contrast to the biggest calliper size tree of 2.48 cm (30-month-old planting materials), the growth rate was highest at 28 MAP and became constant onwards. For D99, again 2.0 cm calliper size tree had the highest growth rates as compared to all other tree sizes. However, their growth rate increments were quite gradual whereby highest growth rate was achieved at 42 MAP. In this D99 clone, the slowest growing trees were the bigger sized calliper trees similar to D24 clone.

At the beginning of the study, girth size of all planting materials was significantly different. But at 12 MAP, the growth rate of tree calliper size of 2.0 cm and less (i.e. 6-

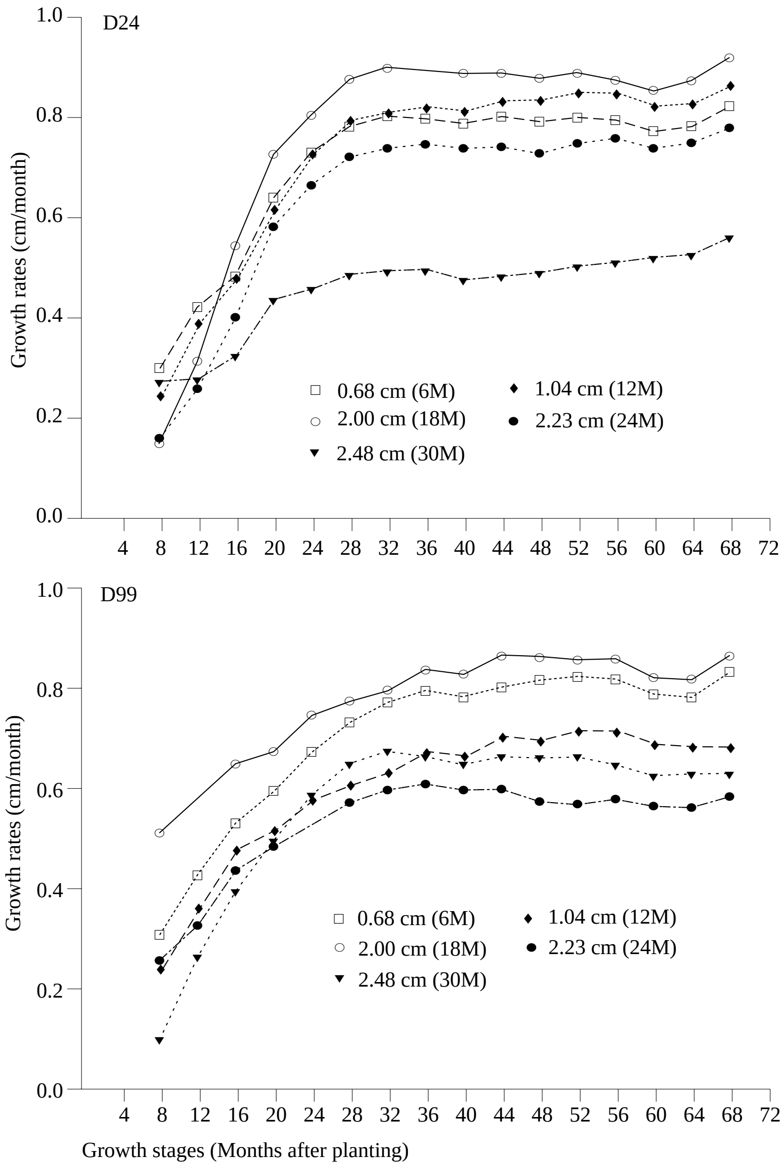

Figure 2. Crop growth of various planting materials for D24 and D99 clones beginning from December 1992–1997

month, 12-month and 18-month planting materials) were significantly higher than trees with calliper size of more than 2.23 cm (i.e. 24-month and 30-month planting materials) *(Table 3)*. The highest growth rate was exhibited in the plants with 2.0 cm calliper size (18-month planting materials) throughout the growing periods recorded.

However, this was not significantly different from the planting materials with calliper size of 1.04 cm or less (6 or 12 months). After 24 months in the field, the growth rate was always more than 0.8 cm/month and this continued on until 60 months. The highest total girth increment at 60 MAP was also achieved by the 2.0 cm tree calliper size (18-month planting materials), which was 53.57 cm. This clearly indicated that planting materials with calliper size of 2.0 cm and less (18 months and below) were more vigorous and were fast growing in the field. The bigger planting materials grew slower and attained highest growth rate faster. This was probably due to earlier alteration of tree assimilate from vegetative to reproductive development. This incident coincided with the first flowering, i.e. at 36 months after field planting which was recorded during the study *(Table 4)*.

In apples, the tree growth rate is related to the initial girth size or calliper size. The larger the initial tree size, the better the tree growth and productivity (Robinson and Stiles 1996). In apples, the first criterion for choosing quality trees for field planting is the number of feathers (branches) followed by the calliper tree size of 1.53–1.68 cm. The younger apple trees bear almost as soon, are easier to keep alive, and develop into more-healthy, vigorous trees than the oversized stock (Relf 2000).

In this study, the initial calliper size also influenced tree vigour. Smaller calliper size trees (≤2.0 cm) were more vigorous than bigger trees (calliper size >2.0 cm). Therefore, in durians, for both D24 and D99 clones, planting materials with calliper size 2.0 cm is a better choice for field planting.

Table 4. Percentage of durian trees that flowered after 3 years of establishment (1995–1998)

	Percentage of trees that flowered in year			
Treatment	1995	1996	1997	1998
6-month	–	–	25.0	30.5
12-month	–	12.9	27.0	69.5
18-month	–	13.3	37.5	65.0
24-month	3.2	3.7	43.5	82.5
30-month	–	9.7	4.5	23.5
Mean	3.2	7.92	27.5	54.2

Means of clones D24 and D99 from 12 observations

Flowering and fruiting

Different calliper tree sizes had some effects on the flowering activity of durian trees. Trees started to bear their first flowers as early as 3 years after planting but without fruit set *(Table 4)*. However these were not the effect of different sizes or ages of planting materials. As the age of the trees got older, more trees produced flowers but still no specific trend among the different treatments.

After the third and fourth year (1995 and 1996) of planting, only 3.2% and 7.92% of the respective trees flowered. All the flowers had no fruit set. Five years after planting (1997), 27.5% of trees started to bear flowers and only a very small quantity developed into fruits *(Table 5)*. By the sixth year (1998), 54.2% of the trees bore flowers and developed into fruits. Fruiting was significantly heavier in D99 clones and tree calliper size of 2.0 cm (18 months). The interesting part was, although trees originating from different clones and tree calliper sizes did not show any relatively precocious or heavy flowering, D99 and 2.0 cm tree calliper size produced significantly highest fruit number, 19 and 23 fruits respectively.

Flowering in durian can be affected by many factors. Previous studies have indicated that chemically induced trees are able to produce abundant flowers 3 years after establishment, but without fruit set (Rushidah 1999). Flowering and fruit set are

Table 5. Flowering habit and fruit number for different ages of durian planting materials in year 1997 and 1998

Variables	Flowering trees within a plot (no.)		Fruit number/tree	
	1997	1998	1997	1998
Clone*				
D24	1.46a	1.45a	0.00a	3.65b
D99	1.42a	1.88a	0.78a	18.49a
Treatment**				
6-month	1.50a	1.75a	0.00a	11.58b
12-month	1.16a	1.70a	1.50a	9.73b
18-month	1.71a	1.80a	0.00a	22.96a
24-month	1.42a	1.58a	0.28a	2.18b
30-month	1.00a	1.25a	0.00a	2.87b

Values with the same letter are not significantly different at $p \leq 0.05$
*Means of 30 observations
**Means of 12 observations

highly influenced by water stress (Masri 1999), either too much or too little, both are detrimental. Durian is a heavy flowering tree, but less than 0.1% of the flower set and developed into fruits. There are also other factors that could have influenced the trees to bear flowers and set, such as the relationship of biannually to weather changes. Abd Razak et al. (2000) reported that changes in environmental elements influence flowering. Moreover, source-sink relationship and fruit load can have very big influence in durian fruit development (Salakpeth et al. 1992).

Conclusion

Tree survival after field establishment did not depend on calliper size in D99 but for D24, bigger calliper size tended to reduce the survival rate. Although growth of D24 and D99 was similar at all stages of tree development, D99 had better survival rate when transplanted into the field. Besides tree calliper size, there are some other related factors that might contribute to the tree survival rate upon establishment such as management practices in the nursery and also during transplanting.

Age of planting materials may play an important role in tree vigour, but size of initial tree calliper is more important. In durian, tree calliper size of 0.67–2.0 cm (6–18 months old) was the optimum requirements for precocity while tree with calliper size of 2.0 cm or 18-month-old planting material seemed to have the highest growth rate and tree vigour and was able to produce better fruit set and fruit number. The mean fruit number recorded was 23 fruits.

Other advantages of using smaller calliper size trees are that tree handling in the nursery is much easier, a smaller space area is required and shorter time period is needed in raising those materials which is only 18 months. During the short time period, casualties can be reduced and risk lowered. Whereas bigger calliper size tree of more than 2.23 cm had slower growth rate and low fruit set. Raising bigger planting materials are non-economic since cost of maintenance is increased and a wider space is required and therefore higher risk and casualties.

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Abstrak
Perkembangan tumbesaran serta pembuahan bagi bahan tanaman durian pelbagai saiz (saiz diameter batang 0.64–2.53 cm) yang berumur antara 6–30 bulan selepas cantuman telah dikaji. Saiz bahan tanaman yang paling sesuai ditentukan bagi meningkatkan prekositi dan seterusnya mengurangkan fasa juvana dalam tanaman durian. Percubaan dijalankan di Stesen MARDI Jerangau bermula pada 1992, menggunakan durian klon D24 dan D99. Tumbesaran pokok telah dipantau dan data yang direkod ialah ukur-lilit batang, pembungaan dan hasil buah selama 6 tahun selepas dipindah ke ladang.

Tumbesaran kedua-dua klon D24 dan D99 cergas, tetapi peratus kemandirian klon D99 adalah lebih tinggi selepas setahun di ladang serta menghasilkan lebih banyak buah berbanding dengan D24. Saiz bahan tanaman memberi kesan negatif terhadap kemandirian durian di ladang, iaitu semakin besar saiz batang semakin menurun kadar kemandirian. Pembungaan pertama dikesan pada sebahagian bahan tanaman selepas 3 tahun durian ditanam di ladang tetapi tanpa menghasilkan buah. Selepas 5 tahun di ladang, semua pokok berbunga dan mengeluarkan buah. Keputusan menunjukkan bahawa bahan tanaman bersaiz 2.0 cm diameter mempunyai kadar tumbesaran yang paling tinggi serta cergas, dan saiz batang yang optimum bagi meningkatkan prekositi. Ia juga menghasilkan bilangan buah paling banyak iaitu 23 biji.

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